
ICG
International Commission on Glass
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WELCOME

ICG
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Dr. Manoj Choudhary
P.E., F.S.G.T., F. Am. Cer. Soc.

President, International Commission on Glass
Owens Corning Science and Technology
2790 Columbus Road, Route 16, Granville,
OH 43023, USA

On behalf of the International Commission on Glass (ICG) and myself, I am delighted to extend a warm welcome to you to the 2017 ICG Annual Meeting and the 32nd Şişecam Glass Symposium being held in Istanbul, Turkey during October 22-25.

I am privileged to know many colleagues in Şişecam and have attended several technical meetings organized by them. I, therefore, know first-hand their exceptional organizational capability and warm and generous hospitality. I can say with complete confidence that the upcoming events will impress you in every respect be it the technical program, the logistics, or the social dimensions. The city of Istanbul, world-renowned for its history, culture, and architecture, and the conference venue, the HALİÇ CONGRESS CENTER, located on the banks of the Golden Horn (Haliç) estuary, provide a perfect ambiance to discuss and share the latest developments in glass science and technology and to combine 'business with pleasure'.

I am convinced that the meetings will be an important forum for exchanging ideas, advancing knowledge, and promoting collaboration among the members of the global glass community. It will also be an excellent venue for renewing old friendships and establishing new ones.

On behalf of my colleagues in the ICG Management Board and myself, I offer you our most cordial greetings and best wishes and look forward to seeing you in Istanbul.

(Manoj Choudhary)

Prof. Dr. Ahmet Kırman
Vice Chairman and Chief Executive Officer

Türkiye Şişe ve Cam Fabrikaları A.Ş.
İçmeler Mah., D100 Karayolu Cad. 44A, 34947, Tuzla, İstanbul, Türkiye

It is a great pleasure for me to host 2017 ICG Annual Meeting to be held in conjunction with the 32nd Şişecam Glass Symposium in Istanbul, Turkey on October 22-25th 2017 and to invite glass scientists and technologists from many different parts of the World to Istanbul.

The International Congress on Glass conferences helps to enable and intensify a close contact between all experts from science, engineering and industry for disseminating recent developments on glass science and technology and creating a network for global cooperation among glass scientists and technologists for collaborative research on future trends.

To support that purpose, ICG 2017 Istanbul features ways to assist, especially younger researchers' attendance at national and international level. We hope that young generation of glass scientist will effectively use that opportunity.

Scientific programme covers seventeen different session topics in 3 days on 5 parallel sessions, with relevant keynote and invited presentations on emphasized subjects digitalization and sustainability, and selection of advanced technical and scientific papers will provide the attendees a broad insight on todays and future directions of glass research. Innovative glass manufacturing technologies, new functionality in glass for future applications, advanced glasses and functional coatings are the significant highlights. Detailed workshops on specific topics with expert participation and ICG Technical Committee meetings will take place and status of the continuing collaborative research will be presented.

ICG congress is also a good source of information for engineering and technology suppliers of glass industry in every field of glass manufacturing and science to follow future trends, acknowledge requirements and to better serve global glass industry.

I would like to thank the conference organizing committee for their competent work in setting up the programme. I hope that all participants will enjoy attending the conference and visiting our historical city Istanbul.

Prof. Dr. Ahmet Kırman

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Committees

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Lobomir Nemec *(ICT, CZ)*
Macit Özenbaş *(Middle East Technical Univ, TR)*
Abdullah Öztürk *(Middle East Technical Univ, TR)*
Lütfi Özyüzer *(IYTE, TR)*
Carlo Pantano *(Penn State Univ, US)*
John Parker *(Sheffield Univ, UK)*
Mehmet Parlak *(Middle East Technical Univ, TR)*
Alphan Sennaroğlu *(Koc Univ, TR)*
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Hakan Urey *(Koc Univ, TR)*

Local Organizing Committee

Mustafa Oran
Melek Orhon
Hande Sesigür
Hakan Sesigür
İlkay Sökmen
Atilla Ünsal

Conference Secretariat

Semih İşevi
Ebru Çelebi
Fatma Aksu Arıuçar

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Meeting, Special Session & Event Schedule

Sunday, October 22nd, 2017

15:00 – 18:00	Registration
16:00 – 18:00	ICG Coordinating Technical Committee Meeting / Cibali 1
16:00 – 18:00	ICG Technical Committee 14 Meeting (Gases in glass) / Cibali 3

Monday, October 23rd, 2017

08:30 – 09:30	Opening Ceremony
09:30 – 10:00	Award Ceremony
16:00 – 19:00	ICG Coordinating Technical Committee – Business Meeting / Marmara
16:30 – 17:30	Panel: EU Environmental Issues / Sadabad Adeline Farrely, Felice Simonelli, Katalin Zaim, Yüksel Soykut, Haluk Erdem, Tunç Görüney
19:00	Welcome Reception / Sadabad Foyer

Tuesday, October 24th, 2017

08:00 – 10:30	ICG Steering Committee Meeting / Cibali 1
08:30 – 16:30	ICG Technical Committee 02 Meeting (Durability and Analysis) / Cibali 2
08:30 – 10:00	Workshop : Ion Exchange / Marmara Guglielmo Macrelli
14:00 – 15:30	The William R. Prindle Memorial Session / Sadabad Alica Duran, Manoj Choudhary, David Pye, Helmut Schaeffier, Alev Yaraman, Fabiano Nicoletti
15:45 – 18:45	ICG Council Meeting / Marmara
17:20 – 18:40	Glass Trend Council Meeting / Kasımpaşa 4-5
19:30	Gala Dinner / Hotel CVK Bosphorus

Wednesday, October 25th, 2017

08:30 – 10:00	ICG Youth Outreach Session / Marmara
08:30 – 10:30	ICG Technical Committee 02 Meeting (Durability and Analysis) / Cibali 2
08:30 –10:30	ICG Technical Committee 11 Meeting (Refractories) / Kasımpaşa 3
10:30 –13:00	ICG Technical Committee 09 Meeting (Energy Efficiency) / Marmara
10:30 – 12:30	Closing Ceremony / Sadabad Alev Yaraman, Manoj Choudhary

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Program at a Glance

Sunday, October 22nd, 2017

15:00-18:00	REGISTRATION
16:00-18:00	CTC MEETING
16:00-18:00	TC 14 MEETING

Monday, October 23rd, 2017

07:30-08:30	REGISTRATION
08:30-10:00	WELCOME / OPENING CEREMONY / AWARD CEREMONY
10:00-10:40	PLENARY SESSION
10:40-11:10	COFFEE BREAK
11:10-12:30	PLENARY SESSION
12:30-14:00	LUNCH
14:00-16:00	GLASS STRUCTURE & PROPERTIES
	COATINGS
	ION EXCHANGE / CHEMICAL TEMPERING
	FURNACE MODELING & SENSORS
	BIOMATERIALS
16:00-16:30	COFFEE BREAK
16:00-19:00	CTC BUSINESS MEETING
16:30-17:30	PANEL – EU ENVIRONMENTAL ISSUES
17:30-18:40	GLASS STRUCTURE & PROPERTIES
	COATINGS
	ION EXCHANGE / CHEMICAL TEMPERING
	FURNACE MODELING & SENSORS
	OPTO-ELECTRONICS
19:00	WELCOME RECEPTION

Tuesday, October 24th, 2017

08:30-10:10	GLASS STRUCTURE & PROPERTIES
	COATINGS
	GLASS PRODUCTION (GLASS TREND)
	ENERGY & ENVIRONMENT
	ICG STEERING COMMITTEE MEETING
	ION EXCHANGE WORKSHOP
	TC 02 MEETING
10:10-10:40	COFFEE BREAK
10:40-12:30	GLASS STRUCTURE & PROPERTIES
	COATINGS
	GLASS PRODUCTION (GLASS TREND)
	REFRACTORIES
	FIBER GLASSES
	GLASS PROCESSING
	TC 02 MEETING
12:30-14:00	LUNCH
14:00-15:30	THE WILLIAM R. PRINDLE MEMORIAL SESSION
15:30-16:00	COFFEE BREAK
15:45-18:45	ICG COUNCIL MEETING
16:00-17:30	GLASS STRUCTURE & PROPERTIES
	SURFACE
	GLASS PRODUCTION (GLASS TREND)
	NUCLEATION & CRYSTALIZATION
	NUCLEAR WASTE VITRIFICATION
	TC 02 MEETING
17:20-18:40	GLASS TREND COUNCIL MEETING
17:30-18:30	POSTER SESSION
19:30	GALA DINNER

Wednesday, October 25th, 2017

08:30-10:00	GLASS STRUCTURE & PROPERTIES
	COATINGS
	RAW MATERIALS
	MELTING TECHNOLOGIES
	FUNCTIONAL GLASSES
	YOUTH OUTREACH
	TC 02 MEETING
	TC 11 MEETING
10:00-10:30	COFFEE BREAK
10:30-13:00	TC 09 MEETING
10:30-12:30	CLOSING CEREMONY

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Scientific Program

Sunday, October 22nd

15:00-18:00	**REGISTRATION**
16:00-18:00	**CTC MEETING**
16:00-18:00	**TC 14 MEETING**

Monday, October 23rd

07:30-08:30	**REGISTRATION**
08:30-09:30	**Welcome / Opening Ceremony** Hall: Sadabad Auditorium
09:30-10:00	**Award Ceremony** Hall: Sadabad Auditorium
10:00-10:40	**Hubertus Böhm** *How the Glass Industry Takes Advantage of Digitalization* Hall: Sadabad Auditorium
10:40-11:10	**Coffee Break**
11:10-11:50	**Julian Jones** *Bioglass: From Hench to Bouncy Hybrids* Hall: Sadabad Auditorium
11:50-12:30	**Lothar Wondraczek** *Smart Glasses In Large-Area Fluidic Windows and Suspended Particle Devices for Facade Integration* Hall: Sadabad Auditorium
12:30-14:00	**Lunch**

Parallel Sessions

GLASS STRUCTURE & PROPERTIES
Hall: HASKÖY
Chair: **Hiroyuki Inoue**

14:00-14:30	**Hiroyuki Inoue, Takayoshi Koizumi, Yoshihiro Watanabe, Atsunobu Masuno, Invited Speaker** *Fluorescence and Structure of Divalent Eu Ions in Borate Glasses*
14:30-14:50	**Yevgeniy Sgibnev, Dmitriy Marasanov, Nikolay Nikonorov, Alexander Ignatiev** *Luminescent Properties of Silver Ion-Exchanged Aluminosilicate Glass Doped with Eu3+ Ions*
14:50-15:10	**Elena Kolobkova, Bo Min Dinh, Nikolay Nikonorov** *Fluorine Phosphate Glasses with High Fluorine Concentration Doped with Er3+–Yb3+ and Nd3+Ions*
15:10-15:30	**Atsunobu Masuno, Yasuhiro Watanabe, Masaki Azuma, Yutaka Yanaba, Hiroyuki Inoue** *Optical and Magnetic Properties of Binary Rare Earth Borate Glasses*

15:30-15:50 **Jong Heo, Wonji Park, Woon Jin Chung**
Analysis of the Rare-Earth Ion Clusters in Glasses and Their Effects on the Optical Properties of PbS Quantum Dots

COATINGS
Hall: KASIMPAŞA-1,2
Chair: **Reha Akçakaya**

14:00-14:30 **Claes-Göran Granqvist, Invited Speaker**
Electrochromic Glazing for Energy Efficient Buildings: Fundamentals, Current Technology, Recent Progress and Prospects

14:30-15:00 **Bernd Szyska, Invited Speaker**
From Bytes to Atoms – Modelling of Thin Film Processes for Large Area Glazing

15:00-15:30 **Peter Sieck, Invited Speaker**
Modern Large Area Glass Coatings by Magnetron Sputtering

15:30-15:50 **Yasemin Demirhan, Hurriyet Yüce, Merve Akkaya, Hakan Altan, Lütfi Özyüzer, Gülnur Aygün**
Modification of Tunable THz Filters Fabricated from Vanadium Dioxide Thin Films

15:50-16:10 **Lukas Simurka, Tuncay Turutoğlu, Gence Bektaş, Radim Ctvrtlik, Klaus Bange,**
Mechanical Properties of Sputtered Oxide Thin Films Deposited on Glass

ION EXCHANGE / Chemical Tempering
Hall: KASIMPAŞA-4,5
Chair: **Cemil Tokel**

14:00-14:30 **Guglielmo Macrelli, Invited Speaker**
Advances in Mathematical Modeling of Chemically Strengthened Glass by Ion Exchange: Concentration Depth Profile and Residual Stress

14:30-14:50 **Peter Sundberg, Lina Grund Bäck, Robin Orman, Simon Johnson, Jonathan Booth, Stefan Karlsson**
Novel Thermo-Chemical Strengthening of Glass for Solar Energy Applications and its Impact on the Physical Properties

14:50-15:10 **Salih Erserin, Aslı Özel, Duygu Güldiren, İpek Erdem, Süheyla Aydın**
Strengthening of Soda Lime Glasses Using Molten Salt Bath and Salt Paste Applications via Ion Exchange

15:10-15:30 **İpek Erdem, Duygu Güldiren, Süheyla Aydın**
Variations in the Application Methods of Ion Exchange for Chemical Strengthening Purposes

15:30-15:50 **Meryem Sarıgüzel, Melis Can Özdemir Yanık, Yusuf Öztürk, Esin Günay**
Characterization of Silver Nanoclusters in Soda Lime Silicate Glass Developed by Ion Exchange Process

	FURNACE MODELING & SENSORS Hall: BALAT ***Chair:*** **Abdullah Kılınç**
14:00-14:30	**Jörg Leicher, Invited Speaker** *The Impact of Higher Hydrogen Concentrations in Natural Gas on Industrial Combustion Processes*
14:30-14:50	**Bruno Malphettes, Fatih Mehmet Güçlü, Çağlar Altun, Michel Gaubil, Isabelle Cabodi, Thibaut Champion, Hazal Bal** *Glass Furnace Regenerators: Benefits of Design Optimization and Feedback from Industrial Experience.*
14:50-15:10	**Burçin Gül, Merve Durubal** *A Numerical Investigation for the Effect of the Electric Boosting in an Oxy Fuel Fired Glass Fiber Furnace*
15:10-15:30	**Faizan P. Siddiqui, Kaan Menekşedağ, Altuğ Melik Başol, Pınar Mengüç, Adnan Karadağ,** *Towards Real-Time Continuous Annealing Furnace Simulations via Hybrid GPU - CPU Approach*
15:30-15:50	**Marcela Jebavá, Lubomír Němec, Jiří Brada** *Improvements of Glass Melt Flow in Container Furnace*
	BIOMATERIALS Hall: CİBALİ-1 ***Chair:***
14:00-14:20	**Ayse Özyuğuran Arifoğlu, Ayşen Aktürk, Özlem Tuğçe Şahin, Sadriye Küçükbayrak** *Comparison of 3D Scaffolds Containing Cu-Doped Bioactive Glass and Sr-Doped Bioactive Glass with Cu Nanoparticles*
14:20-14:40	**Ayşen Aktürk, Melek Erol Taygun, Gültekin Göller, Sadriye Küçükbayrak** *An Optimization Study to Fabricate Fibrous Nanocomposite Scaffolds Containing Silver Nanoparticles and Bioactive Glass*
14:40-15:00	**Azade Yelten, Suat Yilmaz** *Preparation and Characterization of Alumina-Hydroxyapatite-Bioactive Glass Composites*
15:00-15:20	**Ashok Mohan Adur** *Using ZeMac® Copolymers to Modify Surface Chemistry of Glass Fibers to Improve Performance of GF-Reinforced Polyamides*
16:00-16:30	**Coffee Break**
16:00-19:00	**CTC BUSINESS MEETING** Hall: MARMARA

16:30-17:30 **PANEL: EU ENVIRONMENTAL ISSUES**
Hall: Sadabad Auditorium
Panelists:
- **Adeline Farrely** (FEVE),
- **Felice Simonelli** (CEPS),
- **Katalin Zaim** (Şişecam),
- **Yüksel Soykut** (Paşabahçe),
- **Haluk Erdem** (Paşabahçe),
- **Tunç Görüney** (Şişecam)

Parallel Sessions

GLASS STRUCTURE & PROPERTIES
Hall: HASKÖY
Chair: **Mustafa Oran**

17:30-17:50 **Shinji Kohara, Osami Sakata, Koichi Tsuchiya, Yohei Onodera, Shuta Tahara, Yasuaki Hiraoka**
Understanding Diffraction Patterns from Glass, Liquid, and Amorphous Materials

17:50-18:10 **Ondrej Gedeon, Tadeas Gavenda, Karel Jurek**
Model Glasses Irradiated with Electron – Macroscopic and Structure Relations

18:10-18:30 **Shigeki Sawamura, Rene Limbach, Lothar Wondraczek**
Lateral Deformation and Scratching of Compacted Silica Glasses

COATINGS
Hall: KASIMPAŞA-1,2
Chair: **Koichi Suzuki**

17:30-18:00 **Koichi Suzuki, Invited Speaker**
Noteworthy Dry Coating Technologies for Large Area & High Volume Glass Related Products

18:00-18:20 **Jens Birch, Bo Jonson, Per Eklund, Sharafat Ali,**
Synthesis and Properties of Vitreous Thin Films Based on M2+ or M3+ Modified Silicon Oxynitrides

18:20-18:40 **Özge Bayraklı, Hasan Hüseyin Güllü, Makbule Terlemezoglu, Mehmet Parlak,**
Optimizaton of the Fabrication Process for Al-doped ZnO Thin Films on Soda Lime Glass Substrates by Thermal Heating

ION EXCHANGE / Chemical Tempering
Hall: KASIMPAŞA-4,5
Chair: **Süleyman Koç**

17:30-17:50	**Berkel Kayacan, Caner Kayaalp, Nahide Özben, Pelin Akkaya, Cevher Tol, Semin Atılgan, Burcu Öğüt, Lukas Simurka, Erdem Atar, Miray Çelikbilek Ersundu, İlkay Sökmen** *Ion Exchange Strengthening of Glasses: Influence of Glass Composition and Thickness*
17:50-18:10	**Melis Can Özdemir Yanık, Meryem Sarıgüzel, Yusuf Öztürk, Esin Günay** *Effect of Silver-Sodium Ion Exhange on Mechanical and Surface Properties of Soda Lime Silicate Glass*
	FURNACE MODELING & SENSORS Hall: BALAT ***Chair:*** **Mathew Hyre**
17:30-18:00	**Mathew Hyre, Invited Speaker** *Progress and Limitations to Glass Container Forming Modelling for Virtual Sampling and Mold Design*
18:00-18:20	**Hazal Özcan** *A Numerical Investigation of Thermal Tempering of Deep Hollow Glassware*
18:20-18:40	**Adrià Biosca Mecías, Salvador Borrós, Vicenç Pedret Clemente, Andrés-Amador García Granada** *Polyflow Validation of Gob Drop Test*
	OPTO-ELECTRONICS Hall: CİBALİ-1 ***Chair:*** **Tunç Görüney**
17:30-17:50	**Martin Mika, Frantisek Lahodny, Kristyna Rysova** *Electro-Optic Glass for Infrared Modulators*
17:50-18:10	**Suat Kurt, Syed Sultan Shah Bukhari** *Chalcogenide Glass Based Integrated Photonics*
18:10-18:30	**Jan Mrazek, Ivan Kasik, Michal Kamradek, Jan Aubrecht, Ondrej Podrazky, Ivo Barton, Vlastimil Matejec, Pavel Peterka** *Sol-Gel Route to Holmium-Doped SiO2-GeO2 Glasses for Photonic Applications*
19:00	**Welcome Reception**

Tuesday, October 24th

Parallel Sessions

GLASS STRUCTURE & PROPERTIES
Hall: HASKÖY
Chair: **Dusan Galusek**

08:30-09:00 **Dusan Galusek, Invited Speaker**
Crystallization of Aluminate and Aluminosilicate Glasses

09:00-09:20 **Claudia Gonçalves, Raphaël Mereau, Eric Furet, Michaël Deschamps, Laurent Le Pollès, Claire Roiland, Pierre Florian, Lila Bouëssel du Bourg, Virginie Nazabal, Catherine Boussard-Pledel, Marc Dussauze, Bruno Bureau**
Telluride Glasses as Materials for Far-Infrared Applications: A Theoretical and Spectroscopic Investigation

09:20-09:40 **Neşe Güngör, Mustafa Alevli**
Optical Properties of GaN and InN on Quartz Grown by Hollow-Cathode Plasma-Assisted Atomic Layer Deposition

09:40-10:00 **Merve Kutluğ, Duygu Güldiren, Gürkan Yiğiter, Fehiman Akmaz**
Characterization Studies on Selenium Retention in Soda Lime Silicate Glasses

COATINGS
Hall: KASIMPAŞA-1,2
Chair: **Hong Wang**

08:30-09:00 **Hong Wang, Invited Speaker**
High Performance Solar Heat Conversion Coatings with CrNxOy Composite Absorbing Layer

09:00-09:20 **Turgay Çoruhlu, Necdet Aslan, Kenan Şentürk, Tuba Şen**
The Observation of Surface Plasmon Resonance Effect on ITO-Titanium-ITO Multilayer Thin Films on Glass

09:20-09:40 **Elmira Ryabova**
Non-metallic Solar Heat Control Coating for Architectural and Automotive Windows

09:40-10:00 **Evelyne Fargin, Maxime Paraillous, Thierry Cardinal, Angeline Quentin-Poulon, Marc Dussauze**
Hardness Reinforcement by Surface Engineering of Soda Lime Silicate Glass Under Thermal Poling

GLASS PRODUCTION (GLASS TREND)
Hall: KASIMPAŞA-4,5
Chair: **Anne-Jans Faber**

08:30-08:50 **Erik Muijsenberg**
Advantages of an Expert System Full Automatic Control of Glass Feeders

08:50-09:10	**Sandra Fischer, Rongxing Bei, Joaquin de Diego** *Refractory Application for Extreme Firing Condition in the Regenerator of Glass Melting Furnaces*
09:10-09:30	**Mark Bennett** *Infrared Temperature Measurement in the Glass Melt Tank*
09:30-09:50	**Luc Jarry, Xavier Paubel, Taekyu Kang, Tunç Görüney, Neşet Arzan** *Combustion with Oxygen and Natural Gas Preheated at High Temperature: Latest Results and New Development*
	ENERGY & ENVIRONMENT Hall: BALAT ***Chair:*** **Nikola Favaro**
08:30-09:00	**Nikola Favaro, Invited Speaker** *Glass, Emissions and Energy in Europe: an Overview*
09:00-09:30	**Pınar Mengüç, Invited Speaker** *Radiation Transfer for Glass & with Glass*
09:30-09:50	**Terutaka Maehara, Takeshi Yamazaki, Yoji Doi** *Preheating of Glass Batch Briquette*
09:50-10:10	**Alessandro Cortopassi** *All New "OMN" Combustion System for Feeders*
08:30-10:10	**ICG STEERING COMMITTEE MEETING** Hall: CİBALİ-1
08:30-10:10	**ION EXCHANGE WORKSHOP, GUGLIELMO MACRELLI** Hall: MARMARA
08:30-10:10	**TC 02 MEETING** Hall: CİBALİ-2
10:10-10:40	**Coffee Break**

Parallel Sessions

	GLASS STRUCTURE & PROPERTIES Hall: HASKÖY ***Chair:*** **Cristina Siligardi**
10:40-11:10	**Cristina Siligardi, Invited Speaker** *Luminescent Heavy Glasses for Hadron Calorimeter*
11:10-11:30	**Melis Gökçe, Deniz Koçyiğit Uslu, Gözde Burgaz, Aytaç Gürhan Gökçe** *Samarium Doped B2O3-GeO2-Gd2O3 Glasses: Structural, Optical and Photoluminescence Characteristics*
11:30-11:50	**Sena Dayıoğlugil, Nuri Solak** *Improvement of Persistent Phosphorescence Properties of Zinc Borosilicate Glasses with the Addition of Rare Earths*
11:50-12:10	**Michal Kamrádek, Jan Aubrecht, Pavel Peterka, Ondřej Podrazký, Pavel Honzátko, Jakub Cajzl, Jan Mrázek, Václav Kubeček, Ivan Kašík** *Spectroscopic Study of Silica Optical Fibers Doped with Holmium and Thulium*

COATINGS
Hall: KASIMPAŞA-1,2
Chair: **Serkan Şahin**

10:40-11:00 **Kanit Tapasa, Usanee Pantulap, Ekarat Meechoowas, Parida Jumpeerueng**
Synthesis of TEOS-SiO2-OTES Film for Enhancing the Hydrophobic Property and Weathering Durability of Float Glass

11:00-11:20 **Fatma Beyza Yedikardeş, Refika Budakoğlu, Esra Özkan Zayim**
Preparation and Characterization of Scratch and Wear Resistant Anti-Bacterial Hybrid Coatings by Sol-Gel Method

11:20-11:40 **Anıl Özen, Lukas Simurka, Ayşegül Yörür Yıldız, Haluk Erdem, Ferdi Keskin, Umut Enkara, Aslı Topak, Melis Özbirlik, Sevgi Kes**
Golden Touch of MIDAS: Development of Mythology Inspired Decorated Glass that Change Color via Interference Effect

11:40-12:00 **Eren Özmen**
Hydrophobic and Oleophobic Glass Coatings for Using at High Temperatures

GLASS PRODUCTION (GLASS TREND)
Hall: KASIMPAŞA-4,5
Chair: **Sven Kahl**

10:40-11:00 **Anne Jans Faber, O.S. Verheijen**
Routes to CO2 Neutral Glass Melting

11:00-11:20 **Estella Alejandro**
Improving Batch Caking and Melting Properties by Using Calcined Lime. An Industrial Experience

11:20-11:40 **Hande Sesigür, Mustafa Oran, Banu Arslan, Gülin Demirok**
Fining: Impact of Sodium Sulphate and Anthracite in Soda- Lime Silicate Glass

11:40-12:00 **Jaroslav Klouzek, Miroslava Hujova, Richard Pokorny, Seungmin Lee, Joseph Traverso, Michael Schweiger, Albert Kruger, Pavel Hrma**
Gas Evolved Reactions during Conversion of Nuclear Waste Melter Feed to Glass

ENERGY & ENVIRONMENT
Hall: BALAT
Chair: **Rongxing Bei**

10:40-11:00 **Rongxing Bei, Jean-Pierre Meynckens**
Activities of TC 11 - Materials for Furnaces

11:00-11:20 **Simone Tiozzo, Stefano Sanchetti**
Refractory Materials in the Global Market: How to Assess Quality and Defects Generation Potential

11:20-11:40	**Melih Üstün, E. Burak İzmirlioğlu** *Applied Performance Tests of Various Refractory Types for Accurate Selection in Designing Glass Furnaces*
	FIBER GLASSES Hall: CİBALİ-1 ***Chair:*** **Davide Pico**
10:40-11:10	**Davide Pico, Invited Speaker** *In Situ Thermoplastic Coating of Melt Spun Glass Fibres*
11:10-11:40	**Bekir Karasu, Invited Speaker** *Investigations On Reinforcing Concrete (Gfrc) Materials With Smfmzs (SrO-Mn2O3-Fe2O3-MgO-ZrO2-SiO2) System Glass Fibres*
11:40-12:00	**Gözdem Dittel, Till Arne Quadflieg, Andreas Koch, Thomas Gries** *Textile Reinforcements Made of Alkali Resistant Glass Rovings in Concrete Structures*
	GLASS PROCESSING Hall: MARMARA ***Chair:*** **Jorma K.J Vitkala**
10:40-11:10	**Bernard Poumellec, Invited Speaker** *Femtosecond Laser Induced Crystallization from Glasses.*
11:10-11:40	**Jorma K.J Vitkala, Invited Speaker** *Worldwide Glass Market and Trends – Summary from GPD 2017*
11:40-12:00	**Hamit Kalaycıoğlu, Ö. Akçaalan, P. Elahi, P. Deminsky, Ş.G. Karamuk, F. Ömer Ilday** *Ablation-Cooled Laser-Material Removal and its Application to Glass Cutting*
12:00-12:20	**Serkan Çakır** *Expert Optical Coating Inspection Solutions*
10:40-12:20	**TC 02 MEETING** Hall: CİBALİ-2
12:30-14:00	**Lunch**

14:00-15:30	**The William R. Prindle Memorial Session** Hall: Sadabad Auditorium **Alicia Duran** *President Elect, Spain* *Welcome and Program Summary* **Laudations** **Manoj Choudhary** *ICG President, USA* **L. David Pye** *ICG President, USA (1997 - 2000)* **Helmut Schaeffer** *ICG President, Germany (2000 - 2003)* **Alev Yaraman** *ICG President, Turkey (2003 - 2006)* **Fabiano Nicoletti** *ICG President, Italy (2009 - 2012)* **Alicia Duran** *Closing remarks*
15:30-16:00	**Coffee Break**
15:45-18:45	**ICG COUNCIL MEETING** Hall: MARMARA
16:00-17:30	**TC 02 MEETING** Hall: CİBALİ-2

Parallel Sessions

GLASS STRUCTURE & PROPERTIES
Hall: HASKÖY
Chair: **Nuri Solak**

16:00-16:20	**Mustafa Ünal, Aydın Tankut, Raşit Turan** *A Light Trapping Method for Thin Film Solar Cells: Aluminum Induced Glass Texturing*
16:20-16:40	**Jun Matsuoka, Tamaki Ikuho, Lisa Naemura, Akihiro Yamada, Satoshi Yoshida** *Optical Absorption of Nickel (II) in Borosilicate Melts in Relation to the Temperature Dependence of Network Structure*
16:40-17:00	**Dmitry K. Tagantsev, Andrey A. Lipovskii, Il'ya V. Reshetov, Valentina V. Zhurikhina** *The Origin of the Violation Of Charge Conservation Low in Glass Poling-Depoling Process*

17:00-17:20	**Kıvanç Güngör, Manoj Sharma, Aydan Yeltik, Murat Olutas, Burak Guzelturk, Yusuf Kelestemur, Talha Erdem, Savaş Delikanlı, James R. McBride, Hilmi Volkan Demir** *Luminescent Solar Concentrators Made of Near-Unity Efficient Copper-Doped Semiconductor Nanocrystals between Glasses*

SURFACE
Hall: KASIMPAŞA-1,2
Chair: **İlkay Sökmen**

16:00-16:20	**Andrey A. Lipovskii, Igor V. Reduto, Alexandre N. Kamenskii, Alexey V. Redkov, Dmitri K. Tagantsev, Valentina V. Zhurikhina** *2D Structuring of Glass Surface: Peculiarities of Thermal Poling and Chemical Etching*
16:20-16:40	**Semin Atılgan, Ezgi Deniz Biçer, Esra Duman, Emel Mercan, İlkay Sökmen, Emin Burak İzmirlioğlu** *Effective Cleaning Solution for Corroded Bottles*
16:40-17:00	**Ezgi Deniz Biçer, Emel Mercan, Lukas Simurka, Hasan İsmail, Tuncay Turutoğlu, İlkay Sökmen** *Effect of Dealkalization Process on Float Glass Surface*
17:00-17:20	**Gamze Atak** *All-Solid-State Electrochromic Device*

GLASS PRODUCTION (GLASS TREND)
Hall: KASIMPAŞA-4,5
Chair: **Oscar Verheijen**

16:00-16:20	**Arnaldo Moreno** *Factors Affecting Frit Solubility in Glaze Suspensions*
16:20-16:40	**Anja Zarah Friedberg, Francesco Castellino, Johannes Skotte** *TopFrax™ Catalytic ceramic filters: Simultaneous fine dust separation and NOx, CO and VOCs emission abatement*
16:40-17:00	**Sven-Roger Kahl, Maarten den Heijer, Bert Kraaiveld** *Thermagy (R) a New Way to Recover Waste Heat from Glass Melting Furnaces*
17:00-17:20	**W.Kuhn & A. Reynolds** *Oxy-combustion Tanks with Low Crown Design for Flue Gas Guidance Above Batch Blankets: Advantages and Risks*
17:20-18:40	**Glass Trend Council Meeting**

	NUCLEATION & CRYSTALIZATION Hall: BALAT ***Chair:*** **Melek Taygun Erol**
16:00-16:20	**G. Gorni, R. Balda, J. Fernández, J.J. Velázquez, L. Pascual, A. Durán, M.J. Pascual** *Up-Conversion Emission in Er-Yb Doped Transparent Oxyfluoride Nano-Glass-Ceramics*
16:20-16:40	**Ekarat Meechoowas, Benjamon Petchareanmongkol, Usanee Pantulap, Kanit Tapasa** *The Effect of Zirconium and Lithium on Crystallization of Glass-Ceramics in Soda-Lime Silicate System*
16:40-17:00	**Maziar Montazerian, Mina Eilaghi, Edgar Dutra Zanotto** *4-Decade Quest for Tough Bioactive Glass-Ceramics*
17:00-17:20	**Mrinmoy Garai, Shibayan Roy** *Microwave Heat-treated Crystallization and Microstructure of ZrO2 Containing SiO2–MgO–Al2O3–K2O–B2O3–F Glass-ceramics*
	NUCLEAR WASTE VITRIFICATION Hall: CİBALİ-1 ***Chair:*** **Burak İzmirlioğlu**
16:00-16:30	**Russell J Hand, Invited Speaker** *Durability of Nuclear Waste Glasses Under High pH Conditions*
16:30-16:50	**Pavel Hrma, Jaroslav Kloužek, SeungMin Lee, Richard Pokorny, Miroslava Hujova, Michael Schweiger, Albert Kruger** *High-Level Waste Vitrification: Balance of Oxygen*
16:50-17:10	**Mevlüt Karabulut** *Iron Phosphate Based Glasses as Alternative Host Matrices for Nuclear Waste Vitrification*
17:10-17:30	**Tetsuji Yano, Tetsuo Kishi** *Ionic Conductivity of Borosilicate Glass and Melt Containing Simulated High-Level Radioactive Waste Elements*
16:00-17:30	**TC 02 MEETING** Hall: CİBALİ-2
17:30-18:30	**Poster Session** Hall: Kuleli Block Foyer
19:30	**Gala Dinner**

Wednesday, October 25th

Parallel Sessions

GLASS STRUCTURE & PROPERTIES
Hall: HASKÖY
Chair: **Ali Serpengüzel**

08:30-08:50 **Nurperi Yavuz, Muhammad Rehan Chaudhry, Ali Serpengüzel**
Silica Glass Fiber Optics Processing with a Pulse CO2 Laser

08:50-09:10 **Woo Hyung Lee, Jun Ho Lee, Ju Hyeon Choi, Woon Jin Chung, Yong Gyu Choi**
Kramers-Kronig Relations of Chalcogenide Glasses in the Long-Wavelength Infrared Region

COATINGS
Hall: KASIMPAŞA-1,2
Chair: **Seniz Türküz**

08:30-08:50 **Alp Osman Kodolbaş, Ümmü Mustafaoğlu, Birsen Handem Ergün, Nilüfer Evcimen Duygulu, Okan Yılmaz, Öcal Tuna, Seniz Türküz, Ahmet Karaaslan**
Investigation the Influence of Doping Elements on Etched Zinc Oxide Thin Films Deposited by Sputtering Technique

08:50-09:10 **Okan Yılmaz, Ümmü Mustafaoğlu, Birsen Handem Ergün, Nilüfer Evcimen Duygulu, Öcal Tuna, Alp Osman Kodolbaş**
The Development of ZnO:Ga as TCO's for Thin Film Silicon Solar Cells

09:10-09:30 **Nilüfer Evcimen Duygulu, Ümmü Mustafaoğlu, Birsen Handem Ergün, Okan Yılmaz, Alp Osman Kodolbaş, Ahmet Karaaslan**
Influence of Doping Elements on Zinc Oxide Thin Films Deposited by Sputtering

09:30-09:50 **Birsen Handem Ergünhan, Öcal Tuna, Nilüfer Duygulu, Seniz Türküz**
Effect of Sputtering Power and Post Annealing Process on Properties of ZnO:Ga Thin Film

09:50-10:10 **Nilüfer Evcimen Duygulu, Ümmü Mustafaoğlu, Birsen Handem Ergün, Alp Osman Kodolbaş, Ahmet Karaaslan**
Etched Zinc Oxide Thin Films Deposited by Sputtering Technique

RAW MATERIALS
Hall: KASIMPAŞA-4,5
Chair: **Ertuğrul Yay**

08:30-08:50 **Stefano Ceola, Nicola Favaro**
Quality Assesment of Glass Cullet and Glassy Sand

08:50-09:10 **Bernard Somerhausen, Elise Di Marino, Tuna Hunturk, Stefano Ceola**
Benefits for Fiber Glass Producers to Use Calcium Oxide in Their Raw Material

09:10-09:30 **Yoji Doi, Terutaka Maehara, Tetsuji Yano**
Thermal Diffusivity of Soda-Lime Silicate Powder Batch and Briquettes

09:30-09:50 **Jozef Kraxner, Jozef Chovanec, Dušan Galusek**
Production of Hollow Glass Microspheres with Na2SO4 Blowing Agent by Flame Synthesis from Waste Glasses

09:50-10:10 **Mustafa Özer, Hüseyin Baştürkcü, Fırat Burat**
Value-Added Materials Production from By-Products of Glass-Sand Plants

MELTING TECHNOLOGIES
Hall: BALAT
Chair: **Adnan Karadağ**

08:30-08:50 **Cevher Tol, Dadal Arıburnu, Türkay Yıldız, Selahattin Çınar, Selim Taşcı, Hakan Erdil, Bahtiyar Dalgıç, Çağlar Şahin, Zeki Alimoğlu**
Process Optimization for Enhancement of Tableware Thermal Shock Resistance

08:50-09:10 **Mahdie Kamali Moaveni**
Effective Implementation of Electric Boosting in Glass Furnace

09:10-09:30 **Miroslava Vernerová, Lubomír Němec, Jaroslav Kloužek, Miroslava Hujová**
Bubble Nucleation in Soda-Lime-Silcate Glass Containing Sulphur Compounds

09:30-09:50 **Arca Iyiel, Ali Otken, Erkul Efendiler, Selim Taşcı, Erdinç Şükrü, Turgay Gün**
Forehearth Coloring at a Glance

FUNCTIONAL GLASSES
Hall: CİBALİ-1
Chair: **Vedat Sediroğlu**

08:30-08:50 **Barış Demirel, Melek Erol Taygun**
Production of Antibacterial Glass Doped with Silver, Strontium and Copper Ions by Using Conventional Melting Method

08:50-09:10 **Musa Mutlu Can, Shalima Shawuti, Satoru Kaneko, Cleva Ow-Yang, Sanapa Lakshmi Reddy, Mehmet Ali Gülgün, Tamio Endo**
Magnetization in Oxide Semiconductors: Dependency to Native Defects and Impurity Atoms

09:10-09:30	**Göktuğ Günkaya, Yiğit Okumuş** *Effects of Catalyst on Synthesis of Glass Nanopowders by Sol-Gel Process*
08:30-10:00	**YOUTH OUTREACH** Hall: MARMARA
08:30-10:00	**TC 02 MEETING** Hall: CİBALİ-2
08:30-10:00	**TC 11 MEETING** Hall: KASIMPAŞA-3
10:00-10:30	**Coffee Break**
10:30-13:00	**TC 09 MEETING** Hall: MARMARA
10:30-12 :30	**Closing Ceremony** Hall: Sadabad Auditorium **Alev Yaraman** **Manoj K Choudhary & David Pye** *A Special Moment in Time: Arrival of the Glass Age*

ICG
International Commission on Glass

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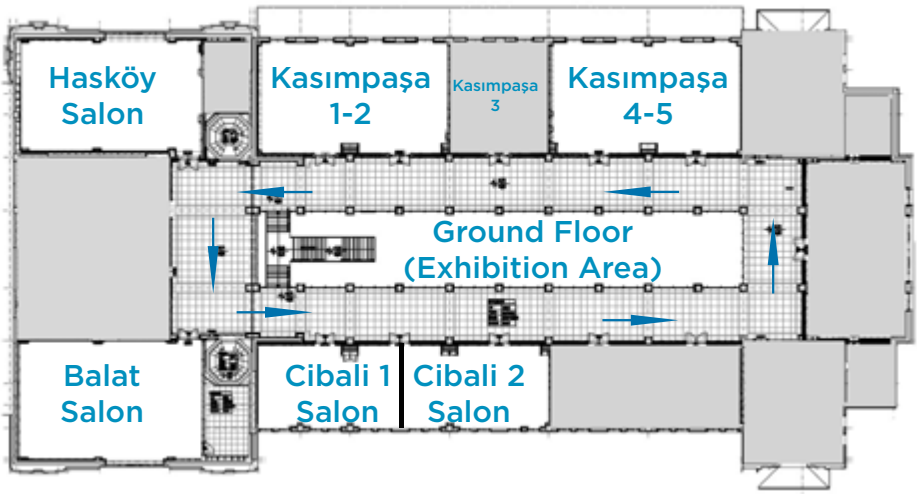
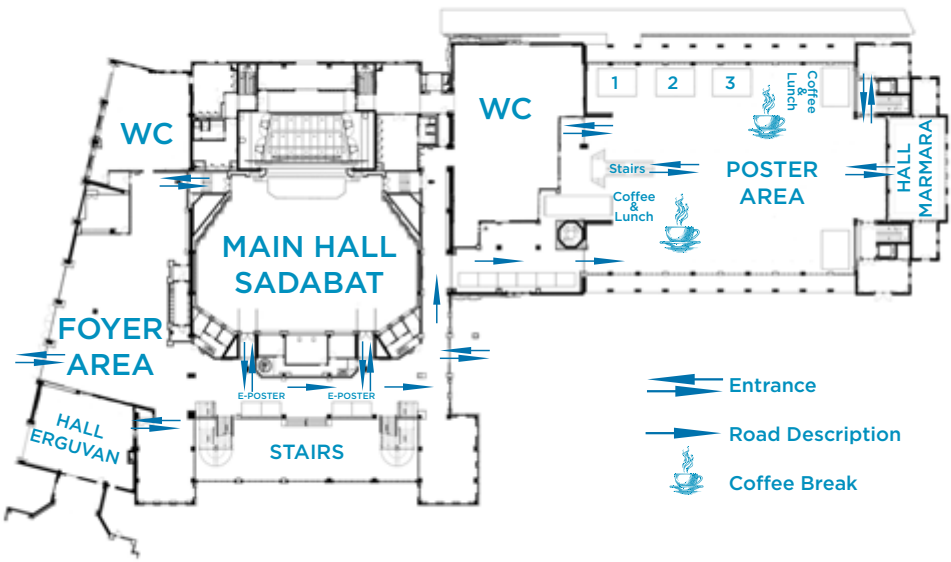
GlassTrend

Location of Activities





2017 ICG ANNUAL MEETING & 32nd ŞİŞECAM GLASS SYMPOSIUM

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Invited Speaker Profiles

Hubertus Böhm

Hubertus Böhm (*1962) graduated from Technical University Darmstadt in 1989 with a Master of Science degree in Electrical Engineering specialized on Control and Automation. He was a product manager for compact controllers and a new DCS for the Hybrid Market for Hartmann & Braun of Frankfurt Germany since 1989. This included project engineering and service calls for Glass plants in Algeria. From 1996 to 2003 he served Elsag Bailey (acquired 1999 by ABB) as Regional Marketing Manager small DCS and technical support in Wilmington, DE; Cleveland, OH and Mannheim (Germany). He joined Hirschmann Electronics Automation and Network Solutions in 2004 as a segment manager for process industries with focus on industrial IT-Security. He joined Siemens in 2006 as Consultant for DCS-Migration and IT-Security. In this role was leading the security assessment of SIMATIC PCS 7 by the Idaho National Labs. As of 2008 he was overseeing the Process Automation Business as Regional Manager for USA/ Canada and as of 2012 for China. Today (2017) he is in charge of Siemens' Process OEM, especially for the Glass industry

Manoj Choudhary

Dr. Manoj Choudhary is the president of the International Congress on Glass (ICG), and a member of Senior Technical Staff at Owens Corning's Science & Technology Center in Granville, Ohio.
He received B. Tech. (Hons) degree in Chemical Engineering from the Indian Institute of Technology, Kharagpur, M.S. in Chemical Engineering from the State University of New York at Buffalo, and Sc.D. in Materials Science and Engineering from Massachusetts Institute of Technology. The many awards he received during his educational years include Professor S. K. Nandi Gold Medal for being the best all-rounder Chemical Engineering Graduate, Institute Silver Medal for securing the first rank in Chemical Engineering (both while at IIT, Khargapur) and Falih N Darmara Award for excellence in academic performance, research, and extracurricular activities from the Department of Materials Science and Engineering at MIT.
Dr. Choudhary is one of Owens Corning's foremost experts in the application of engineering fundamentals, materials science, and computational approaches for process and product innovation. He is a 'founding father' of Computational Fluid Dynamics simulation of glass

melting and foam extrusion processes at Owens Corning. His contributions have been at the core of some of the most significant technology developments in Owens Corning during the past 30 years. He has received Owens Corning's highest technical achievement awards multiple times. Dr. Choudhary is also a recipient of several awards and honors from outside of Owens Corning, including the Arthur L. Friedberg Ceramic Engineering Tutorial and Lecture Award from the National Institute of Ceramic Engineers, the Glass Service Modeling Award, and a Best Paper Award from the Glass Industry Committee of IEEE Industry Application Society. He is a Fellow of the British Society of Glass Technology, and a Fellow of the American Ceramic Society. Prior to becoming the ICG president, Dr. Choudhary has presided over several professional organizations including the Industry-University Center for Glass Research at Alfred University, the Glass and Optical Materials Division of the American Ceramic Society, and the Glass Manufacturing Industry Council. He currently serves on the Board of Directors of the American Ceramic Society and is a Specially-appointed Professor of China State Key Laboratory of Advanced Technology for Float Glass.

Nicola Favaro

Education
• Master's Degree in Industrial Chemistry - Ca' Foscari University of Venice (1993)
Employment:
• Stazione Sperimentale del Vetro (National Glass Research Institute)
Laboratory Technical Director (2011 to present)
Main National Working Group Activities
• National Environmental Glass Expert – European Environmental Glass BREF Revision WG
• National Environmental Glass Expert – TC13 Environmental, ICG International Commission on Glass
• European Glass REACH Coordinator – Glass Alliance Europe REACH WG
• European Glass Food Contact Expert – EURL (EU Commission) WG for development of a new glass food contact test method
• National Glass Food Contact Expert – ISO TC166 – Revision of ISO 7086
Main Lectures and Publications
• Lectures and/or publication on more than 26 national and international congress in the glass field (Environment, Glass Chemistry, Food Contact and Pharma)
Main experience and knowledge on glass
• Glass property testing (Chemical, Mechanical and Physical properties)
• Glass product testing (Food Contact, Pharma, ROHS, etc.)
• Glass industrial testing (Environmental and Workplace)
• European Regulation applied to Glass (REACH, IED, ROHS, CAD, FOOD

CONTACT, PHARMA, etc)
• Glass technology (raw materials, glass furnace, emission abatement system)
• Project Management

Dušan Galusek

Prof. Galusek has been working in the area of structural ceramic composites, and functional glasses since 1991. After earning his PhD at the Slovak University of Technology in Bratislava in 1995 he spent several years working at various research institutions abroad, including Brunel University in London, University of Leeds, Darmstadt University of Technology and Karlsruhe University of Technology. He became full professor in 2013, and obtained the degree Doctor of Science (DSc.) in 2014. He coordinated more than 15 national and six international research projects, authored and co-authored more than 85 peer reviewed papers in scientific journals and more than one hundred contributions in conference proceedings, which have been cited more than 500 times. He is author and co-author of 4 books. He is the director of the Centre for functional and surface functionalized glasses in Trenčín, Slovakia, and serves as the vice-rector for research, science, and international relations of the Alexander Dubček University of Trenčín.

Claes-Göran Granqvist

Claes-Göran Granqvist, born 1946, is Emeritus Professor of Solid State Physics at the Department of Engineering Sciences, The Ångström Laboratory, Uppsala University, Sweden, since 1993. Granqvist's research during the past several decades has covered materials, mostly thin surface coatings, for energy efficiency and solar energy applications particularly in the built environment. Variable-transmittance "smart" windows with electrochromic or thermochromic properties is one prominent example, which also forms the basis of ChromoGenics AB, a company founded by Granqvist and his collaborators for producing electrochromic foil for glass lamination. Other research interests include nano-science and sensors. Granqvist has published about 600 scientific papers in refereed journals and many books and proceedings volumes. He is a member of the Royal Swedish Academy of Sciences and the The Royal Swedish Academy of Engineering Sciences. He has received several prizes and distinctions, including the 2015 Jan Czochralski Award.

Russell J Hand

Professor Russell Hand obtained both his first degree and his PhD in Physics from the University of Cambridge. He moved to the School of Materials (now the Department of Materials Science & Engineering) at the University of Sheffield in 1989, initially as a PDRA, became a member of academic staff in 1990, and was promoted to Professor of Glass Science & Engineering in 2012. He has held various significant roles within the Faculty of Engineering at the University of Sheffield. Prof Hand's major research activities are focussed on the mechanical properties of glasses and waste vitrification, especially compositional development and wasteform durability, and he was a founder member of the Immobilisation Science Laboratory (ISL) at the University of Sheffield. Prof Hand was the President of the Society of Glass Technology from 2014-17 and represents the SGT on ICG Council. He is also a member of TCs 5, 6 and 23 and is a former chair of TC6.

Matthew Hyre

Matthew Hyre is the Chair of the Department of Applied Mathematics and Engineering at the University of Northwestern - Saint Paul. He holds a Ph.D. from the Massachusetts Institute of Technology in mechanical engineering with a minor in economics, a M.S from Villanova University in mechanical engineering, and a B.S. from the United Stated Military Academy, West Point in nuclear physics.
Matthew has worked in the glass industry for over 20 years with numerous publications in the field of glass forming modeling. He has 17 years of experience teaching numerical modeling and simulation courses at the undergraduate and graduate level. Matthew also has 30 years of engineering industry experience focusing on the use of computational software and hardware in the development of numerical simulations of glass manufacturing and biomedical processes. He has been an invited lecturer in dozens of countries from Singapore and Russia, to England and Brazil. He holds over a dozen U.S. patents, has garnered numerous research and teaching awards, and has presented around the world and in a wide range of journals - with publications numbering in the hundreds.

Hiroyuki Inoue

Hiroyuki Inoue is a Professor of Amorphous Materials at Institute of Industrial Science, The University of Tokyo. He obtained his Doctor of Engineering (under Professor Itaru Yasui supervision) from The University of Tokyo in 1987. His research began with structural analysis of glasses and evolved into structural simulations of glass materials. In the past decade, his group has developed new glass systems using a gas levitation furnace and analyzing their atomic arrangement and physical properties. He has published more than 100 scientific papers in refereed journals. He is member of atomistic simulation Technical Committee (TC27). He is chair of the glass division of the Ceramic Society of Japan and Coordinating Technical Committee (CTC) of the international commission on Glass (ICG).

Julian Jones

Julian R. Jones is a Professor of Biomaterials at Imperial College London. He obtained his PhD (under Professor Larry Hench's supervision) from Imperial in 2002. In 2004 he obtained a Faculty position through being awarded a Royal Academy of Engineering/ EPSRC Research Fellowship. He has more than 110 articles in the fields of bioactive glasses and sol-gel inorganic/organic hybrids and has co-edited three biomaterials text books. He was elevated to Fellow of the American Ceramics Society in 2015 and was awarded an ISCM (International Society for Ceramics in Medicine) Excellence Award in 2016; the 2014 Vittorio Gottardi Award from the International Commission on Glass (ICG) for outstanding achievements in glass research and the Robert L. Coble Award (American Ceramics Society) in 2010. He is chair of the International Commission on Glass (ICG) biomedical glass technical committee (TC04).

Bekir Karasu

Bekir Karasu was born in 1965. He graduated from İstanbul Technical University, Department of Metallurgical Engineering in 1986 and made his MSc (in 1990) and PhD (in 1994) in Sheffield University of England on engineering ceramics and engineering glasses respectively. He has been working in Anadolu University of Turkiye since 1994. He has got 230 international and national publications, 42 of which are SCI papers. So far, his publications have been cited 352 times.

Jörg Leicher

Jörg Leicher (born 1973 in Essen, Germany) studied Mechanical Engineering at the Ruhr University Bochum, Germany and was awarded a Ph.D. in 2006 for his work on the numerical modelling of combustion processes. From 2007 to 2008, he worked as a Post-Doc. at the Institut Français du Pétrole (IFP) in Lyon, France, before joining ANSYS Germany in Munich as a CFD support engineer. Since 2009, he has been working in the Department of Industrial Combustion Technology of Gas- und Wärme-Institut Essen e. V. (GWI) where he is in charge of the Numerical Simulations Group. GWI is a non-profit independent German research organization which focuses on applied research into the utilization of gaseous fuels.
Mr. Leicher's professional interests include the modeling of industrial combustion processes, the impact of natural gas quality on industrial gas-fired applications and the use of alternative fuels such as biogas or syngases in industrial furnaces and power plants. He is a member of several national and international committees for issues of gas utilization and natural gas quality and the author of numerous publications on matters of industrial gas combustion processes.

Guglielmo Macrelli

Guglielmo Macrelli is senior scientist in Isoclima SpA-R&D Department. He received his Master's Degree (MSc) in Physics- Università Degli Studi di Bologna in 1982 working at the Bologna ENEA computational Center in the field of diffusion and transport of neutrons in matter. He has been active since 1990 in many glass science areas: ion exchange in silicate glasses, thin film optical coatings and mechanical glass properties. He works for Isoclima SpA since 1992 and he has been involved in the development of industrial chemical strengthening plants and processes for sodalime silicate glasses, sodium alumina-silicate glasses, and lithium aluminasilicate glasses and in the development of thin film coating on glass for heated glazing, induced transmittance solar control coatings and electrochromic coatings based on all solid state thin film inorganic layers.
He is specialist in glass strength and strengthening processes and in optical characterization of glazing He has authored a number of peer reviewed scientific papers and participated as speaker in several international conferences. He has an extended experience (more than 25 years) in glass testing and glass processing (thin film coatings, glass chemical strengthening by Ion Exchange and glass strengthening by thermal processing). Guglielmo Macrelli is member of the American Ceramic Society.

M. Pınar Mengüç

Pınar Mengüç has completed his BS and M.S. degrees at the Middle East Technical University (METU), in Ankara, Turkey. He has received his PhD in Mechanical Engineering from Purdue University, Indiana, USA in 1985. He joined the faculty at the University of Kentucky the same year, and was promoted to the ranks of associate and full professor in 1988 and 1993, respectively. He was a visiting professor at the Universita degli Studi "Federico II," in Napoli, Italy in 1991, and at Massachusetts General Hospital/Harvard University in Boston during 1998-1999. In 2006, he was recognized as an Honorary Professor at ESPOL (Escuela Superior Politécnica del Litoral'), Guayaquil, Ecuador. He served as the founding director of the Nano-Scale Engineering Certificate Program at the University of Kentucky, where in 2008, he was named as the Engineering Alumni Association Chair Professor.
Professor Mengüç has authored/coauthored more than 125 refereed journal articles and more than 180 conference papers, and two books, including Thermal Radiation Heat Transfer, along with J.R. Howell and R. Siegel, and Thermal Transport for Applications in Micro/Nano-Machining, with B. Wong. He has four assigned and three pending patents, and has guided more than 60 MS and Ph.D. students and post-doctoral fellows. He is the Editor-in-Chief of Elsevier Journal of Quantitative Spectroscopy and Radiative Transfer. Since early 2009, Mengüç is at Ozyegin University in Istanbul as the Founding Head of Mechanical Engineering Program and the founding Director of Center for Energy, Environment, and Economy. He has received the Knowledge Transfer Award and the Outstanding Researcher Award from Ozyegin University in 2014 and 2015, respectively. He is a fellow of the American Society of Mechanical Engineers (ASME) and the International Center for Heat and Mass Transfer (ICHMT), and a Senior Member of Optical Society of America (OSA). He is elected to the Science Academy of Turkey (BA) in 2016.

Davide Pico

He studied Chemical Engineering and Process in University of Genoa. In 2006 he started his academic carrier as project assistant at the Institute of Chemical Engineering at Vienna University of Technology. As university assistant he focused his research topic on fibrous reinforcements for plastics and recovery potential for end-of-life fibers. During the period 2006 – 2011 as university assistant he conducted publicly as well as industry funded research projects.
Since 2011 he works at the Institut fuer Textiltechnik of RWTH Aachen University as scientist and project leader of European and National funded

projects focusing on glass, basalt and special inorganic fibers for heat insulation as well as reinforcements for plastics and inorganic matrices in collaboration with research institutes and companies.
Since 2013 he is head of the “inorganic fibers” research group at the Institut fuer Textiltechnik of RWTH Aachen University.
He is founder and organizer of the “international Glass Fiber Symposium”, reviewer for scientific journals and author of several papers and conferences proceedings. He is author of the chapter “glass fiber” in Ullmans Encyclopedia He is the inventor of the process for the production of inorganic aerogel fibers, the lightest inorganic fiber in the world and authored the related patent.

Bernard Poumellec

Bernard Poumellec leads the group « Advanced Material for Photonics » at Institut for Molecular Chemistry and materials of Orsay (ICMMO), at Univ. Paris-Sud (in Univ. Paris-Saclay), France. Director of Research for CNRS. Senior Member of Optical Society of America since 2015. Elected in 2015 Vice-President of the Academic Advisory Council of "University Paris Saclay" (a cluster of graduate schools and universities) after 3 years as a member of the board. He is best known for his Group’s work structural changes induced by IR and UV laser irradiation, electron beams, at the based of localized optical properties modification in oxide glasses. Sensitivity of silica-based materials to femtosecond IR lasers for nano/micro-structuration of the solid.

Cristina Siligardi

Cristina Siligardi obtained both her first degree in Chemistry and her PhD in Materials Engineering from the University of Modena and Reggio Emilia. She has held various significant roles within the Department of Engineering Enzo Ferrari. Prof. Siligardi’s major research activities are focussed on design (Mixture Design, DoE method) characterization and application of glasses, glass-ceramics and ceramic glazes for floor tiles. She collaborates with several international and national research groups and she was the coordinator of four international (LIFE+ and other European Projects) and national projects also in collaborations with Italian industries. She is author and co-author of more than 130 scientific papers.

Peter Sieck

Peter Sieck is an independent consultant to the flat glass sputter coating industry. He received his Bachelors of Science (Cum Laude) in Physics and Applied Mathematics from Sonoma State University in California in 1982. He has worked extensivel in Applied R&D developing equipment and processes for architectural & automotive glass coatings, large area mirrors and display applications. Peter has also spent time in manufacturing engineering positions improving process stability and efficiency using design of experiments and other statistical production strategies.

Koichi Suzuki

After completing Master degree at Tohoku University (Japan) in 1976, Koichi Suzuki joined to Research Center of Asahi Glass Co.,Ltd. and started R&D work for coatings on glass. In 1981~1983, he took PhD in Loughborough Universityof Technology (UK). In 1992~1996, he stayed in Brussels as a technical advisor of GlaverbelSA (Belgium). In 1994, he founded ICCG (International Conference on Coatings on Glass)and became a secretary. In 1998, he left Asahi Glass, became independent as a consultant for theEU-Japan technology transfer and founded SurFtech Transnational Co.,Ltd.. At the same time, he became Japanese representative of Fraunhofer FEP (Germany), the visiting scientist of Institute for New Materials (Germany), and aconsultant for TNO (The Netherlands). In this year, he founded “Association of Innovative Optics Technologies” with several university professors and his colleagues to provide a solution to Japanese industriesin the optics related fields.

Bernd Szyszka

Jorma Vitkala

Jorma Vitkala, the originator and chairman of the Glass Performance Days (est. 1992), has more than 36 years of industrial experience from the safety glass industry both at Glaston and its predecessor Tamglass. The world-leading glass specialist conference GPD – The Glass Performance Days – was organized under his leadership for the 15th time in 2017.
The Chairmanship of the GPD has given Jorma Vitkala a unique platform for perspectives on the global glass industry and a contact network with leading glass professionals ranging from glass specialists and research institutions to architects and structural engineers worldwide. His GPD contact activity since 1992 has brought him a personal contact network more than 1100 speakers from 50 countries and broad international access and ongoing contacts to over 30 000 specialists all over the world.
Jorma Vitkala is a frequent lecturer at glass industry conferences and seminars. He has written numerous articles for leading publications in the trade. He is also a specialist on LowE glass tempering and has filed and been granted a number of patents related to this field.

Hong Wang

Hong Wang earned a Ph.D. in Materials Science and Engineering from the University of Illinois at Urbana-Champaign. He worked in the thin film technology field in US as an industrial research scientist for 16 years in semiconductors, flat panel displays and large area coatings for global companies such as SONY, Panasonic and Guardian Industries Corp. In 2010, he became the Chief Scientist for the National Research Center for Glass Processing and Associate Director of State Key Laboratory of Green Building Materials, China Building Materials Academy in Beijing. His research there is focused on the development of coated glass for energy efficient buildings, solar heat conversion materials, and smart windows.

Lothar Wondraczek

Alev Yaraman

Alev Yaraman was born in Antakya in 1947. She graduated with a B.Sc. degree in Chemistry from Middle East Technical University in 1969, and received her Ms.Sc:Tech degree in Glass Technology from University of Sheffield in 1971.

Mrs. Yaraman started her professional career as a R&D Engineer at Şişecam where she oversaw and managed the establishment of the Glass Research Center. She became the Research Manager in 1977, and then Assistant General Manager in charge of Technology in 1984. She first served as the President of the Glassware Group and then as the President of the Flat Glass Group of Şişecam between 1991 and 2007. She was appointed as the acting chairperson of the Board of Directors of Şişecam in 2008 and later served as a member of the Board until 2015. She is currently serving as the Vice Chairperson of the Advisory Board of Şişecam Academy.

Mrs. Yaraman actively participated in the management and technical investigations of international glass organizations. She was a member of the Board of the European Domestic Glass Committee, and chaired the association in the 1995-1996 period.

She was elected as a member of the ICG (International Commission on Glass)'s Technical Coordinating Committee in 1984 and chaired the committee in subsequent years. She joined the Board of Directors of ICG as a member in 1998. In 2003, Mrs. Yaraman was elected as the 21st and first female President of ICG. Following her tenure as the President, she had continued to contribute as a member of the Board of Directors since 2006.

Mrs. Yaraman is a fellow at Society of Glass Technology. She is also a member of the American Ceramic Society.

Over the years, she has actively participated in various non-governmental organizations such as ITO, KALDER, IMSAD.

Mrs. Yaraman authored numerous scientific articles printed and presented in national and international journals, magazines and congresses.

She was the recipient of the Phoenix Award "Glass Person of the Year" in USA in 1999. She is the first and sole woman recipient of this award. She also received the Service Award of the Prof. Mustafa Parlar Research and Education Foundation in 1999. She was voted as the Most Successful Businesswoman in glass and ceramics sector in Turkey in 2000. In 2007, Mrs. Yaraman received the Presidential Award of the ICG.

Mrs. Yaraman received Honorary Doctor of Engineering Degree from University of Sheffield in 2014.

In May 2017, she was awarded the "METU Outstanding Service Award" in accordance with the Middle East Technical University Senate's directive.

ICG
International Commission on Glass

ŞİŞECAM

GlassTrend

Oral Presentations

Monday, October 23rd

Plenary Sessions

10:00-10:40
How the Glass Industry Takes Advantage of Digitalization
Hubertus Böhm
Siemens AG

Executive Summary
From Integrated Engineering to Integrated Operations and Services: Digitalization solutions along the entire value chain make glass plant operators and equipment suppliers more efficient, more flexible, better and faster. The impact of Digitalization to the glass industry will be as big as electrification and automation did in earlier times. The result will be huge leaps in productivity and flexibility.

Introduction
A recent study [1] by German industry association VDMA and McKinsey forecasts that in Europe more than ten percent of revenue in the mechanical engineering industry alone will be generated using data-based business models by 2020. Open standards, powerful communication networks as well as integrated automation and drive technologies are of great importance to the glass industry as it is heading towards Industrie 4.0.

A step-by-step approach to Digitalization of the value chain
Digitalization acts in two main directions:

1. Horizontal refers to the digitalized value chain, which is why we say 'From Integrated Engineering to Integrated Operations and Services,' to describe consistency throughout the life cycle of a plant – from designing the production facility and engineering to commissioning and operation, and the necessary services."
2. The vertical direction, referred to as "Integrated Operations" describes the link between the real world and the virtual world in the operation phase, in other words the connection between the field, automation and management levels, right up into the Cloud.

Anyone dealing with the digitalized value chain has observed that consistency of data is key. Plant operators and equipment suppliers that use a standardized data platform like Comos to integrate their engineering stages significantly reduce time-to-market. The fact that multiple planning stages can be executed simultaneously saves both: time and costs.

The Digital twin: A virtual copy of the plant
The result of applying Integrated Engineering is a so-called "digital twin" – a virtual copy of all or part of the plant. At the heart of this digital twin is a consistent data model that operators and equipment suppliers can use for multiple purposes, many of them not available before:

- Train operators prior to commissioning of the plant
- Practice abnormal situation handling
- Guide maintenance people to the correct location
- Conducting maintenance procedures in a safe manner

The data gathered during operation is fed back into the data model. This keeps the digital twin up to date and maintains it as a one-to-one representation of actual plant status throughout the entire life cycle.

The Presentation further discusses

- Benefits of Integrated Engineering, Integrated Operations and Integrated Services
- Cloud-based solutions as a foundation for new, data-based business models
- Smart Motors Cloud application
- Defense in Depth to ensure IT-Security

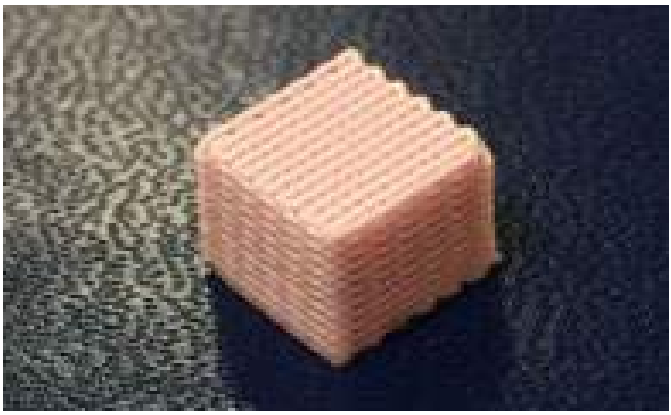
Keywords: Digitalization, integrated engineering, integrated operations, integrated services, siemens, glass

References
[1] https://www.vdma.org/viewer/-/article/render/16241528

11:10-11:50
Bioglass: From Hench to Bouncy Hybrids
Julian R Jones
Professor of Biomaterials, Department of Materials, Imperial College London, South Kensington Campus, London, SW7 2BP.
www.imperial.ac.uk/people/julian.r.jones

Larry Hench's Bioglass was the first material found to bone with bone. Since then, it has been termed as having the property of "osteostimulation" because it can stimulate cells to produce new bone and accelerate healing. Commercial products, such as NovaBone and BonAlive have generally been in the form for powders. Now cotton-wool like bioactive glass scaffolds are revolutionizing chronic wound care. Orthopedic surgeons need bioactive materials that can share load with host tissue (bone and cartilage), provide a suitable temporary template (scaffold) for tissue regeneration before they biodegrade at a controlled rate. We have developed glass foam and 3D printed scaffolds (both sol-gel and melt-derived) and I will show how the architecture affects bone regeneration. Glass scaffolds work well but are brittle. Surgeons need devices that can take cyclic loads in bone and others

that can replace the articular surface of cartilage, then regenerate the cartilage to replace the device, all while recruiting cells from and anchoring to the underlying bone. Such devices do not yet exist, but they could using bioactive glass based materials. Composites have been developed but the inorganic and organic phases tend to resorb at different rates, leading to material instability, and the bioactive components can be masked by the polymer matrix. We need to design materials for purpose and build them from the bottom-up. Hybrids have nanoscale co-networks of inorganic glass and organic components, e.g. sol-gel silica and biodegradable polymers. We now have hybrids that can "bounce" and self-heal. The hybrids are ideal for 3-D printing, which can yield bespoke scaffold architectures. Device designs are ideal for osteochondral devices and intervertebral discs.



Figure

11:50-12:30

Smart Glasses in Large-Area Fluidic Windows and Suspended Particle Devices for Facade Integration

Lothar Wondraczek
Otto Schott Institute of Materials Research, University of Jena
Center of Energy and Environmental Chemistry, University of Jena

Buildings represent more than 40 % of Europe's energy demands and about one third of its CO_2 emissions. Energy efficient buildings and, in particular, building skins have therefore been among the key priorities of international research agendas. Glass materials with added functionality are one of the key components in addressing this issue. This concerns thin-glass integration, but also the exploitation of complex devices which enable control of heat and light transmission among the building and its environment. Among other examples, here, we will focus on fluidic systems for large-area integration with adaptive facades and smart windows. Involving several highly-engineered glass components, these enable harnessing and dedicated control of various liquids for added functionality

in the building envelope, and can be integrated with state-of-the-art window glazings or facades to harvest and distribute thermal as well as solar energy, wrapping buildings into a fluidic layer. High visual transparency is achieved through adjusting the optical properties of the employed liquid. Also secondary functionality, such as chromatic windows, polychromatism or adaptive energy uptake can be generated on part of the liquid.

Keywords: Glass, window, smart windows, thin glass

Parallel Sessions

Glass Structure & Properties
October 23rd, 2017 (14:00-15:50), Hall: Hasköy
Chair: **Hiroyuki Inoue**

14:00-14:30 (Invited Speaker)

Fluorescence and Structure of Divalent Eu Ions in Borate Glasses

Hiroyuki Inoue[1], Takayoshi Koizumi[1], Yoshihiro Watanabe[1], Atsunobu Masuno[2]
[1]Institute of Industrial Science, The University of Tokyo, Tokyo, JAPAN
[2]Hirosaki University, Aomori, Tokyo, JAPAN

Fluorescent spectrum of divalent Eu ions is strongly dependent on the chemical composition of glasses and the structure around the ions. The fluorescent spectra of divalent Eu ions in alkaline earth borate glasses was investigated.
The raw materials with 0.25 mol% Eu_2O_3 were melted in a platinum crucible at 1373-1873 K. Pieces of obtained samples were melted in an gas levitation furnace using complex gas (4% H_2 + N_2) and a 100 W CO_2 laser.
The emission wavelength shifted to the longer wavelength side with increasing the content of alkaline earth metal oxide. Fugure shows the fluorescent spectra of Eu ions in SrO-B_2O_3 glasses. Furthermore, the emission wavelength shifted to the longer wavelength side as the ion radius became smaller. It was found that the red shift was related to surrounding non-bridging oxygen atoms. The structure around Eu ions was discussed from the structural models prepared by classical molecular dynamics simulations.

Keywords: Divalent Eu ions, fluorescence, borate glass, molecular dynamics simulation

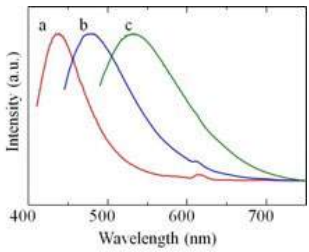


Figure : Fluorescent spectra of (a) 20SrO·80B_2O_3, (b) 30SrO·70B_2O_3 and (c) 40SrO·60B_2O_3 glasses

14:30 – 14:50

Luminescent Properties of Silver Ion-Exchanged Aluminosilicate Glass Doped with Eu^{3+} Ions

Yevgeniy Sgibnev, Dmitriy Marasanov, Nikolay Nikonorov, Alexander Ignatiev

Itmo University, Russia

Nowadays, silver nanostructures are of great interest for many applications of photonics due to their unique optical, non-linear and electrical properties. It's well known that silver clusters (SCs) in glass have intense and broadband luminescence in the visible. Glasses with luminescent SCs were proposed to be used as phosphors for white LEDs, cover down shifting glasses for solar cells and optical data storage media. On the other hand, well-known rare earth ions are characterized by narrow and weak absorption bands. Energy transfer from SCs can be used for improving characteristics of optical glasses doped with rare earth ions.

Glasses based on the $Na_2O–Al_2O_3–ZnO–SiO_2–F$ system doped with different concentration of Sb_2O_3 (0-0.002% mol.) and Eu_2O_3 (0-0.5% mol.) were synthesized (Table 1). In order to embed silver ions the glass samples were immersed in a bath with melt of nitrate mixture 5AgNO3/95NaNO3 (mol. %) at 320°C for 15 minutes. The ion-exchanged samples were heat-treated at temperatures in the range of 350-500°C for 4h.

After the ion exchange process, a long-wavelength shift of the UV edge of strong absorption is occurred. Emerging of broad absorption bands related to silver clusters and nanoparticles are observed after the HT. The absorption amplitude increases with rising the HT temperature owing to the increase in concentration of SCs. As it was shown in our previous research antimony ions play the role of reducing agent for silver ions:

$$Sb^{3+} + 2Ag^{+} \rightarrow Sb^{5+} + 2Ag^{0}$$

As-prepared samples show no luminescence under UV excitation at 350 nm, weak emission was observed after the IE. Broadband luminescence related to SCs are observed in the Sb-doped glasses after the IE and subsequent heat treatment (HT). Intensity of SCs luminescence, as well as Eu3+ ions emission, increases with rising the (HT) temperature from 350 to 450 °C (Fig. 1). Moreover, intensity of the Eu^{3+} emission in the glasses after formation of SCs is much higher than that in the as-prepared glasses due to energy transfer from SCs to Eu^{3+} ions. Formation of silver nanoparticles, which are characterized by the surface plasmon resonance, in the ion-exchanged glass samples heat-treated at 500 °C results in luminescence quenching.

In the glass with no antimony formation of small amount of SCs is possible only by capturing electrons by silver ions from glass impurities. Shape of the luminescence spectrum of SCs is the same for all glass. Thus, adding europium oxide in the glass composition does not influence on the formation and luminescent properties of SCs. Luminescence of SCs falls down with increasing Eu_2O_3 concentration in the glass composition (Fig. 2),

which also indicates to energy transfer from SCs.
Thus, we observed effective energy transfer from SCs to Eu3+ ions in silver ion-exchanges aluminosilicate glass. The developed glass can be used as down-convertors for solar cells and phosphors for white LEDs.
Keywords: Luminescence, silver clusters, nanoparticles, ion exchange, silicate glass

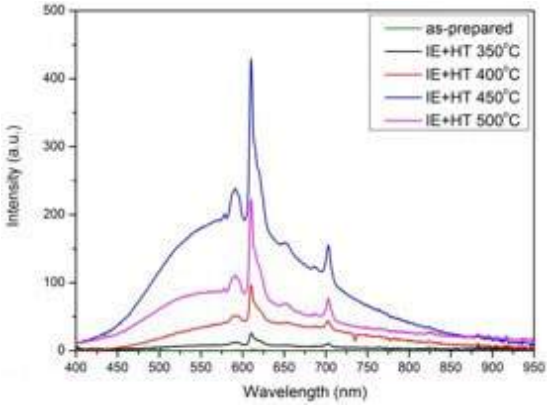


Figure 1

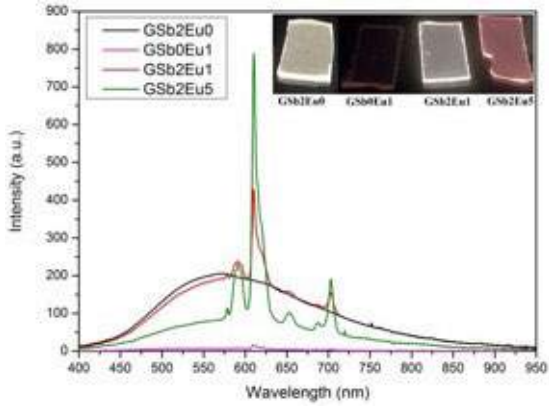


Figure 2

Table 1. Batch concentration of dopants in the synthesized glass.

glass	Sb_2O_3, mol. %	Eu_2O_3, mol. %
GSb2Eu0	0.002	0
GSb0Eu1	0	0.1
GSb2Eu1	0.002	0.1
GSb2Eu5	0.002	0.5

14:50-15:10

Fluorine Phosphate Glasses with High Fluorine Concentration Doped with Er^{3+}–Yb^{3+} and Nd^{3+}Ions

Elena Kolobkova[1], Bo Min Dinh[2], Nikolay Nikonorov[2]
[1]St. Petersburg State Institute Of Technology (Technical University)
[2]Itmo University, Russia

Many potential host glass materials doped with rare earth ions have been developed. In general, the optical and spectroscopic properties are strongly dependent on host materials. Among them, fluorine phosphate glasses show outstanding advantages such as low phonon energy and OH –group concentration, transmittance from UV to IR spectral range, and low nonlinear refractive index. Fluorophosphate glasses doped with Nd^{3+}-and Er^{3+}–Yb^{3+}ions has attracted particular interest as materials for optical amplifier as well as for high-power laser in the near- infrared (NIR) spectral region for use in telecommunication applications since the emission of these optical materials is located in the first, second and third optical communication windows.
In this work, the fluorine phosphate glasses with composition 0.05 $Ba(PO_3)_2$ (0.95-x)($MgCaBa(Pb)SrAl_2F_{14}$)-xLnF_3 (Ln=Er,Yb and Nd), were studied. Glasses were prepared by conventional glass melting in closed glassy carbon crucible in Ar-atmosphere at the temperature 950-1060 °C. Characteristics temperatures were analyzed using results of the differential scanning calorimetry (DSC). It was found that glass transition temperature (Tg) depends on PbF_2 and LnF_3 content and varied in the range 400-450°C. The effect of the host composition and rare earth ions concentration on the crystallization and optical properties of the glasses are discussed. The X-ray diffraction (XRD) measurements revealed the presence of the two fluoride crystallites species in the glassy matrix after heat treatment: monocline (usovit) and cubic. Spectral-luminescence studies, confirmed REI incorporation in the cubic phase and gave information about changing of the REI environment during crystallization. Absorption and luminescence spectra of the Nd^{3+}-ions in fluorine phosphate glasses were studied. The analysis of the spectra was in the framework of the Judd-Ofelt theory.
Keywords : Fluorine phosphate glasses ,crystallization, luminescence

15:10 – 15:30

Optical and Magnetic Properties of Binary Rare Earth Borate Glasses

Atsunobu Masuno[1], Yasuhiro Watanabe[2], Masaki Azuma[3], Yutaka Yanaba[2], Hiroyuki Inoue[2]
[1]Graduate School Of Science And Technology, Hirosaki University
[2]Institute Of Industrial Science, The University Of Tokyo
[3]Laboratory For Materials And Structures, Tokyo Institute Of Technology

R_2O_3-B_2O_3 glasses (R = rare earth element) were prepared by a levitation technique. Bulk glass forming region in B-rich composition was extended

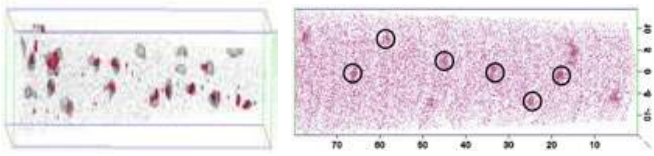
compared to that in conventional melt-quench technique. Furthermore, additional glass formation was realized in R-rich composition. With an increase of R_2O_3 content, optical absorption edge in UV region shifted to high wavelength side. Additional IR transmittance window was observed in R-rich glasses. Temperature and field dependence of magnetization of Gd_2O_3-B_2O_3 glasses showed that the glasses were paramagnetic from 5 K to 300 K. Local structural analyses using ^{11}B MAS NMR and Raman scattering spectra of La_2O_3-B_2O_3 glasses revealed that every B atom in La-rich glasses forms a planar trigonal BO_3 unit and the BO_3 units are entirely isolated.
Keywords: Containerless processing, aerodynamic levitation

15:30 – 15:50

Analysis of the Rare-Earth Ion Clusters in Glasses and Their Effects on the Optical Properties of Pbs Quantum Dots

Jong Heo[1], Wonji Park[1], Woon Jin Chung[2]
[1]Department Of Materials Science And Engineering / Division Of Advanced Nuclear Engineering, Pohang University Of Science And Technology (postech), Republic Of Korea
[2]Division Of Advanced Materials Engineering, Kongju National University, Republic Of Korea

Glasses doped with PbS quantum dots (QDs) can absorb and emit light at different wavelengths by adjusting QDs' sizes. There are possible application areas including fiber-optic amplifiers. We have reported that photoluminescence located at ~ 1500nm shifts to short wavelength side as Nd_2O_3 content increases. Scanning transmission electron microscopy (STEM) and energy dispersive x-ray spectroscopy (EDS) show that relatively high concentrations of heavy metals such as Pb^{2+}, Nd^{3+} inside QDs instead of glass matrix. Radii (r) of QDs are proportional to tx when x varies between 0.203 to 0.217 and it is considerably smaller than the value predicted by classical crystallization theory. Atom probe tomography (APT) method is used to analyze the distribution of RE^{3+} ions inside glass matrix and its effect on the precipitation of PbS QDs. We found Nd3+ clusters of approximately 2-4nm in diameter exist inside the glass. Extended x-ray absorption fine structure (EXAFS) analysis showed that Nd^{3+} ions are surrounded by ~8 oxygen ions inside the QDs and there is no evidence of forming Nd-S bonds. EDS and EELS results showed that Nd^{3+} ions are preferentially concentrated inside the PbS QDs rather than in the glass matrix after heat-treatment. Therefore, we believe that those Nd^{3+}-O clusters work as nucleating sites for precipitation of PbS QDS.
Keywords : Rare-earth clusters, APT, quantum dots, optical properties



Figure

COATINGS
October 23rd, 2017, 14:00-16:10, Hall: KASIMPAŞA-1,2
Chair: **Reha Akçakaya**

14:00-14:30 (Invited Speaker)
Electrochromic Glazing for Energy Efficient Buildings: Fundamentals, Current Technology, Recent Progress and Prospects
Claes G Granqvist
Department of Engineering Sciences, The Ångström Laboratory, Uppsala University, Uppsala, Sweden
claes-goran.granqvist@angstrom.uu.se

Abstract:
Electrochromic thin-film devices are able to change their throughput of visible light and solar energy under the action of a low voltage. These devices are essentially thin-film batteries whose charging state is manifested as optical absorption. Electrochromics is currently being used in buildings—on "smart" windows and glass facades—and impart energy efficiency jointly with indoor comfort and convenience. Most of today's electrochromic devices utilize coatings on float glass but another option, which is emphasized in this talk, is to deposit onto flexible plastic web. The electrochromic device is then implemented as a thin foil which, in its turn, is used for glass lamination. This approach thus separates electrochromic functionality from glass coating and window fabrication, which makes the technology compatible with the current value chain for window manufacturing. The talk describes electrochromic device technology, both current and forthcoming, and discusses manufacturing aspects and optical and electrical properties. Furthermore, the talk ventures to look into the future and gives a brief introduction of thermochromic technology, for diminishing solar energy transmittance upon increased temperature, and how this technology may in the future be integrated with electrochromism for superior device performance.

14:30-15:00 (Invited Speaker)
From Bytes to Atoms – Modelling of Thin Film Processes for Large Area Glazing
Bernd Szyszka[1], Ruslan Muydinov[1], Stefan Körner[1], Michael Siemers[2], Stephan Ulrich[2], Volker Sittinger[2], Oliver Kappertz[2], Andreas Pflug[2], Günter Bräuer[3]
[1]TU Berlin, Chair Technology of Thin Film Device TFD,
Einsteinufer 25, Office HFT 5-2, 10587 Berlin, Germany
[2]Fraunhofer IST
bernd.szyszka@tu-berlin.de

The model based prediction of thin film properties is a key issue for the development of high performance glazing. It's a multi-scale challenge:

Starting from the atomistic description of film properties we need to proceed towards deposition systems with robust control loops for performance and production yield prediction. Parts of this multi-scale modelling approach is purely quantum dynamics relying on the density functional theory (DFT). From that starring point, the challenge is to convey to classical particle dynamics and plasma and transport phenomena simulation which allow for setting up the modelling as a Digital Twin for the industrial mass production.
In this paper, we report on the current understanding of model based designs in thin film processing. We review the multi-scale approach on the various scales and we outline the perspectives for model based coating and coater development for large area glass coating. The challenging applications, e. g. bendable triple Ag low-E sun-control, nanoscale TCOs for the ice-free windshield and dielectric layers on position one for E-mobility will be reviewed from the perspective of the Digital Twin.
Keywords: Band structure simulation, thin film growth modeling, plasma process simulation, the digital twin, digital factory, bendable coatings on glass, ice-free windshield

15:00-15:30 (Invited Speaker)
Modern Large Area Glass Coatings by Magnetron Sputtering
Peter Sieck
Large Area Consulting

A review of the technological advances and state of the art. Advantages and disadvantages of the large area sputtering method are discussed from both the theoretical and practical points of view. An overview is given of past, present products and processes that continue to evolve. Hardware and software innovations that define the manufacturing landscape are described. Modern sputtering platforms are purpose built and optimized for throughput of particular products. This evolution of the hardware makes it difficult to introduce radical new products such as Electrochromics, Solar PV or others which require adaptations that may not be economically feasible given the specialization of current architectural and automotive coating systems.
Keywords: Sputtering, coating, manufacturing, thin films

15:30 – 15:50
Modification of Tunable THz Filters Fabricated from Vanadium Dioxide Thin Films
Yasemin Demirhan[1], Hurriyet Yüce[1], Merve Akkaya[2], Hakan Altan[2], Lütfi Özyüzer[1], Gülnur Aygün[1]
[1]Department Of Physics, Izmir Institute Of Technology, Urla, 35430, Izmir, Turkey
[2]Deartment Of Physics, Middle East Technical University, Çankaya, 06800, Ankara, Turkey

Terahertz (THz) radiation is a part of the electromagnetic spectrum lying between microwaves and the infrared. The frequency range between 0.1 and 10 THz is usually called the THz gap as it is difficult to develop devices which can interact, generate or detect radiation since bulk materials typically do not exhibit a strong electromagnetic response in this region. There are notable attempts aiming to fill this vacancy in the spectrum [1-2]. In recent studies, tunable THz filters have been fabricated and improved. However, the transmittances and resonance frequencies of such devices are difficult to be further tuned since the metallic structures are used. Therefore, metallic filters can only be used as passive THz devices. Among the active, THz-agile materials, vanadium dioxide (VO_2) shows promising potential for switchable photonic and THz devices. VO_2 exhibits metal-insulator phase transition (MIT) which can be initialized by temperature, electrical field and light. The transition occurs at nearly 68 °C [3]. The resistivity of VO_2 abruptly changes by a factor of 104 at MIT. Furthermore, the optical properties of the material in IR and THz region change as depending on the temperature. In this work, high quality VO_2 thin films were deposited on c-Al_2O_3 and fused silica substrates by dc magnetron sputtering technique. In order to determine structural, optical and electrical properties of grown films, various analyses carried out at between 25 and 100 °C for two different crystal structure of VO_2. MIT in VO_2 was observed with the change in resistivity by a factor of 104. We propose a unique geometry (fourcross shaped) for the conductive layer that can be used as a metamaterial device operating in the THz frequency range. The metamaterial consists of a rectangular structure with strip lines at sides of the ring on a dielectric substrate. Then, VO_2 films were shaped by electron beam lithography (EBL) in order to create designed filter structure. The spectral performances of these filters were investigated experimentally using both a THz time domain spectrometer and a Fourier transform infrared spectrometer (FTIR). Commercial electromagnetic simulation software, CST Microwave Studio, was used to verify the experimental data. Our results show that the transmittance of the fourcross shaped filter can be actively modulated by the temperature triggered metal–insulator phase transition of VO_2.

References

1. M. Tonouchi, Nat. Photonics 97, 1 (2007).
2. L. Ozyuzer et al., Science 318, 1291 (2007).
3. D. Ruzmetov et al, J. Appl. Phys. 107, 114516 (2010).

Keywords: Vanadium dioxide, terahertz waves, metamaterial filters, metal-insulator transition

15:50 – 16:10

Mechanical Properties of Sputtered Oxide Thin Films Deposited On Glass

Lukas Simurka[1], Tuncay Turutoğlu[1], Gence Bektaş[2], Radim Ctvrtlik[3], Klaus Bange[4]

[1]Şişecam Science and Technology Center, Kocaeli, Turkey

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[4]Mk Consulting Gmbh, Jugenheim, Germany

Optical thin films have been widely used in glass coating industry for various energy saving applications such as antireflective coatings and low-emissivity glasses. However, handling and processing of these systems can lead to different mechanical defects decreasing its lifetime and optical performance. Therefore, understanding and control of the mechanical properties play an important role in thin films production. Silicon dioxide films are good interference-active layers in optical systems due to their low refractive indices and low absorption. Moreover, silica films exhibit excellent blocking properties and are being used as barrier layers preventing the diffusion of alkali from glass substrates into the neighboring alkaline sensitive coatings. The mechanical and optical properties can be additionally tuned by adding nitrogen to the oxide structure. Resulting oxynitride structure provides higher refractive indices and better mechanical performance. The optical performance of low emissivity and antireflective coatings can additionally be modified by titanium dioxide thin films providing high refractive indices and good mechanical performance. The present work focuses on mechanical and optical properties of silicon dioxide, silicon oxynitride, and titanium dioxide thin films deposited by reactive magnetron sputtering on soda-lime silicate glass. The chemical structure, mechanical and optical properties of the films were investigated as a function of the process pressure and magnetron power. Nanoindentation and spectroscopic ellipsometry measurements revealed that the film hardness, reduced elastic modulus and refractive index decrease as the process pressure is increased and magnetron power decreased. Obtained hardness and reduced elastic modulus correlate with the film density measured by X-ray reflectivity, and scratch resistance follows the H/Er ratio.
Keywords: Thin films, density, refractive index, composition, mechanical properties, glass

ION EXCHANGE / Chemical Tempering
October 23rd, 2017, 14:00-15:50, Hall: KASIMPAŞA-4,5
Chair: **Cemil Tokel**

14:00-14:30 (Invited Speaker)
Advances In Mathematical Modeling of Chemically Strengthened Glass By Ion Exchange: Concentration Depth Profile and Residual Stress.
Guglielmo Macrelli
Isoclima SpA – R&D Department
Via A. Volta 14
35042 Este (PD) – Italy

Mathematical modeling of chemically strengthened glass is relevant for residual stress evaluation and final reliable strength prediction. As ion exchange is a non equilibrium kinetic process, concentration depth profile calculation is the basic step towards the calculation of the induced stress profile by ion stuffing in the glass silicate matrix. While this is straightforward for traditional processes based on immersion of glass articles in molten salts, it becomes more intriguing for processes with subsequent thermal treatments or processes with a limited thin or thick ion source coating deposited on the glass surface. An analytical solution based on a classical mathematical physics approach is presented that allows modeling ranging from an infinite ions reservoir (erfc like solution) to a "delta" source thin layer (exponential thin film solution). The presented solution is also considered to model concentration profile of traditional ion exchange processes after subsequent thermal treatments. Another area of interest for Ion Exchange modeling is the residual stress determination including relaxation effects and, hopefully, a zero time surface compression prediction. In this area there is still a not fully clarified linear network dilatation coefficient (LNDC) anomaly and effects can be noticed generated by stress relaxation after build up resulting in specific stress profile characteristics (subsurface compression maximum, tensile maximum after the zero point). Several approaches, again based on classical mathematical physics, are presented both semi-empirical (based on experimental surface compression determinations) and fully theoretical with fixed and variable coefficients. Final strength determination examples are presented with some discussions of surface flaws geometry conservation after ion exchange.

14:30 – 14:50

Novel Thermo-Chemical Strengthening Of Glass for Solar Energy Applications and Its Impact on the Physical Properties

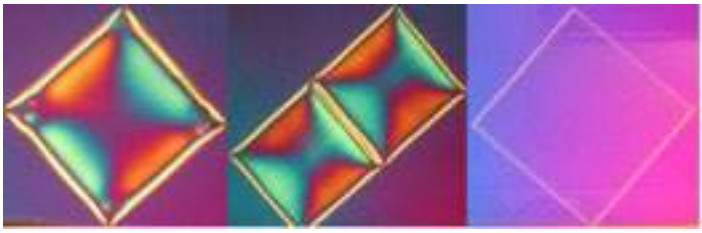
Peter Sundberg[1], Lina Grund Bäck[1], Robin Orman[2], Simon Johnson[2], Jonathan Booth[2], Stefan Karlsson[1]

[1]Rıse Research Institutes Of Sweden - Glass, Pg Vejdes Väg 15, Se-351 96 Växjö, Sweden

[2]Johnson Matthey Technology Center, Blounts Court, Sonning Common, Reading, Rg4 9nh, Uk

The LIMES project (Light Innovative Materials for Enhanced Solar Efficiency), a Solar-ERA.NET project, have been a fruitful collaboration project to optimize many different properties in state-of-the-art solar glasses for photovoltaic (PV) modules. Here, we present results related to the effectiveness of reactive gas strengthening and its improvement of the physical properties of thin glasses. Novel thermo-chemical strengthening has been created using reactive chemicals that react with the glass surface during the thermal strengthening process. The glass surface gets a markedly increase of Al_2O_3, which in previous studies has been shown to

have a beneficial effect on the mechanical properties. Successful thermo-chemical strengthening of 4 and 2 mm glasses to a similar strengthening level have repeatedly been performed, polariscope images in Figure 1. The strengthening level has been quantified using SCALP (Scattered Light Polariscope) and were found to be in the range of 85-110 MPa of compressive stresses in the surface which are comparable to values for conventional thermally strengthened glass.
The strength of the glasses was quantified using the ring-on-ring method and the surface mechanical properties were evaluated by means of nano/microindentation. UV-Vis spectroscopy measurements have also been performed.
Results for the ring-on-ring tests show that the 2 mm thin glass were positively affected by the thermo-chemically strengthening while 4 mm did not show any significant change as compared to thermally strengthened. The thermo-chemically strengthened glasses have a significantly higher crack resistance than both the reference float glass and the traditionally thermally strengthened glass. The hardness results show that for low loads, ≥1 mN, the hardness follow the order thermo-chemically strengthened glass > thermally strengthened glass > annealed float glass. The scratch resistance for thermo-chemically strengthened glass is increased as compared to ordinary float glass. In addition, the transmission is not markedly reduced.
Keywords: Thermo-chemical strengthening, solar panel glass, alumina coating



Figure

14:50 – 15:10
Strengthening of Soda Lime Glasses Using Molten Salt Bath and Salt Paste Applications via Ion Exchange
Salih Erserin[1], Aslı Özel[1], Duygu Güldiren[2], İpek Erdem[3], Süheyla Aydın[3]
[1]Arcelik A.Ş.
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[3]Istanbul Technical University

The use of glass is frequently restricted by its mechanical fracture. The actual strength and fracture behaviour is mostly determined by surrounding environmental factors causing surface flaws. These reduce the theoritical strength to a great extent. Researchers study to eliminate the large

difference between the theoretical and actual strength values for glasses to increase usage areas, thus chemical strengthening has become a method highly focused recently.
In the scope of this study; chemical strengthening was provided to commercial soda lime glasses of 3 and 6 mm thickness through the application of ion exchange process, using a K+ ion containing salt paste and molten salt bath. Molten salt bath applications were realized by immersing samples in a molten KNO3 bath at 450°C for 6, 12 and 24 hours. Salt pastes of KNO_3:KCl (2:1) and KNO_3:KCl (1:2) by weight were prepared and applied to the surface. Ionic exchange was again carried out at 450°C for 6, 12 and 24 hours. Strength was determined by equibiaxial flexure test, hardness was investigated by micro Vickers hardness tests and the diffusion depth was analyzed by SEM/EDS line scan analysis. The effect of kaolin addition to these compositions was also studied in terms of the mentioned characterizations, the results were compared regarding the thickness of samples.
Keywords: Soda lime glass, ion exchange, molten salt, salt paste, glass strengthening

15:10 – 15:30
Variations in the Application Methods of Ion Exchange for Chemical Strengthening Purposes
İpek Erdem[1], Duygu Güldiren[2], Süheyla Aydın[1]
[1]Istanbul Technical University, Metallurgical And Materials Engineering Dept., Maslak, Istanbul, Turkey
[2]Şişecam Science and Technology Center, Kocaeli, Turkey

Since chemical tempering has become a preferred treatment for glass strengthening, it has been applied through ionic exchange process executed conventionally by molten salt bath method. Molten salt bath has been effective in the means of strength enhancement amounts, but it is widely known that the method causes the consumption of too much experimental ingredient as large volumed salt baths are required, leaving behind an excessive amount of waste. It is also a method with some feasibility constrictions for serial production. The mentioned ionic exchange takes place between the ions in the original glass surface and a salt that it is contacted with. The hardness, cracking behavior, bending strength and mechanical properties as such are improved by the compressive stress generation on glass surface by the incorporation of larger ions. There are different ion exchange methods to incorporate these ions to generate compressive stress. Recently, combining salts with a binder to obtain a paste like salt bath with a much smaller volume and the possibility of controlled application has become a focus of studies. So in the present study, Corning® 2947 soda-lime glass slides were submitted to ion exchange process using a binder mixed with KNO_3 salt to obtain a much denser salt bath. The process was applied under varying temperatures that are below

the glass transition temperature, and varying durations. Mechanical properties of the ion exchanged glasses were studied in terms of the Vickers hardness and bending strength. Investigation of potassium ion concentration amount incorporated into the ion exchanged glasses were performed by using energy dispersive X-ray spectroscopy (EDS). The results were evaluated together with the results of conventional molten salt bath method.
Keywords: Ion exchange, chemical strengthening, soda-lime glass, mechanical properties, salt paste method

15:30 – 15:50
Characterization of Silver Nanoclusters in Soda Lime Silicate Glass Developed by Ion Exchange Process
Meryem Sarıgüzel[1], Melis Can Özdemir Yanık[1], Yusuf Öztürk1, Esin Günay[1], Arca İyiel[2], Burak İzmirlioğlu[2]
[1]Tubıtak Marmara Research Center Materials Institute
[2]Şişecam Science and Technology Center, Kocaeli, Turkey

Silver-containing soda-lime silicate glasses (commercial ŞİŞECAM Inc. composition: 72.09 SiO_2-13.46 Na_2O-0.40 K_2O-8.28 CaO-4.24 MgO-1.20 Al_2O_3-0.035 TiO_2-0.20 SO_3-0.09 Fe_2O_3, in wt%) were developed by ion exchange and following thermal annealing in reducing atmosphere. It was determined the silver concentration changed the intensity of coloring. Due to surface plasmon resonance (SPR) of nanoclusters formed through reduction-migration mechanism, absorption band was observed in absorption spectrum acquired by UV-visible spectrometer. Average radii of silver nanoclusters were calculated according to the Mie theory. Only amorphous structure and metallic silver was detected by X-ray diffraction (XRD). Antibacterial activity test was performed to evaluate the antibacterial efficacy against E.coli. The structural and microstructural properties in the glass matrix showing the formation of silver nanocluster have been studied using Fourier Transform Infrared Spectroscopy (FTIR) and Scanning electron microscopy (SEM).
Keywords: Glass, ion exchange, silver nanocluster

FURNACE MODELING & SENSORS
October 23rd, 2017, 14:00-15:50, Hall: BALAT
Chair: **Abdullah Kılınç**

14:00-14:30 (Invited Speaker)
The Impact of Higher Hydrogen Concentrations in Natural Gas on Industrial Combustion Processes
Jörg Leicher, Tim Nowakowski, Bledar Islami, Anne Giese, Klaus Görner
Gas- und Wärme-Institut Essen e.V., Essen, Germany

The integration of volatile renewable energy sources such as wind and solar

power into existing energy infrastructures poses a significant challenge to the operators of electricity grids today. A possible solution that is being discussed is “power-to-gas”, i.e. the use of surplus electricity to produce hydrogen (or even methane with an additional methanation process) which could then be injected into the public natural gas grid. The huge storage capacity of the gas grid would serve as a buffer, offering benefits with regards to sustainability and climate protection while also being cost-effective since the required infrastructure is already mostly in place. The consequence would be, however, that the distributed natural gas could contain larger and even fluctuating amounts of hydrogen. There is some uncertainty, however, how different gas-fired industrial applications and processes may react to these changes. Here, in addition to operational safety, factors like efficiency, pollutant emissions (NO_X), process stability and of course product quality have to be taken into account.
In a German research project, Gas- und Wärme-Institut Essen e. V. (GWI) investigated the impact of higher and varying hydrogen contents (up to 50 vol.-%, much higher than what is currently envisioned) on a variety of industrial combustion systems, using both numerical and experimental methods. Some results from this project will be presented in this contribution.
Keywords: Industrial combustion, process heating, power-to-gas, natural gas, hydrogen, renewable energies

14:30 – 14:50
Glass Furnace Regenerators: Benefits of Design Optimization and Feedback from Industrial Experience.
Bruno Malphettes[1], Michel Gaubil[2], Isabelle Cabodi[2], Thibault Champion[2]
[1]Sefpro
[2]Saint-gobain Cree

As regenerative process is the dominant technology in sodalime glass industry to optimize specific energy consumption, the detailed engineering of regenerators is still not standardized and sometimes overlooked, with a vast variety of geometry, type of refractory materials and checkerpack design.
Instead of “filling a box”, the choice of a regenerator solution must carefully factor all glassmakers’ requirements: glass type, raw materials, cullet ratio and quality, surrounding technology choices such as NOx abatement solutions, batch preheating, fuel type, but also specific pull and expected lifetime.
This paper presents a comprehensive approach and method for regenerator engineering and re-engineering starting from the requirements, constraints and experience of the glassmaker.
In each project, several design options can be considered with different impacts on initial investment, performance level and stability of the whole system.

Actual industrial cases will be developed to illustrate different fundamental choices made at furnace design stage and evaluate their performance both in lifetime and energy efficiency.
In particular we will review the impact of regenerator crown and wall materials, the choice of checkerpack materials and shapes, and the impacts of plugging and corrosion on regenerator efficiency.
Keywords : Regenerator, design, glass, furnace, checkerpack, cruciforms, bonded, materials, wall, crown, rider, arches, energy, efficiency, corrosion, fused, cast, AZS, spinel, alumina, chamber

14:50 – 15:10
A Numerical Investigation for the Effect of the Electric Boosting in an Oxy Fuel Fired Glass Fiber Furnace
Burçin Gül, Merve Durubal
Şişecam Science and Technology Center, Kocaeli, Turkey

Today's more energy-efficient glass fiber furnaces are increasingly utilizing the oxy-fuel fired systems to significantly reduce the level of NOx and particulate emissions compared to traditional air-fired furnaces with electric boosting.
Strong insulation effect of undesired foam frequently seen in glass fiber furnaces requires an increment in the share of electricity in the specific energy consumption. This paper aims to investigate the benefits experienced through the application of supplementary electrical heating to the glass melting process in an oxy-fuel fired glass fiber furnace designed as cross fired unit-melter. For this purpose, numerical simulations of an oxy-fired glass fiber furnace that contains an electric boosting system are carried out and effect of electrical heating amount in a multi zone boosting system is examined. Additionally, the system is coupled with a double row of bubblers for reinforcement of convection flows in the glass tank. Impact of adapting electric boosting system and thermal barrier effect created by the bubbler system is also compared and discussed.
The obtained data is evaluated in terms of glass flow rates, temperature values, amount of heat transfer to the glass melt from combustion space and electric boost system and residence time in the glass tank. Based on the evaluated results, an optimum electrode configuration and boost per electrode zone are determined to meet the requirements of expected pull rate and product quality. The study claims that increase in supplementary electrical heating has a favorable effect on convection currents in the melt, enabling increased pull rates, better fining, and glass quality improvements. The results also shows that utilization of the bubbler system with the electric boosting system considerably increases average temperature in the glass tank.
Keywords : Glass furnaces; glass fiber furnaces; mathematical modelling; energy efficiency, oxy-fuel

15:10 – 15:30

Towards Real-Time Continuous Annealing Furnace Simulations via Hybrid GPU - CPU Approach

Faizan P. Siddiqui[1], Kaan Menekşedağ[1], Altuğ Melik Başol[1], Pınar Mengüç[1], Adnan Karadağ[2]

[1]Özyeğin University / Mechanical Engineering Department

[2]Şişecam Science and Technology Center, Kocaeli, Turkey

Annealing process is one of the critical stages of the glassware manufacturing. Its main objective is to control the cooling rate of the glass objects inside the furnace to obtain the desired mechanical properties of the end-products. During the process, the temperature profiles of the objects are not directly measured, but instead the air temperature inside the furnace is monitored assuming that the objects are in thermal equilibrium with the surrounding air. However, with the increasing thickness of glass, this assumption leads to erroneous results.

This work focuses on developing fast and accurate algorithms for the numerical solution of the annealing process in continuous furnaces. The thermal radiation, as one of the dominant heat transfer modes, is solved using a Monte Carlo ray tracing (MCRT) method, and the conduction within glass is solved via conventional finite volume based methods. The excessive numerical cost of the MCRT method is minimized with the use of graphic processors (GPU) and the heat conduction equations are solved simultaneously on the central processing unit (CPU). The performance tests regarding the thermal radiation part show a more than 10x acceleration in the computational time with the utilization of GPU. This work demonstrates the potential of hybrid computer architectures (CPU + GPU) on the real-time solution of continuous annealing process.

Keywords : Annealing furnace, thermal radiation, modeling, graphic processors

15:30 – 15:50

Improvements of Glass Melt Flow in Container Furnace

Marcela Jebavá[1], Lubomír Němec[1], Jiří Brada[2]

[1]Laboratory Of Inorganic Materials, Joint Workplace Of The University Of Chemistry And Technology Prague And The Institute Of Rock Structure And Mechanics Of The Ascr, V.v.i., Prague, Czech Republic

[2]Glass Service, Inc., Vsetín, Czech Republic

A container furnace was chosen as a representative of an industrial furnace for evaluation of the character of glass melt flow with respect to melting quality by mathematical modelling. Previous model studies of the melt flow character in simple melting channels helped to understand appropriate distributions of the boosting energy in the melting space. The courses of sand particles dissolution and fining were modelled as criteria of quality.

The utilization of the melting space, the melting performance, and the specific energy consumption were used for evaluation of the resulting melt flow character.
The melting performance increases and the specific heat losses decrease with the growing amount of boosting energy located in the batch region, regardless of the detailed arrangements of electrodes. However, the double central longitudinal row of electrodes (in x-direction) provides best results and the melt flow shows patterns of the helical flow.
Generally, the melting characteristics improve when the critical melting performance approaches the curve describing the flow rate as a function of energy delivered in the batch region under balanced energetic state. The derived simplified formulas describe the development of the flow rate as a function of longitudinal and transversal energy distribution. Then, the beneficial flow character can be predicted for the homogenization phenomena (sand dissolution and fining).
The procedure shows the significance of the melt flow character for the melting effectivity besides the melting kinetics.
Keywords: Glass melting, melt flow, energy consumption, space utilization

BIOMATERIALS
October 23rd, 2017, 14:00-15:20, Hall: Cibali 1
Chair: **XXXX**

14:00 -14:20
Comparison of 3D Scaffolds Containing Cu-Doped Bioactive Glass and Sr-Doped Bioactive Glass with Cu Nanoparticles
Ayse Özyuğuran-Arifoğlu, Ayşen Aktürk, Özlem Tuğçe Şahin, Sadriye Küçükbayrak
Istanbul Technical University, Chemical & Metallurgical Faculty, Chemical Engineering Department
34469 Maslak-ıstanbul

Purpose
The combination of biodegradable polymers and bioactive glasses (BG) results in a new group of composite materials for applications as temporary orthopedic implants, bone filler materials or as three-dimensional (3D) biocompatible scaffolds in tissue engineering. The combination of biocompatibility of biodegradable polymers and the bioactivity of BG can be achieved by preparation of porous polymer/BG composites by different methods. However, the need for advanced scaffold systems has compelled the addition of different functionalities (bioactivity, mechanical competence, growth factor or drug delivery, antioxidative effects, angiogenic potential and antibacterial behavior) into the substrates to be able to mimic the natural bone structure. This study proposes the fabrication of novel multifunctional 3D composite scaffolds based on Cu-doped BG and Sr-doped BG with Cu nanoparticles delivery in order to repair large bone defects in the skeletal system.

Materials and Methods
3D bioactive glass-polylactide (PDLLA) composite porous scaffolds were prepared using a modified salt template-particulate leaching technique. The bioactive glasses in the systems of SiO_2-CaO-P_2O_5-Na_2O-CuO and SiO_2-CaO-P_2O_5-Na_2O-SrO were produced by classical melting method. The copper doped BG and, strontium doped BG - Cu nanoparticles obtained by chemical reduction using microwave irradiation method were used in the fabrication of composite scaffolds. The bioactive behavior of scaffolds was performed in vitro through the immersion of samples in SBF for different soaking periods: 1, 7, 14 and 28 days. The samples were then characterized using SEM, XRD and FTIR. Inductively coupled plasma optical emission spectrometry (ICP-OES) was used to determine the changes in the concentrations of therapeutic ions in the SBF solution due to the soaking of scaffolds.

Results
In the present study, BG doped with therapeutic ions were successfully incorporated into the PDLLA matrix by means of modified salt template-particulate leaching technique. It was observed that there was a good pore interconnectivity maintained in the scaffold microstructure. FTIR, XRD and SEM results revealed the HA formation on the surface of all scaffolds after immersion in SBF. The scaffolds containing Cu-doped BG and, strontium doped BG-Cu nanoparticles may have therapeutic potential considering both Sr^{2+} and Cu^{2+}ions release profiles detected in this study.
Keywords : Scaffold, bioactive glass, therapeutic ions, nanoparticle, bone tissue engineering

14:20 -14:40
An Optimization Study to Fabricate Fibrous Nanocomposite Scaffolds Containing Silver Nanoparticles and Bioactive Glass.
Ayşen Aktürk, Melek Erol Taygun, Gültekin Göller, Sadriye Küçükbayrak
Istanbul Technical University

Researchers focused on developing scaffolds from electrospun fiber mats to be used in tissue engineering applications have given many credits to the nanomaterials for the purpose of mimicing the structure of extracellular matrix in human body. The success of created scaffolds is depended on lots of parameters, including good mechanical properties, water insolubility, appropriate pore size and infection. Among them, infection is one of the major challanges that may cause to elimination of prosthesis or notable delay in healing. To overcome this issue, biomaterials with antibacterial characteristics can be designed by doping, substituting or incorporating metal nanoparticles during the scaffold fabrication. In addition, bioactive inclusions or coatings provides good osteoconductivity properties to the polymer matrix, which allows for a better cell seeding and growth environment. It was aimed to fabricate nanoscaled polymeric antibacterial

composite material showing bioactivity by the incorporation of silver nanoparticles and bioactive glass.
In this work, nano-scaled composite materials from polyvinyl alcohol (PVA), bioactive glass, and silver nanoparticles were fabricated by electrospinning technique. For this purpose, silver nanoparticles were fabricated using chemical reduction method using soluble starch as a biopolymer, while bioactive glass will be produced by melt derived process. Then, solutions containing PVA with metal nanoparticles and bioactive glass particles were prepared to be converted into electrospun nanofibers at the relevant conditions (i.e., applied voltage, tip-to-collector distance, feeding rate, solution concentration, solvent composition etc.). Hence, the optimal conditions to produce nanocomposite scaffolds were investigated by using response surface methadology based on Box Behnken design.
The individual and the interactive effects of these parameters on the fiber diameter were determined. The characterization studies performed with Fourier transform infrared spectroscopys (FTIR), Field Emission Scanning Electron Microscopy (FESEM), Dynamic Light Scattering (DLS) and Xray Diffraction (XRD) and the antibacterial tests showed that the obtained fibrous nanocomposites are suitable for biomedical appications.
Keywords : Electrospinning, bioactive glass, silver nanoparticles, box behnken design

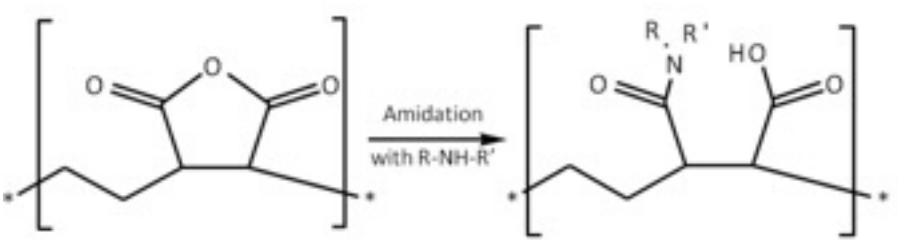
14:40 – 15:00
Preparation and Characterization of Alumina-Hydroxyapatite-Bioactive Glass Composites
Azade Yelten, Suat Yilmaz
Istanbul University, Faculty Of Engineering, Department Of Metallurgical And Materials Engineering

Glasses fulfill various expectations such as optical needs, aesthetical view, conservation and protection of food and medicine, biomedical studies, etc. Bioactive glasses is a type of bioceramic material and can take part in hard and soft tissue healing and replacement applications. Bioactive ceramic materials can form biochemical bonds with the tissues and accelerate the injured tissue repairing process. Hydroxyapatite (HA, $Ca_10(PO_4)_6(OH)_2$) is also a bioactive ceramic material and has a chemically very similar structure to the calcium phosphate minerals found in human hard tissues. Alumina (α-Al_2O_3) has a bioinert character which restricts biological fixation between the material and tissue. However, it possesses better mechanical properties compared to HA and bioactive glass. The target of this study was to achieve a biocomposite material with superior properties by assembling the aforementioned 3 bioceramics. α-Al_2O_3 was synthesized through the sol-gel technique utilizing aluminum iso-propoxide (AIP, $Al(OC_3H_7)_3$) as the starting material. HA was obtained following the wet chemical precipitation technique where calcium hydroxide ($Ca(OH)_2$) and phosphoric acid (H_3PO_4) were the calcium and phosphorus sources.

Reaction temperature (30 and 85 °C) between the sources was selected as the process parameter. Bioactive glass powders were produced by applying the conventional melting-quenching procedure. The well-known 45S5-Bioglass chemical composition (wt. 45% SiO_2, 24.5% Na_2O, 24.5 % CaO, 6% P_2O_5) developed by Hench and his team was considered while preparing the glass batches. Melting was performed at 1250, 1300 and 1350 °C. Quenching of the molten batches was carried out in cold water with ice. After grinding each composite component, they were mixed and cylindrical pellets were formed by pressing the composite powder mixtures. Finally, the green pellets were sintered at 1250 °C for 1h. Chemical (XRD, FTIR), physical (bulk density and apparent porosity measurements), microstructural (SEM-EDS) and mechanical (compression and microhardness tests) properties of the samples were characterized.
Keywords : Alumina, bioactive glass, hydroxyapatite, biocomposite, characterization

15:00 – 15:20
Using ZeMac® Copolymers to Modify Surface Chemistry of Glass Fibers to Improve Performance of GF-Reinforced Polyamides
Ashok Mohan Adur
Vertellus Llc

The unique chemistry of ZeMac® alternating copolymers of ethylene and maleic anhydride, used as a critical part but at a low dosage additive during the manufacture of glass fibers in the sizing emulsion provides reactive anhydride groups on the surface of the glass fiber modifying their surface chemistry. When such glass fibers are compounded with polyamides to form glass fiber reinforced polyamide composites, significant improvement in mechanical and thermal properties as well as hydrolysis resistance to radiator fuel are obtained. This technology can also be applied to the surface sizing of other reinforcements. Examples of specific applications as well as other benefits will also be presented.
Keywords : Glass fiber, surface chemistry, interfacial bonding and adhesion, glass fiber reinforced polyamide composites, applications, automotive, wind blade



Figure

Figure

GLASS STRUCTURE AND PROPERTIES
October 23rd 2017, 17:30 – 18:30, Hall: Hasköy
Chair: **Mustafa Oran**

17:30 -17:50
Understanding Diffraction Patterns of Glass, Liquid, and Amorphous Materials
Shinji Kohara[1], Osami Sakata[2], Koichi Tsuchiya[2], Yohei Onodera[3], Shuta Tahara[4], Yasuaki Hiraoka[5]
[1]National Institute For Materials Science, Jst
[2]National Institute For Materials Science
[3]Kyoto University
[4]University Of The Ryukyus
[5]Tohoku University

Diffraction patterns of glass, liquid, and amorphous materials usually do not provide us with sufficient structure information due to which, in turn, is the result of "disorder" arose from the lack of periodicity. However, it is well known that glass forming oxide materials exhibit a first sharp diffraction peak (FSDP), manifesting the formation of intermediate-range ordering. Figure 1 shows total structure factors, S(Q) of $Zr_{50}Cu_40Al_{10}$ metallic glass, amorphous Si[1]), and SiO_2 glass[2]). Note that scattering vector Q is normalized by multiplying d (first correlation distance appeared in real space function obtained by a Fourier transformation of the S(Q). The definition of Q_1, Q_2, and Q_3 was proposed by Zeidler and Salmon[3]). SiO_2 glass exhibit Q_1 (FSDP), Q_2 (principal peak, PP), and Q_3, which stands for intermediate-range ordering, chemical ordering, and first-neighbour atomic

correlation, respectively. On the other hand, an FSDP can hardly be observed in the S(Q) of amorphous Si and $Zr_{50}Cu_{40}Al_{10}$ metallic glass has only Q_3 peak. We apply this classification to other disordered materials for systematic understanding of diffraction from disordered materials. Furthermore, a topological analysis method employing persistent homology proposed by Hiraoka et al.[4]) will be introduced to uncover the relationship between diffraction pattern and topology.

References

1. K. Laaziri et al., Phys. Rev. Lett., **82**, 3460 (1999).
2. http://www.alexhannon.co.uk/DBindex.htm.
3. A. Zeidler and P. S. Salmon, Phys. Rev. B, **93**, 214204 (2016).
4. Y. Hiraoka et al., Proc. Natl. Acad. Sci. U.S.A., **113**, 7035 (2016).

Keywords : Glass, structure, diffraction

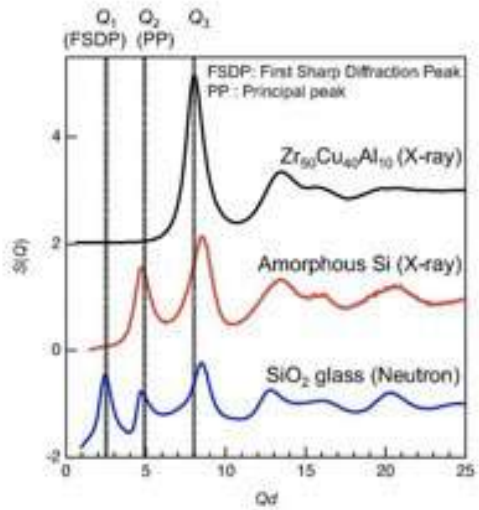


Fig. 1 Total structure factors, S(Q) of $Zr_{50}Cu_{40}Al_{10}$ metallic glass, amorphous Si, and SiO_2 glass.

17:50 – 18:10

Model Glasses Irradiated with Electron – Macroscopic and Structure Relations

Ondrej Gedeon[1], Tadeas Gavenda[1], Karel Jurek[2]
[1]University Of Chemistry And Technology
[2]Institute Of Physics, The Czech Academy Of Sciences

Glass is often exposed to radiation when used in cosmic and nuclear industry; influence of fast electrons on glass properties is of especial interst as all types of irradiation generates secondary electrons. The presented study was limited to the effect of 50 keV electron beam on model glasses, namely to vitreous silica and two binary alkali-silicate glasses ($15K_2O.85SiO_2$ and $15Li_2O.85SiO_2$), with aim to better understand, evaluate and correlate

the observed changes in volume and structure.
Glasses were irradiated with 50 keV electron beams with various doses up to a few decades of kC/m^2. The beam was defocused to 60 mm to supress the temperature increase in the irradiated volume. Atomic Force Microscopy was utilised to monitor volume changes induced by electron bombarding. Volume responses to low-dose electron bombardment were alike for all glasses; the compaction was recorded. On the other hand, higher doses showed volume expansion of alkali-silicate glasses while vitreous silica revealed only shrinkage. The foil (around 8 mm thick) of silica glass was also made; such thickness enables to observe the glass under the transmission conditions as the penetration depth of 50 keV electron is about 20 mm. Irradiated spots were observed by confocal Raman spectroscopy to find out structural changes generated by radiation. In irradiated silica glass, it was observed a shift and narrowing of Si-O-Si vibration band what means the volume compaction in vitreous silica is given by both the decrease of the average Si-O-Si bond angle and the narrowing of the Si-O-Si angle distribution. Comparing thin and bulk glass showed the volume changes are proportional to the irradiated thickness and can be calculated from the shift in Raman peak. It is also shown, compaction at lower doses is strongly correlated with the increase of the D2 peak, situated at 602 cm^{-1}, that is responsible for the increase of the three-membered rings.
Expansion of alkali-silicate glasses is related to migration of alkali ions out of the irradiated volume. Quantitative differences can be attributed to the different ion sizes and the ongoing relaxation around the original sites. Volume relaxation of irradiated glasses was observed by annealing. It resulted in the levelling of the pits created by irradiation, but only for doses below the incubation dose. Annealing of high-dose (above incubation dose) irradiated glass did not lead to full volume recovering as the alkali ions had migrated out of the irradiated volume. Relaxation was accompanied with a decrease of D2 peak and the reversion of the Si-O-Si vibrations band. Low-frequency region of the annealed Li15 glass was undistinguishable from that of pristine glass, while annealing of K15 glass did not result in the full reconstruction to the original shape.
Keywords : Silicate glass, electron irradiation; volume changes; raman spectroscopy, structure changes

18:10 – 18:30
Lateral Deformation and Scratching of Compacted Silica Glasses
Shigeki Sawamura, Rene Limbach, Lothar Wondraczek
Otto Schott Institute of Materials Research, Friedrich Schiller University Jena

Modern applications of glass, in particular, as covers and substrates in handheld electronic devices, relay on its mechanical performance and visual appearance. In this context, the scratching behavior is of fundamental importance, both in reducing optical appeal and initiating surface defects. In an effort to provide quantitative descriptors for the scratch resistance of

glasses, here, we consider vitreous silica as a model system. In this system, we vary density by melt-compaction at T_g, achieving volume densification of ~3 %. Such compacted SiO_2 glasses show higher density, young's modulus and hardness as compared to their pristine precursor. We then conduct lateral testing, using a Berkovich indenter in edge-forward configuration for evaluating lateral force and friction coefficient during scratch. This provides access to the quantitative work of lateral deformation. We demonstrate that the method is sensitive to the above-noted variations in volume density, where more compaction leads to higher lateral force.

Keywords : Silica glass, mechanical property, scratch, friction, and cracking

COATINGS

October 23rd, 2017, 17:30-18:40, Hall: KASIMPAŞA-1,2

Chair: **Koichi Suzuki**

17:10-17:40 (Invited Speaker)

Noteworthy Dry Coating Technologies for Large Area & High Volume Glass Related Products

Koichi Suzuki
President of SurFtech Tranantional Co.,Ltd.
Japanese Representative of Fraunhofer FEP
Deputy managing director of AIOT (Association of Innovative Optics Technologies)
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Not only coated glass products but also glass products with highly functional coated plastic films are gathering attention in the recent glass market. Because of this, it is worthwhile to know and understand the different coating technologies which are currently used for glass and plastic substrates commercially and/or in pilot scale in order to select the best technology for one's future glass related product business.
Based on the presenter's 20year EU-Japan technology transfer business and experiences as the secretary of ICCG (International Conference on Coatings on Glass and plastics), several noteworthy dry coating technologies will be introduced and compared. In sputtering, C-mag for optical multilayer coating of Fraunhofer IST, RM cathode & hybrid pulse powering for precision coating of Fraunhofer FEP, and HIPIMS for highly durable coating of IST will be explained. In ultra high rate plasma assisted evaporation, HCD gun of FEP and UR gun developed in Japan will be compared. In PECVD, HCD gun (=arcPECVD) of FEP and ETP source of Meyer Burger Eindhoven will be explained. In atmospheric process, R2R-Fast(Spatial)-ALD of Meyer Burger Eindhoven will be specially highlighted. In addition, recent special development of coatings on thin glass foil of FEP will be shortly introduced.

18:00 – 18:20

Synthesis and Properties of Vitreous Thin Films Based On M2+ or M3+ Modified Silicon Oxynitrides

Jens Birch[2], Bo Jonson[1], Per Eklund[2], Sharafat Ali[1]
[1]Linnaeus University
[2]Linköping University

Thin films in the compositional system M-Si-O-N systems were deposited on various substrates – among others commercial soda-lime silicate float glass. The films were deposited by use of RF magnetron co-sputtering from M and Si targets in a controlled $Ar/N_2/O_2$ gas mixture.
The chemical compositions, optical and mechanical properties of the films were investigated using X-ray photoelectron spectroscopy, spectroscopic ellipsometry and nanoindentation, respectively. The thin films were found to be non-crystalline and containing N and M contents up to 80 atomic % and 50 atomic %, out of anions and cations respectively. This compositional range of bulk oxynitride materials is difficult to synthesize by melt-quench techniques.
The mechanical properties of the films, e g hardness and reduced elastic modulus show high values - up to 20 GPa and up to 160 GPa respectively These properties were related to the chemical composition and showed a dependency as increasing when the N content increased.
The film refractive indices were determined to range from 1.60 to 2.02 at the light wavelength 633 nm. The refractive indices were found to increase when the N and M contents of the film was increases.
The films were as well transparent in the visible region of the spectrum, making them interesting candidate materials in various applications in which increased surface hardness or refraction are targeted.
Keywords : Thin films, oxynitrides, mechanical properties, optical properties

18:20 – 18:40

Optimization of the Fabrication Process for Al-Doped ZnO Thin Films on Soda Lime Glass Substrates by Thermal Heating

Özge Bayraklı, Hasan Hüseyin Güllü, Makbule Terlemezoglu, Mehmet Parlak
Middle East Technical University

Transparent conducting oxides are commonly used for a wide range of electronic applications including photovoltaics and light-emitting diodes. Among them, ZnO has attracted more interest due to its environmentally friendly, low cost and highly thermal stability properties. However, the nature of high electrical resistivity has been a major concern in device applications, and thus there have been several researches focused on doping processes. Al doped ZnO (AZO) thin film is one of the most promising transparent and conductive oxide film for its high optical transmittance in the visible range and relatively low resistivity, compared

with ZnO films. In this work, AZO thin films were RF sputtered on soda lime glass substrates by using ZnO/Al_2O_3, 2% standard doping target. In order to find the optimal condition for the optoelectronic device applications, material properties of the films were analyzed as a function of both deposition and post-annealing temperatures. The structural, optical and electrical properties of thin films were investigated with particular emphasis on the effects of thermal treatments to reach better film quality. In structural characterization, X-ray diffraction (XRD) measurement was carried out and preferred orientation of AZO films was found to be along the (002) direction. In addition to the grain size analysis from XRD spectra, surface morphology of the films were analyzed by scanning electron microscopy, and it was obtained that surface properties can be improved by releasing the thin film stress through thermal heating process. In optical characterization, transmission measurements were used to investigate the transmittance and optical band gap characteristics, and the value of the band gap of AZO thin films was found in increasing behavior with increase in the applied temperature. The experimental results indicated that the electrical resistivity of the AZO films also depends on the heat treatments and the value of resistivity of AZO thin films decreases with increasing deposition temperature.

Keywords : Glass substare, thin film, transparent conducting oxide (TCO), AZO

ION EXCHANGE/Chemical Tempering
October 23rd 2017, 17:30-18:10, Hall: Kasımpaşa 4-5
Chair: **Süleyman Koç**

17:30 – 17:50

Ion Exchange Strengthening Of Glasses: Influence of Glass Composition and Thickness

Berkel Kayacan[1], Caner Kayaalp[1], Nahide Özben[2], Pelin Akkaya[3], Cevher Tol[3], Semin Atılgan[3], Burcu Öğüt[3], Lukas Simurka[3], Erdem Atar[2], Miray Çelikbilek Ersundu[1], İlkay Sökmen[3]
[1]Yıldız Technical University Department Of Metallurgical And Materials Engineering, Istanbul, Turkey
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Ion exchange is a chemical strengthening technique that improves the mechanical strength of glasses by modification of the surface chemical structure via immersion of the glass into a molten salt bath (KNO_3), wherein small sodium ions in the glass structure are replaced by potassium ions, thereby inducing the formation of a compressive stress layer.
Present study compares the ion exchange behaviors of one sodium alumina silicate glass composition and two soda lime silicate glass compositions

with different alumina contents and glass thicknesses by applying KNO_3 salt bath at varying temperatures and time intervals. Mechanical properties of ion exchanged glasses in terms of strength, hardness, scratch and cracking were studied by different techniques. Investigations of the concentration depth profile of potassium ions incorporated into the glasses and the structural modifications were performed by scanning electron microscope energy dispersive X-ray spectroscopy and fourier transform infrared spectroscopy methods, respectively. Furthermore the changes in optical and morphological properties were examined.
Depending on the glass composition and thickness, an optimum layer thickness of 5–40 **Q**m was found to be adequate to counteract the surface flaws responsible for glass fracture. Increase in the hardness, substantial enhancement in the indentation crack resistance and scratch resistance as well as 3 times higher bending strength on average were achieved for all of the ion exchanged glass samples compared with the original glasses.
Well-known positive effect of alumina content on the ion exchange reaction in sodium alumina silicate glass also manifested itself in the case of soda lime silicate glass.
Keywords : Chemical tempering, ion exchange, sodium, potassium, SEM, EDX, FTIR

17:50 – 18:10

Effect of Silver-Sodium Ion Exchange on Mechanical and Surface Properties of Soda Lime Silicate Glass

Melis Can ÖZDEMİR YANIK[1], Meryem SARIGÜZEL[1], Yusuf ÖZTÜRK[1], Esin GÜNAY[1], Türkay YILDIZ[2], Ezgi BİÇER[2], Arca İYİEL[2], Burak İZMİRLİOĞLU[2]
[1]Tübitak, Marmara Research Center, Materials Institute
[2]Şişecam, Science and Technology Center, Kocaeli, Turkey

Recently, the use of modified glass by the ion exchange method has increased considerably. The resistance of these glasses to atmospheric conditions and mechanical effects are important in terms of their area of usage like window glass, automobile glass, and display glass etc. In this study, atmospheric resistance and mechanical properties of silver ion exchanged and thermal annealed (reducing atmosphere- Ar/H2 mixture) soda lime silicate glasses were investigated. Glasses were subjected to 4-Point Bending tests according to ASTM Test Standards (C158-02-ASTM Standard Test Methods for Strength of Glass by Flexure (Determination of Modulus of Rupture) to determine the mechanical properties. Scratch resistance with an increasing load was measured and surface roughness of glass samples was examined by Atomic Force Microscopy (AFM). Climatic tests were performed at 40 °C, under 95% relative humidity for 21 days in a test chamber. Optical transmission and colorimetric analysis of the specimens were realized by UV-Vis-NIR spectrophotometer before and after climatic tests. FTIR analyses were conducted on the surface of the silver

ion-exchanged glasses in order to observe corrosion reaction by using the reflection technique in the 400-4000 cm-1wavenumber range. All the test results compared with untreated glass and no significant corrosion reaction after the climatic tests was observed.
Keywords : Silver-sodium ion exchange, scratch resistance, mechanical properties, soda-lime glass, surface properties

FURNACE MODELING & SENSORS
October 23rd, 2017, 17:30-18:40, Hall: BALAT
Chair: **Mathew Hyre**

17:30-18:00 (Invited Speaker)
Progress and Limitations to Glass Container Forming Modelling for Virtual Sampling and Mold Design
Hyre M. R.
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The use of computational models in the simulation of glass container forming processes has gained widespread use. These models have been successful in predicting final container properties insofar as they utilize appropriate numerical algorithms, material properties, boundary conditions, and are supported by accurate machine data. The aim of this study is to provide modelling guidelines and highlight limitations of the predictive capabilities of forming models. By evaluating the impacts of various glass conditioning and forming parameters, and evaluating the impact of IS machine configurations, a pragmatic assessment can be made as to the level of accuracy and precision which can be expected from the simulations. This presentation will focus especially on those modelling parameters which, in the past, have often been neglected (semi-transparent internal radiation, glass/mold slip) or simplified (variation in heat transfer during various IS events, effect of mold temperature distribution). The potential for using forming simulations for defect reduction, blank mold design, and mold cooling strategies will be discussed.

18:00 – 18:20
A Numerical Investigation of Thermal Tempering of Deep Hallow Glassware
Hazal Özcan
Şişecam, Science and Technology Center, Kocaeli, Turkey

Thermal tempering is the most commonly used method for increasing strength in glass. The goal in thermal tempering is to increase the resistance of the product to both mechanical and thermal loads by creating permanent compressive stresses (compression) on the surfaces. It is important for glass makers to enrich product range by improving the tempering quality of tall glassware products with minimum cost. For this

reason, it has been possible to work on the tempering process through simulation before any production. The results obtained with the simulation are very important to support attempts to improve the tempering quality and to predict the effect of cooling head design changes on the tempering performance of the glass quantitatively. In this study, it is aimed to optimize the tempering quality for deep tumblers which are difficult to temper. In the scope of the planned work, the cooling characteristics are examined by numerical simulation by determining the optimum position according to the blower head and the temperature and pressure of the cooling air.
Keywords : Thermal tempering, numerical simulation, tall glassware, process, process design

18:20 – 18:40

Polyflow Validation of Glass Gob Drop Test

Adrià Biosca Mecías[1], Salvador Borrós[2], Vicenç Pedret Clemente[1], Andrés-Amador García Granada[2]
[1]Ramon Clemente, El Masnou, Spain
[2]Iqs School Of Engineering, Barcelona, Spain

Introduction
Ramon Clemente (RC) is a glass container manufacturing company for the perfume sector. Every year RC develops more than 50 new container designs and produces over 60 million bottles with five lines and two furnaces. New developments and flexibility are key challenges for RC, changing jobs more than twenty-five times per week to adjust production to demand.
Perfume containers are not usually axi-symmetric and may have complex geometries, some examples can be seen at:
http://www.rclemente.net/en/exclusives. New designs are tested during job changes on the production line to define the proper mold equipment design and operation conditions. Blank mold design is a key issue to obtain the desired container quality (e.g. variable thickness distribution as seen in figure 1).
Purpose
Over decades, development process of new containers has been based on glassmakers experience and trial and error method. The use of simulation tools would speed up design process and improve containers quality. Blow-blow glass forming process is currently studied at RC using several simulation tools.
Material
In order to validate simulation tools, thermal IR cameras are used as shown in figure 2 for measuring temperature, velocity and gob geometry.
Methods
While parison design plays a key role, gob formation and blank mold loading are also important steps in the forming process. This part of the process is first validated using experiments where gobs can be completely

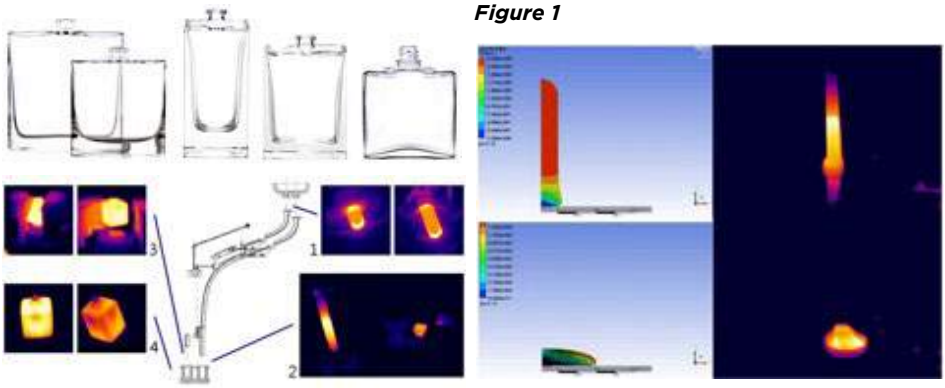
recorded while in mold blowing there is no visibility of the process. Also glass gob temperature variation and its viscosity dependence is not as important as during blowing.

Results

In this presentation drop tests are performed under several experimental configurations to validate the use of Polyflow for glass forming.

Keywords : Polyflow, simulation, gob, validation

Figure 1



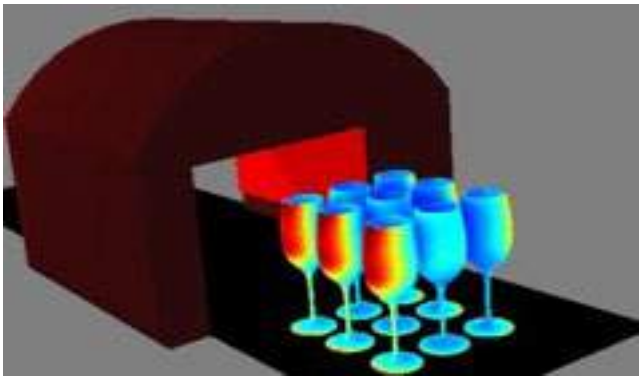


Figure 2

OPTO-ELECTRONICS
October 23rd 2017, 17:30-18:30, Cibali-1
Chair: **Tunç Görüney**

17:30 – 17:50
Electro-Optic Glass for Infrared Modulators
Martin Mika, Frantisek Lahodny, Kristyna Rysova
University of Chemistry And Technology

New cost effective infrared modulators are required for reliable processing

of optical signals in free space or fibre-optic communications. For these modulators, new glass materials with a high electro-optic coefficient need to be developed. Because high values of an electro-optic coefficient can be achieved in heavy metal glasses doped with metallic nanoparticles, we chose such materials as very promising for this application. In our work, we developed a new glass containing Ag0nanoparticles based on the glass-forming system $PbO\text{-}Bi_2O_3\text{-}Ga_2O_3$ that was doped with Ag^+ ions in the combination with Sb_2O_3 as a reducing agent for the precipitation of the nanoparticles. The glass was melted at 1000 °C for 35 min and then cast into a steel mould. Using Sb_2O_3, Ag^+ ions were successfully reduced to metallic silver Ag^0, and during heat treatment nanoparticles of a defined size were formed by the clustering of mobile Ag^0 atoms. The electro-optic coefficient of the glass was measured in our optical transmittance setup with a polarizer and analyser. From the rotation angle of the analyser, the electro-optical coefficient was calculated. Its values of the order 10-11 m·V-2 were measured for the glass containing nanoparticles with the optimized mean size of 5 nm that were precipitated by heat treatment at 350 °C for 15 min. Another advantage of this glass was that in the range of 550–2750 nm it had a transmittance of above 70 %, which is high enough to achieve low optical signal attenuation in the near infrared region. Collectively, our results indicate that the developed glass with Ag^0 nanoparticles of the optimized size could be applied to the construction of cost effective and reliable infrared modulators.

Keywords : Electro-optic modulator, infrared, Ag nanoparticles, glass

17:50 – 18:10

Chalcogenide Glass Based Integrated Photonics

Suat Kurt, Syed Sultan Shah Bukhari
Koç University

Chalcogenide glasses have at least one chalcogenide element such as S, Se, or Te in their composition [1]. The physical qualities of chalcogenide glasses, such as high transparency, high refractive index, and high non-linearity, make these glasses perfect to use in lasers, planar optics, and photonics circuits [2]. One of the minimum attenuation achieved with chalcogenide glasses reported is 12 dB/km at 3.0 **Q**m and 14 dB/km at 4.8 **Q**m [3]. Chalcogenide glasses have a wide range of applications in midinfrared (MIR) photonics such as optical waveguides, all-optical switches [4], and sensors [5]. We analyzed passive chalcogenide glass based integrated photonics devices for various applications. S. S. S. B. would like to acknowledge support from the Higher Education Commission (HEC) of Pakistan.

References

[1] J. Ballato, H. Ebendorff-Heidepriem, J. Zhao, L. Petit, and J. Troles, “Glass and Process Development for the Next Generation of Optical Fibers:

A Review," Fibers, vol. 5, no. 1, 11, 2017.
[2] B. J. Eggleton, B. Luther-Davies, and K. Richardson, "Chalcogenide photonics," Nature Photonics vol. 5, no. 3, pp. 141–148, 2011.
[3] K. Tanaka and K. Shimakawa, "Chalcogenide Glasses in Japan: A Review on Photoinduced Phenomena," Physica Status Solidi (B) vol. 246, pp. 1744-1757, 2009.
[4] K. Ogusu, J. Yamasaki, S. Maeda, M. Kitao, and M. Minakata, "Linear and nonlinear optical properties of Ag–As–Se chalcogenide glasses for all-optical switching," Optics Letters vol. 29, no. 3, pp. 265–267, 2004.
[5] T.-Y. Yan, X. Shen, R.-P. Wang, G.-X. Wang, S.-X. Dai, T.-F. Xu, and Q.-H. Nie, "Hot-embossing fabrication of chalcogenide glasses rib waveguide for mid-infrared molecular sensing," Chinese Physics B vol. 26, no. 2, pp. 024213, 2017.
Keywords : Chalcogenide glass, integrated photonics, midinfrared photonics.

18:10 – 18:30

Sol-gel Route to Holmium-doped SiO2-GeO2 Glasses for Photonic Applications

Jan Mrazek, Ivan Kasik, Michal Kamradek, Jan Aubrecht, Ondrej Podrazky, Ivo Barton, Vlastimil Matejec, Pavel Peterka
Institute Of Photonics And Electronics As Cr, V.v.i.

Rare-earth doped glasses are the essential materials for the development of a number of advanced photonic devices, such a planar optical amplifiers and fiber-lasers. Holmium-doped glass system SiO_2-GeO_2 has been widely used in fiber-lasers operating at around 2 mm. This spectral region is a part of so called "eye safe" wavelength region. Such fiber lasers are usually prepared by a conventional modified chemical vapor deposition (MCVD) combined with the solution-doping method. However, the MCVD approach has several limitations that can be eliminated by employing sol-gel approaches.
We present a versatile sol-gel route to holmium-doped (x)SiO_2-(1-x)GeO_2 (x=<0,1>) glasses for photonic applications. Starting sols, containing 0.5 at. % of holmium ions, were prepared by a hydrolysis of corresponding alkoxides. The pH of the sols was modified and the reaction kinetic of the sol-gel transformation was determined. The sols were applied on planar substrates and thermally treated to form transparent glass layers. Optical properties of the layers were measured. Selected sols were applied into a silica tube which was processed to a holmium-doped optical fiber. Waveguiding and lasing properties of the fiber were determined and compared with those of a fiber prepared by the conventional MCVD approach.
The reaction kinetic of the sol-gel transition, according to theoretical assumptions, strongly depends on the concentration of sols and on pH. The sol-gel approach has resulted in the formation of highly transparent films.

The refractive index of the films was gradually increased with increased concentration of GeO_2 up to 1.605. The films excited at 450 nm provided a strong luminescence at around 2.05 mm with a lifetime around 2 ms. The prepared fiber was fully comparable with the fiber prepared by the MCVD approach. The promising application of glasses in the field of lasers, planar optical amplifiers, and Bragg reflectors is widely discussed in the contribution.

Keywords : sol-gel, SiO_2-GeO_2, holmium, waveguide, photonic

Tuesday, October 24th

GLASS STRUCTURE & PROPERTIES
October 24th, 08:30-10:00, Hall: HASKÖY
Chair: **Dušan Galusek**

08:30-09:00 (Invited Speaker)
Crystallization of Aluminate and Aluminosilicate Glasses
Anna Prnová2, Jozef Chovanec2, Alfonz Plško2, Róbert Klement1 and Dušan Galusek1
1 Centre for functional and surface functionalized glasses, Alexander Dubček University of Trenčín, Trenčín, Slovak Republic
2 Joint glass centre of the IIC SAS, TnUAD, and FChFT STU, Trenčín, Slovak Republic
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Aluminate glasses are transparent in IR, UV and VIS, and as such, they represent an ideal host matrix for optically active dopants. Due to their lower phonon energies in comparison to common silicate glasses, non-radiative transitions are suppressed and high efficiency of luminescence can be expected. They are also able to accommodate higher concentrations of optically active dopants in comparison to their single- or polycrystalline counterparts of similar composition, such as yttrium- or ytterbium aluminium garnets, or the respective rare earth aluminate perovskites. Moreover, the luminescence intensity and wavelength can be tuned by deliberate change of chemical environment of activators, either through tailoring chemical composition of the host matrix, or by changing the coordination sphere of the activator through controlled crystallization of the system. For the latter, detailed knowledge on mechanism and crystallization kinetics of host glass is required. Thermal and crystallization behaviour of various aluminate glasses prepared in the form of microspheres by flame synthesis from powder precursors obtained by the Pechini method was therefore studied by DSC, SEM-EDS, XRD and high temperature XRD. The as-prepared microspheres were X-ray amorphous. Fundamental thermal characteristics of the glasses, i.e. glass transition temperature (Tg), onset of crystallization peak temperature (Tx), temperature of the inflection point of the crystallization peak (Tf) and maximum of crystallization peak temperature (Tp) were determined. Crystallisation of the YAG phase representrd the dominant exothermic process on DSC curves at temperatures ranging from 900 to 1000 °C, with crystallization of α-Al2O3 above 1300 °C in some systems. Polycrystalline microspheres with fine grained microstructure could be eventually prepared by suitable heat treatment at temperatures up to 1500 °C. The DSC data were analysed with the use of the Johnson-Mehl-Avrami-Kolmogorov (JMAK) model. In some cases the raw data were mathematically deconvoluted into two peaks representing two overlapping thermal effects. These were examined by the nucleation – growth Johnson – Mehl – Avrami

vmodel, autocatalytic Sestak – Berggren model and by Malek z(α) and y(α) functions. Most studied systems were characterized by linear temperature dependence of nucleation rate, reaction controlled crystal growth interface, and a volume crystallization with 3D crystal growth.

09:00 – 09:20

Telluride Glasses as Materials for Far-Infrared Applications: A Theoretical and Spectroscopic Investigation

Claudia Gonçalves1, Raphaël Mereau2, Eric Furet3, Michaël Deschamps4, Laurent Le Pollès3, Claire Roiland1, Pierre Florian4, Lila Bouëssel du Bourg3, Virginie Nazabal1, Catherine Boussard-Pledel1, Marc Dussauze2, Bruno Bureau1

1Institut Des Sciences Chimiques De Rennes, Umr-cnrs 6226, University Of Rennes 1

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4Cemhtı, Cnrs, Upr 3079, University Of Orléans

The central goal of our project is to rationalize the substituent effect on the glass structure and physical properties of a new generation of far-infrared transmitting telluride materials. Indeed the research area is nowadays receiving as increased attention because of the various potential photonic-related application, like monitoring, night vision, and CO2 greenhouse effect monitoring. Despite their intrinsic qualities, glasses suffer from one major drawback over crystalline compounds due to the lack of long-range order. Therefore, spectroscopic techniques probing the local environment of selected atoms, such as solid-state NMR, while offering a complementary approach to understand the structural and physical properties of new families of telluride glasses. Another way to get structural and dynamical insights of our materials are the use of structural characterization by IR/Raman. The assets of vibrational spectroscopies are among the few non-destructive, very sensitive techniques which provide several information at the molecular level. An in-depth knowledge of the organization in glasses is essential for any rationalization and optimization of their physical properties. On this context, the first solid-state NMR results will be shown. They deal with different binary crystals of reference, as Ge-Se, Ge-Te, Ga-Se and Ga-Te, and also on ternary glasses, like Ga-Ge-Te and Ge-Te-Se. These works have been carried out using quite unusual nucleus like 73Ge, 77Se, 125Te and 69/71Ga. For instance, the 73Ge nucleus, which is a very low-gamma nucleus with a large quadrupolar moment, needs to be probed using a high magnetic field spectrometer. Besides, results of vibrational spectroscopies will be shown for the two families of telluride glasses, first assignment of vibrational modes will be proposed thanks to DFT calculations implemented using the Gaussian software.

Keywords : Telluride glasses, solid-state NMR, raman, infrared spectroscopy, DFT calculation

09:20 – 09:40

Optical Properties of GaN and InN on Quartz Grown by Hollow-cathode Plasma-assisted Atomic Layer Deposition

Neşe Güngör, Mustafa Alevli
Physics Department, Marmara University

In this study, the optical properties of GaN and InN thin films grown by hollow cathode plasma assisted atomic layer growth on quartz substrates were investigated. In order to investigate the effect of film thickness on optical properties, GaN films with thickness ranging from 5 to 100 nm were grown under similar growth conditions in which films using TEG and N2(50sccm)/H2(50sccm) plasma precursors. In addition, InN films were grown using TMI and N2(50sccm), N2(50sccm)/H2(50sccm) , N2(50sccm)/H2(50sccm) plasma precursors in order to investigate the contribution of the H2 plasma dose to the optical properties. The optical band gap, thickness and refractive index values of the films were determined using UV-visible spectroscopic ellipsometer. It is observed that the optical band gap with increasing film thickness reverses to decreasing behavior at ~60 nm. . The refraction index values show that GaN films are polycrystalline. Furthermore, the InN film thickness increased and the refractive index decreased with increasing H2 plasma. InN, GaN optical band gap was found to be ~1.45 eV, ~3.45 eV, respectively. Transmission and spectroscopic ellipsometer data for Quartz substrate modeled using the Sellmeier dispersion equation and for (Ga,In)N films modeled using the model dielectric function. The thickness of the films and the optical band gap results obtained from transmission and spectroscopic ellipsometer show no noticeable difference. The overall results suggested that GaN films with thicknesses above 60 nm have different behavior compared to the thinner GaN films. On the other hand, addition of H2 plasma resulted in InN films showing high level of impurities with significant voids in the films, resulting in low-density films with poor film quality.

Keywords : GaN, InN, quartz, atomic layer deposition, spectroscopic ellipsometry

09:40 – 10:00

Characterization Studies on Selenium Retention in Soda Lime Silicate Glasses

Merve Kutluğ, Duygu Güldiren, Gürkan Yiğiter, Fehiman Akmaz
Şişecam, Science and Technology Center, Kocaeli, Turkey

Selenium has been used in glass industry as a coloring agent for decades especially for grey, bronze, pink glass batches. Another known role of selenium in glass is its usage as decolorizing agent in clear glass batches. As shown in former studies in the literature and the experience obtained from industry, during melting process, almost 30-90% of selenium either vaporizes or remains in colorless form in the glass melt. Selenium retention

can be affected by several parameters such as selenium source, the amount of oxidizing and reducing agents used in the glass batch, furnace atmosphere, melting temperature, pull rate indicating the residence time. The low ratio of selenium retention in glass can lead to an increase in the batch cost, instability in color and environmental problems, therefore the present study aims to investigate the parameters that affect the selenium retention in the glass. Glass batches were prepared based on the parameters planned to be investigated such as the amount of Na2SO4 and Fe2O3. Chemical compositions and color parameters of the obtained glass samples were analyzed by using X-Ray fluorescence spectrometer and UV/Vis spectrophotometer. The effects of redox level of the glass, %Fe2O3 used in the glass batch, %SO3 retention in the glass, the melting temperature on selenium retention were examined individually and these relations were comparatively evaluated.
Keywords: Selenium retention, color stability, redox level, melting temperature

COATINGS
October 24th, 2017, 08:30-10:00, Hall: KASIMPAŞA-1,2
Chair: **Hong Wang**

08:30-09:00 (Invited Speaker)
High Performance Solar Heat Conversion Coatings with CrNxOy Composite Absorbing Layer
Jing Liu, Zhi-Qiang Sun, Zhong-Zhou Yang and Hong Wang
State Key Laboratory of Green Building Materials and National Research Center for Glass Processing, China Building Materials Academy, Beijing 100024, China

Spectrally selective solar absorbing coating is a key material in solar heat collector. In order to obtain high solar-thermal conversion efficiency, the coating needs to absorb much of the incident solar energy (wavelength ranges from 0.3 μm to 2.5 μm) while losing little heat due to re-radiation. Therefore, it should be designed to have good balance of high solar absorptance α and low thermal emissivity ε. Since the thermal radiation is proportional to T4, achieving low emissivity is particularly important to the coatings designed for high temperature applications.
A typical spectrally selective solar heat absorbing coating stack contains a metal layer at the bottom for low emissivity, a solar absorbing layer in the middle and an anti-reflective/protective layer on the top. The material selection and design of the solar absorbing layer is the most critical to the overall performance. In this presentation, the good balance of high absorption and low emissivity is obtained by employing a composite CrNxOy absorbing layer consisting three different compositions with characteristics ranging from strongly metallic to typical semiconductor. Such a coating stack achieves a solar absorptance of 96% and an

emissivity of 3.5-5.0% (80-200OC), yielding an α/ε ratio of 27-19.2. After a thermal annealing of 200hr at 250 OC in air, the performance criterion ( ) of the stack is 0, indicating very good stability under this condition. When annealing increases to 300hr at 400OC, PC value increases slightly. The microstructure, surface morphology, composition and chemical states and reflective spectra were characterized and analyzed to understand the mechanism for thermal deterioration at higher temperature.

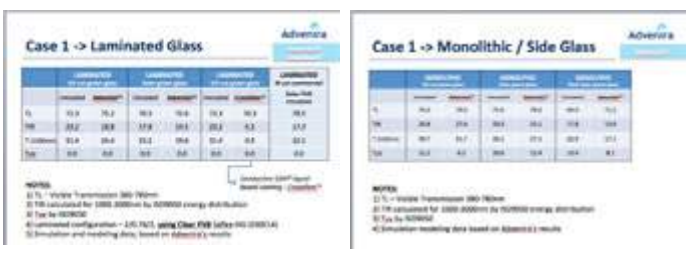
09:00 – 09:20
The Observation of Surface Plasmon Resonance Effect on ITO-Titanium-ITO Multilayer Thin Films on Glass
Turgay Çoruhlu, Necdet Aslan

09:20 – 09:40
Non-metallic Solar Heat Control Coating for Architectural and Automotive Windows
Elmira Ryabova
Advenira Enterprises, Inc

Net-zero buildings and self-driving cars impose a demand for budgetary non-metallic solar heat control windows to eliminate air-conditioning and enable mobile signals and sensors communications inside them.
Advenira Enterprises Inc., has developed high performance coating based on disruptive Solution Derived Nanocomposite SDN® platform technology that enables atmospheric room temperature liquid deposition of wide variety of custom designed coatings and challenges many industry standard coatings on glass by PVD/Sputtering, Energy Saving Coatings & PVB, etc.
AdvenSol™ is specially engineered nonmetal coatings family to deliver economical Solar Heat Control coating for glass featuring:

- Effective at blocking undesirable UV and NIR
- Allowing visible and radio wavelengths
- Durable and scratch resistant
- Design Flexibility – Glass, PVB, Color (neutral, green, blue, grey, pink)

Comparative performance characteristics are discussed and scaled-up technology updates are provided.
Keywords : Non-metallic, solar heat control, liquid, atmospheric



Figure

09:40 – 10:00
Hardness Reinforcement by Surface Engineering of Soda Lime Silicate Glass under Thermal Poling
Evelyne Fargin1, Maxime Paraillous1, Thierry Cardinal1, Angeline Quentin-Poulon1, Marc Dussauze2
1Université Bordeaux, ICMCB, CNRS UPR 9048, F-33600 Pessac, France, Université Bordeaux,
2ISM, CNRS UMR 5255, F-33400 Talence, France

Surface engineering of soda-lime silicate glass has been performed by thermal poling and the correlation between the local structure and the mechanical properties of the field-induced modified surface has been investigated. Glow Discharge Optical Emission Spectroscopy (GD-OES) demonstrates the structuring under a high electric field of a multi-layered material under the surface due to the migration of cations species. The nature of the atmosphere directly impacts on the charge compensation mechanisms involved and on the resulting mechanical properties.
Keywords: Surface engeenering, thermal poling, surface mechanical properties, surface durability

GLASS PRODUCTION (GLASS TREND)
October 24th 2017, 08:30-09:50, Kasımpaşa 4-5
Chair: **Anne-Jans Faber**

08:30 – 08:50
Advantages of an Expert System Full Automatic Control of Glass Feeders
Erik Muijsenberg
Glass Service B.v.
Glass Service A.s. (ınc)

This paper presents the advantages of ES IIITM Advanced Process Control for glass feeders. Purpose of the feeder is to deliver a homogeneous gob of glass to the production machines. To achieve this the ES IIITM system sets up all firing and cooling zones along the entire feeder within one integral Model-base Predictive Controller (MPC). The operator no longer has to specify temperatures in the individual conditioning zones. For ES IIITM it is enough to specify just the final production temperature for the glass article at the feeder delivery, either in the spout or at a (multiple) triple thermo-element ('9-grid'). ES IIITM sets the firing and cooling in the feeder as optimal as possible in order to minimize the risk for re-boil in the glass and to minimize the overall mixing pressure of the feeder burners, thus saving energy for heating the feeder. The ES IIITM system can be continuously used 24/7, also during the job changes. After the job change the ES IIITMsystem stabilizes the feeder temperatures as fast as possible so the new production can start with minimal delay and minimal production losses.
Keywords : ESIII, MPC, feeder optimization

08:50 – 09:10

Refractory Application for Extreme Firing Condition in the Regenerator of Glass Melting Furnaces

Sandra Fischer1, Rongxing Bei1, Joaquin de Diego2
1RhI Glas Gmbh, Germany
2Praxair, USA

The regenerator is one of the most stressed parts of a glass melting furnace. The trend for energy and cost savings in the glass industry causes more aggressive atmosphere in the waste gas.
In this paper the service experience and refractory material choice for extreme conditions are reported, such as:

- under attack by vanadium (e.g. pet-coke firing).
- under attack by NaOH (sodium silicate production or reducing atmosphere at waste gas).
- under attack by changing atmosphere between reducing and oxidising atmosphere (e.g. thermal chemical regenerator).

Keywords: Refractory materials, regenerator, pet coke firing, thermal chemical regenerator

09:10 – 09:30

Infrared Temperature Measurement in the Glass Melt Tank

Mark Bennett
Ametek Land (land Instruments International)

Temperature measurement at critical locations in the production process is essential for full understanding and efficient control of glass manufacture and processing. Blanket (or melt line) temperature, crown and wall temperatures of a glass tank are all monitored to protect the asset and extend tank life by preventing refractory overheating and damage to the furnace.
Process monitoring inside glass melt tanks traditionally utilized visual camera technology and manual inspections. Standard visual cameras show changing conditions, but image intensity is not directly proportional to temperature. Process optimisation based on visual information leads to overheating or inefficient combustion. Manual inspections are slow, labour intensive and expose the operators to significant risk. Data trending is difficult as operators measure temperature at slightly different points.
A Near Infrared Borescope provides a true-temperature radiometric image, so live temperature values can be obtained from >324,000 pixels. The flame is clearly visible, as are any air leaks and glass leaks. The operator can monitor all positions from the safety of the control room, with a simulation of a traditional camera view and automated alarm outputs to instantly warn of any problems with the process or instrument. The instrument provides continuous coverage 24/7, allowing long term data trending for product quality and fuel optimisation.

Keywords : Infrared, temperature measurement, thermal imaging, melt tank, glass manufacturing, blanket, crown, wall, asset protection, furnace, process monitoring, temperature monitoring, process optimisation, data trending, near infrared, borescope, thermal image, leaks, leaks, continuous, fuel optimisation

09:30 – 09:50
Heat Oxy-combustion Combustion with Oxygen and Natural Gas Preheated at High Temperature
Luc Jarry1, Xavier Paubel1, Taekyu Kang1, Tunç Görüney2, Neşet Arzan2
1Air Liquide Wbl Im Market
2Şişecam, Science and Technology Center, Kocaeli, Turkey

Decarbonisation for fossil fuel-based industries has proven to be very difficult. Although industrial intensity (energy consumption per unit of value added) has fallen in developed countries since the 1990s, sufficient alternative energy sources or innovation-based solutions are still not available. Therefore, the development of new technologies is crucial.
Heat Oxy-Combustion, based on oxy-combustion, is one such technology. Unlike current oxy-fuel technologies, which do not take advantage of waste energy recovery from combustion fumes, Heat Oxy-Combustion recovers a significant portion of the heat that is otherwise lost through flue gases by indirectly preheating fuel and oxygen.
The first generation of Heat Oxy-Combustion is operating at Paşabahçe Bulgaria EAD, AGC France and AGC Czech Republic. As a new technology, Heat Oxy-Combustion is rapidly improving in both energy efficiency gain and competitive equipment cost. Currently oxygen can be preheated at higher temperatures, with enhanced design and materials, hence with greater cost-efficiency.
This paper will introduce the latest achievements in terms of performance and new technology development.
Keywords: Oxy-combustion, gas preheated, decarbonisation, melting, environment

ENERGY & ENVIRONMENT
October 24th, 2017, 08:30-10:10, Hall: BALAT
Chair: **Nicola Favaro**

08:30-09:00 (Invited Speaker)
Glass, Emissions and Energy in Europe: an Overview
Nicola Favaro
Stazione sperimentale del Vetro (SSV), Italy

The Glass Industry is a global business covering many different areas and applications, the most important in terms of quantity being: packaging, building, automotive, glass wool insulation, reinforcement fibres for composite materials, tableware. Other applications are less important in

terms of production, but are essential in the improvement of our lives, including biomedical applications, solar glasses, art, optics, electronics and optoelectronics, lighting.
The main future challenges for the European glass industry are related to environmental protection and energy consumption: every year, several new legislations and regulations imposing strong reductions in pollutant emissions (e.g. dust, NOx, SOx, acid gases, volatile metals, etc) are brought forth by European and National Governments, with the final goal of improving the quality of life of their citizens.
Another aspect which nowadays is becoming more and more crucial is Energy Efficiency, both for economical and environmental reasons: in fact, decreasing specific energy consumption not only enhances competitiveness, but also lowers the direct and indirect production of greenhouse gases such as carbon dioxide.
For the European glass industry the most important legislations are: the IED (Industrial Emission Directive), which defines the best available technologies (BAT) that can be applied to reduce pollution; the ETS (Emission Treading Scheme), which sets a series of requirements to reduce the total amount of emitted CO2; the PPWD (Packaging and Packaging Waste Directive), which sets specific targets for the recovery and recycling of packaging materials; etc.
This lecture will provide an overview of the European Glass Industry in terms of total amount of production, installations, etc. Moreover, it will summarize the main legislations currently in force in the EU concerning the glass industry, describing the technologies applied to achieve better environmental protection and lower energy consumption.

09:00-09:30 (Invited Speaker)
Radiation Transfer for Glass & With Glass
M. Pinar Mengüç
Director, Center for Energy, Environment and Economy (CEEE)
Professor and Head, Department of Mechanical Engineering, Özyeğin University, Istanbul, Turkey
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Understanding and controlling the transport phenomena in complex high temperature systems are essential for both the product quality and for the energy efficient operation. Glass manufacturing is such a complex process, where radiation transfer is the predominant mode of heat transfer. The design and operation of the current and the next generation glass furnaces would benefit from the detailed use of the radiative heat transfer concepts in the combustion zone as well as in the melt. Of course, this must be achieved by considering the other physical phenomena including fluid mechanics, conduction and convective heat transfer, phase change, combustion, and surface effects. On the other hand, glass is a very important building material, and its radiative and optical properties are

critically important for achieving higher energy efficiency in buildings. In this presentation, first a general discussion will be presented on the fundamentals of radiation transfer and how it affects glass manufacturing and its use. We will provide a historical outline about the use of optics and radiation transfer (light and heat) over the centuries. Then, we will outline a summary of computational techniques for different physical systems used in pre- and post-digital ages, and comment on how some of these areas cross-pollinated other fields.
Because of integro-differential nature of the governing equations, radiation transfer problems are always oversimplified making some of the predictions physically questionable. The inherent difficulty in solving the radiative transfer equation makes the acceptance of more complex and accurate computational methodologies to the mainstream computational packages slow. We will discuss some of these problems and suggest solutions for both future software and hardware developments that will account for the necessary details of radiative transfer solution schemes. We will also highlight the computational techniques needed for the near-field radiation transfer, which are essential for the understanding of pathways for new devices and processes at the nano-scale levels based on glass. Finally, the impact of glass use on energy efficiency research related to sustainable buildings and cities is to be highlighted. The specific emphasize will be given towards the new-developed concepts on radiative cooling and the visual comfort in future buildings.

09:30 -09:50
Preheating of Glass Batch Briquette
Terutaka Maehara, Takeshi Yamazaki, Yoji Doi
Asahi Glass Co., Ltd.

Batch to melt conversion process is known as a complex process affected not only by chemical reactions but also by physical phenomena like heat transfer through a layer of glass batch. Briquetting (pelletizing by rotated twin rolls) is one of the most effective way to improve glass batch properties like thermal conductivity, contact area between ingredient particles and so on. Furthermore, as a practical benefit, briquetting enable us to handle 'easy to melt' raw materials with fine grain size without dust problem. Previously we had reported various positive impacts of glass batch briquette on batch to melt conversion process; the better heat transfer from the combustion space or hot molten glass beneath the batch blanket, acceleration of calcination reactions during heating up of glass batch. Preheating of glass batch briquette have been well known idea to improve melting kinetics. When we chose adequate grain size distributions of each ingredient, briquette can be preheated up to 850°C without adhesion of briquette to one another. The calcination rate of the glass batch briquette preheated at 850°C reaches ±90%, 1.5GJ/t of energy can be absorbed as a summation of tangible heat and reaction heat for the

calcination. In the presentation, impact of preheating of glass batch briquette on the quality of the initial molten glass will be discussed.
Keywords : Glass melting, raw materials, briquette, pellet, batch preheating, batch to melt conversion process

09:50 – 10:10
All New "OMN" Combustion System for Feeders
Alessandro Cortopassi
Glass Service Srl

Glass Service introduces a new concept of combustion system with the new OMN device. This system features a new air/gas ratio control and it's composed by a special air orifice plate with integrated gas injection valve and a double-stage zero governor.
Main features of ONM are:

- Full customization – each zone exactly tailored on actual demand.
- Suitable both for low and high pressure systems (3 to 50 mBar manifold pressure supported)
- High ratio stability on full-range (maximum dosing error 0,21, average error 0,075)
- High repeatability
- Reduced maintenance demand
- Gas Savings*

*As a direct consequence of its high precision dosing the demand for excess air it's decreased of 80% allowing you to save gas daily.
Keywords: OMN, combustion system

GLASS STRUCTURE & PROPERTIES
October 24th, 2017, 10:40-12:10, Hall: HASKÖY
Chair: **Cristina Siligardi**

10:40-11:10 (Invited Speaker)
Luminescent Heavy Glasses for Hadron Calorimeter
C. Siligardi, C. Mugoni, S. Barbi, C. Gatto, L. G. Jacobsohn, M. Affatigato

Heavy glasses are promising alternatives to crystals and polymers for applications in high energy physics (HEP) such as scintillators for the new hadron calorimeter. This work is focused on the development of transparent heavy metal oxide glasses (bismuth borate and lead borate glasses) as host materials for scintillating rare earth oxides (Dy2O3, Er2O3, Nd2O3, CeO2). In this way, the glass behaves as an absorber and an active medium at the same time. High density and high transparency over ultraviolet and visible regions, low refractive index, high emission intensity and high lifetime decay have to be obtained. The glasses, synthesized by a melt quenching method, were characterized by means of density, DTA, Raman and UV-Vis optical transmission spectroscopy measurements. The scintillating and luminescent properties were studied by radioluminescence (X-ray excitation) and

photoluminescence (UV excitation). All the measured properties showed a non-linear trend for increasing the rare earth ions content into the same glass matrix. High densities (5-6.5 g/cm3) were reached in all the studied systems. Erbium ion doped glasses showed the highest emission intensity and longest lifetime decay. All the studied glasses demonstrated peculiar characteristics that, if properly tuned, can match the requirements needed for particle energy measurement.

11:10-11:30

Samarium Doped B2O3-GeO2-Gd2O3 Glasses: Structural, Optical and Photoluminescence Characteristics

Melis Gökçe1, Deniz Koçyiğit Uslu1, Gözde Burgaz1, Aytaç Gürhan Gökçe2
1Department Of Physics, Adnan Menderes University, Aydın, Turkey
2Department Of Physics, Dokuz Eylül University, İzmir, Turkey

Purpose
In this work Sm3+ rare earth ion doped heavy borogermanate glasses were studied for potential application as scintillators, lasers and displays.
Materials
Glass matrices prepared from 30B2O3-40GeO2-(30-x) Gd2O3-xSm2O3 (x =1, 3, 5 mol%) composition were synthesized by melt-quenching method.
Methods
Glasses characterized structurally by x-ray diffraction (XRD) and Fourier transform infrared (FTIR) analysis. For all the glasses transmission, absorption, photoluminescence and decay time measurements have also been carried out.
Results
The XRD profiles of all the glasses confirm their amorphous nature and the FTIR spectra reveal the presence of BO3 and BO4 units along with OH-groups in the glass matrices. The transmission spectra proved that the title glasses maintained a high transparency about 81% in the 510 to 900 nm region. Based on the absorption spectra, the optical band gaps obtained from Tauc's plot can be narrowed by increasing content of Sm3+. Four emission bands centered at 562 nm (4G5/2 6H5/2), 597 nm (4G5/2 6H7/2), 645 nm (4G5/2 6H9/2), and 709 nm (4G5/2 6H11/2) have been obtained from photoluminescence spectra. Among them 4G5/2 6H7/2 (597 nm) transition give the most intense orange emission. For Sm3+ doped borogermanate glasses the concentration quenching was observed at 3 mol%. The asymmetric ratio of 4G5/2 6H9/2 (645 nm) to 4G5/2 6H5/2 (562 nm) transitions has been investigated to predict the local environment of Sm3+ ions. The values of asymmetric ratio present an increase with increasing doping level, indicating the lower symmetric environment for Sm3+ ions. The non-exponential nature of the luminescence decay curves of 4G5/2 6H7/2 transition of Sm3+ ions confirm the energy transfer from Gd3+ to Sm3+ ions.
Keywords: Borogermanate, glass, samarium, photoluminescence, decay time

11:30-11:50

Improvement of Persistent Phosphorescence Properties of Zinc Borosilicate Glasses with the Addition of Rare Earths

Sena Dayıoğlugil, Nuri Solak
Istanbul Technical Unıversity

Persistent luminescent materials can emit light even for several hours after the removal of the light source. Although ceramic based phosphors are known as popular for long lasting phosphorescence, glass phosphors are very versatile materials due to their transparency, homogeneity and can be easily fabricated to various forms. High quantities of rare earth can be added into the glass matrix thanks to their flexible lattice structure. Also, high concentrations of dopants provide the formation of the luminescence and trap center. However, persistent phosphorescence in glasses has been recently developed and there are limited studies on this topic. In the present study, transparent glasses which desired to gain bright and long lasting phosphorescence doped with rare earths and irradiated by UV-254 lamp. Zinc borosilicate glasses (Tb3+, Sm3+, Mn2+ doped) with persistent phosphorescence properties are synthesized and characterized by using XRD, DTA and Spectrophotometer. After the removal of UV excitation, glasses emit phosphorescence in various colors, including green, pink and red which is observable with the naked eye. The effects of cooling rate, heat treatment temperature/time and the rare-earth co-doping on luminescence of zinc borosilicate glasses have been investigated. The enhancement on the luminescent intensity was observed with the addition of Sm, Eu, Tm, Gd and Ce as co-dopant.
Keywords: Phosphorescence, rare earth dopant, transparent glass

11:50-12:10

Spectroscopic Study of Silica Optical Fibers Doped with Holmium and Thulium

Michal Kamrádek1, Jan Aubrecht1, Pavel Peterka1, Ondřej Podrazký1, Pavel Honzátko1, Jakub Cajzl1, Jan Mrázek1, Václav Kubeček2, Ivan Kašík1
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2Faculty Of Nuclear Sciences And Physical Engineering, Czech Technical University İn Prague, Praha 1, Czech Republic

Rare-earth (RE) doped silica optical fibers form the essential components of fiber laser sources. These lasers have recently been investigated due to a wide range of applications including medicine, defense, wireless communication, spectroscopy and material processing. Holmium-doped and thulium-doped silica-based optical fibers are used for lasers operating at the wavelength range around two micrometers, which is known to be “eye-safer” than widespread lasers at 1 micrometer. Silica-based optical fibers exhibit high transparency, environmental stability, thermal and chemical durability and compatibility with commercially available components. However, the solubility of RE ions in pure silica is low. This fact

can be overcome by modifying the fiber core with various dopants, such as Al2O3, GeO2, P2O5 or B2O3. Especially doping with Al2O3, in a form of aluminium chloride or ceramic nanoparticles, is very favorable, because it allows to reach relatively high RE dopant concentrations and so intensive luminescence without phase separation.
In this contribution we describe the spectroscopic study of silica-based optical preforms and fibers. Low-loss optical fibers doped with Al2O3, GeO2, Tm3+ and Ho3+ were prepared by the modified chemical vapor deposition (MCVD) process. Prepared preforms were characterized in terms of refractive index profile and dopants distribution while the fibers were studied related to spectral attenuation, fluorescence lifetime and laser performance. The influence of fiber core structure and composition on optical and spectral properties were studied. Improved lasing characteristics were achieved and observed trends will be discussed.
Keywords: Optical fiber, fiber laser, holmium, thulium

COATINGS
October 24TH 2017, 10:40 – 12:00, Kasımpaşa 1-2
Chair: **Serkan Şahin**

10:40-11:00
Synthesis of TEOS-SiO2-OTES Film for Enhancing the Hydrophobic Property and Weathering Durability of Float Glass
Kanit Tapasa, Usanee Pantulap, Ekarat Meechoowas, Parida Jumpeerueng
Department of Science Service
This work aims to study the effect of SiO2 and annealing temperature in TEOS-SiO2-OTES film on the hydrophobic property and weathering durability. TEOS-SiO2-OTES film was prepared by sol-gel process. Tetraethylorthosilicte (TEOS) and Octyltriethoxysilane (OTES) were used to form the gel. The contents of SiO2 were varied at 0.5% 1% 3% 5% and 10% by weight. The film was deposited on a glass slide by spin coating and annealed at 200 – 450 ºC for 20 minutes. The hydrophobic property was studied by FTIR, UV-VIS spectroscopy, SEM, XRD and contact angle. The weathering chamber was used for studying weathering durability. The weathering condition was controlled at 50 ºC and 85%RH. The study showed that the silica contents and annealing temperature affected the surface roughness of film. The surface roughness of film decreased with increasing amounts of SiO2 and annealing temperature.
Keywords: Sol-gel process, coating, hydrophobic, weathering durability, float glass

11:00-11:20

Preparation and Characterization of Scratch and Wear Resistant Anti-Bacterial Hybrid Coatings by Sol-Gel Method

Fatma Beyza Yedikardeş1, Refika Budakoğlu2, Esra Özkan Zayim3

1Istanbul Technical University, Nanoscience And Nanoengineering Department

2Şişecam, Science and Technology Center, Kocaeli, Turkey

3Istanbul Technical University, Physics Engineering Department

Coatings are mainly applied on glass surfaces for decorative and functional purposes. Most popular functional coatings are anti-reflective, self-cleaning and anti-bacterial coatings. Popularity of antibacterial coatings comes from the prevention of microorganisms such as bacteria, fungi or viruses which represent potential threat for our daily life. However, durable anti-bacterial coatings are needed because of the damage of coatings by abrasion easily in time. In this study, it was aimed to develop low-temperature curable scratch resistant hybrid anti-bacterial coating. Silver doped organic-inorganic hybrid solutions were deposited on float glass substrates by dip coating technique. An experimental set up was designed to determine the effectiveness of three parameters (n) in sol-gel process, which were hydrolysis reaction time, precursor amount and hydrolysis ratio. And, 27 different coating compositions (n3=27) were prepared. Each set was investigated in detail and compared with one another for close monitoring. All the coating samples were transparent as glass and exhibited very well adhesion (ASTM D3359: 5B) to the glass surface considering the cross hatch test standard. Taber linear abrasion and nano scratch tests were performed to investigate scratch resistance of the coatings. According to the pencil hardness test which is the macro scale hardness test (ASTM D3363: 8H), mechanically hardest coatings were selected and characterized. Film thicknesses and surface properties were determined by SEM-EDS and AFM. Furthermore, providing; i) the amount of silica precursor constant, amount of titanium precursor was changed, ii) both silica and titanium precursors constant, pre-hydrolysis time and water amount were changed. It was observed that as the amount of titanium precursor increases, the gelation of sol-gel reactions increased and lead to brittleness of the coating. FTIR and percent solid test results showed that poly condensation of precursors in the same set increased by increasing hydrolysis ratio and hydrolysis reaction time. The antibacterial activities of the coatings were investigated against Gram (-) Escherichia Coli and Gram (+) Staphylococcus Aureus and all coating samples showed excellent antibacterial activity (log 5). Consequently, scratch and wear resistant antibacterial coating samples were presented as potential for the future glass applications.

Keywords: Anti-scratch, abrasion resistant, anti-bacterial, sol-gel

11:20-11:40

Golden Touch of MIDAS: Development of Mythology Inspired Decorated Glass that Change Color via Interference Effect

Anıl Özen1, Lukas Simurka1, Ayşegül Yörür Yıldız1, Haluk Erdem2, Ferdi Keskin3, Umut Enkara4, Aslı Topak5, Melis Özbirlik5, Sevgi Kes6

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Decoration is a highly effective route to the diversification of glassware items, and it has almost become an integral part of the production process. On the other hand, the increasing role of visual effects in container glass market, most notably in alcoholic beverages, provides ample motivation for producing glass products with a great variety of effects including coloring, matting, glossiness, soft touch feeling, etc. Effect imparting pigments come into play when additional visual appearance characteristics are desired in addition to basic color. Those pigments provide various effects such as gloss, luster, glitter, multicolor and interference. Pearlescent pigments, metallic pigments and interference pigments are frequently used in various sectors for these purposes.

Interference pigments constitute a special family which creates interference when an incident light impinges on layers with different refractive indices. Interference pigments show a significant color changing effect (flip-flop effect) and the perceived color changes by varying the point of vantage. The interference color can only be seen from a certain angle; the glancing angle. In addition to the observation angle, resulting interference color can be controlled with introducing different backgrounds.

In this study different kinds of interference pigments were studied in paint systems containing binders, solvents and sometimes additives to obtain various visual looks and coloring effects culminating in the MIDAS family of glassware products. Special emphasis was placed upon scale-up and adaptability to various means of production. Optimization of pigment content and the adjustment of the application parameters to suit the needs of various means of production such as screen printing, pad printing and spraying were discussed. Resulting paint systems containing interference pigment were also studied based on dishwasher cycle performance, adhesion power and physical tests.

Keywords: Glass, decoration, paint, pigment, interference

11:40-12:00

Hydrophobic and Oleophobic Glass Coatings for Using at High Temperatures

Eren Özmen
Instituto De Ceramica Y Vidrio, CSIC, Spain

Background
Hydrophobic-oleophobic glass coatings with water contact angle up to 150o have been reported by different authors and generated great interest due to its wide range of applications. However, the low temperature of treatment, 100-150oC, limits their future applications.

Objectives
The aim of the work was the preparation of hybrid silica organic-inorganic sols by sol-gel and the corresponding deposition of the sols by dipping on glass surfaces to obtain transparent and durable hydrophobic-oleophobic coatings. The coatings are treated at temperatures (~350ºC) able to be used on oven glassware.

Materials
Hybrid silica sols were prepared using different precursors: tetraethoxysilane (TEOS), triethoxymethylsilane (MTES) and colloidal silica particles (LUDOX). Then, a fluoroalkylsilane (1H,1H,2H,2H Perfluorooctyltriethoxysilane (POTS)) was added to increase the organic character and promote the hydrophobicity properties.

Methods
The silica films were deposited on soda-lime glass slides by dipping at different withdrawal rate using sols with different compositions. The films were heat-treated up to 350oC and 400oC. The coatings were characterised using optical microscope; thickness and refractive index were determined by ellipsometry. The hydrophobicity/oleophobicity behaviour was characterised by contact angle, and measured with water and oil using an Easy Drop equipped with a CCD camera.

Results
Films are optically transparent, thermally stable, and highly resistant against humidity with a maximum thickness of 2 µm. The highest water contact angle (WAC) of 110ºC and oil contact angle (OAC) of 65º were obtained at 350ºC for silica sols modified with silica nanoparticles and fluoroalkylsilane. These properties are promising for preparing hybrophobic/oleophobic glass surfaces to be used at high temperatures. Spray coating is under development to be scaled to industrial processes.

Keywords: Sol-gel coatings, hydrophobic, oleophobic, glassware, fluoroalkylsilane

GLASS PRODUCTION (GLASS TRENDS)
24th October 2017, 10:40 – 12:00, Kasımpaşa 4,5
Chair: **Sven Kahl**

10:40-11:00
Routes to CO2 Neutral Glass Melting
Anne Jans Faber, O.S. Verheijen
Celsian Glass & Solar B.v.

The worldwide transition to durable energy resources will have major consequences for the glass manufacturing industry. The objective of this paper is to highlight the technological opportunities for CO2 neutral melting of glass, including: end-of-pipe carbon capture, flexible hybrid (gas-electric) melters, full electric melters and low carbon combustion. The current status, advantages and challenges of these various technological solutions will be discussed. Moreover, the required knowledge development in view of designing new CO2 neutral glass melter concepts will be outlined.
Keywords : CO2, melting

11:00-11:20
Glass Trend - Improving Batch Caking and Melting Properties by Using Calcined Lime. An Industrial Experience
Estela Alejandro
Vidrala, Spain

Energy consumption is one of the biggest concerns in the glass industry, as it is one of the highest costs of the company, the main part being used for melting. These figures have always led glass industry to the search of new energy reducing alternatives, in technologies, raw materials and batch preparation methods.
Alternative raw materials for reducing energy consumption are already well known among glass technologists: glassy materials like slags, flux materials like lithium oxide, calcined materials like calcined lime or dolomite... All of them have been more or less widely tested on an industrial scale.
Calcined lime and dolomite have been largely proposed to container glass industry since long, but its use has always been limited due to the high cost of these materials, that can be hardly compensated by the melting benefits, being restricted to higher value-added glass products like fiberglass or enamels. In addition, many problems have been reported related to the manageability of these calcined products due to their high hygroscopicity, like dust, batch segregation, etc.
Batch caking or clogging is another problem that can occur in low cullet batches due to the sodium carbonate/moisture ratio. In factories producing high tonnage of glass with low cullet content and high moisture sands, batch caking can generate big problems in the batch plant conveyors and silos and in the furnace chargers that, if they are not quickly solved, can

prevent feeding the furnace and drive to a reduction of glass level.
Two years ago, Vidrala saw the opportunity of using calcined lime to solve the batch caking problems affecting one of its plants in Spain producing flint glass; in the meantime, it appeared to be also a good chance to verify the melting improving properties of this material. This presentation will show the industrial experience when testing the calcined lime and the results obtained on energy consumption, melting rate and batch caking behaviour.
Keywords: Energy consumption, energy reducing alternatives, calcined lime, batch caking, batch clogging, melting

11:20-11:40
Fining: Impact of Sodium Sulphate and Anthracite in Soda- Lime Silicate Glass
Hande Sesigür, Mustafa Oran, Banu Arslan, Gülin Demirok
Şişecam, Science and Technology Center, Kocaeli, Turkey

In many years, sulphates are preferably used in soda-lime silicate glass batches as fining agents. Amount of sulphate added to the batch cannot be calculated with thermodynamic equations; therefore, product quality, batch cost and emission of excess sulphate are considered to determine the amount of sulphate. High quality products can be obtained by adding higher amount of sulphates but it results in higher batch costs and high emission of SO2. Therefore an optimum amount should be determined. Decomposition of sulphate compounds is identified at high and low temperature according to redox state of batches. Sulphate compounds decompose at higher temperature (~1400 °C) in oxidant batches whereas decompose at lower temperature (~1000 °C) in reduced batches and result in gassing.
In this project; effects of sodium sulphate the most widely used fining agent and anthracite used to make reduced batch in the (re)fining process were investigated by using High Temperature Melting Observation System (HTMOS). This project covers two parts. The first part of the project was studied with three batches containing different sodium sulphate amount (1.2 g/100 g glass, 1.0 g/100 g glass, 0.7 g/100 g glass). The second part of the project was studied with two batches with and without anthracite. Formation of foam and bubble behaviours depending on the batches were identified numerically by image processing and gases evolved during fining were measured by FTIR. According to the obtained data; the batch containing the highest amount of sodium sulphate demonstrated the earliest fining onset temperature, the highest amount of SO2 emission and height of foam formation. Reduced batch containing anthracite indicated earlier fining onset temperature and less bubble counts compare to that of oxidant batch.
Keywords: Fining, sodium sulphate, anthracite, soda- lime silicate glass

11:40-12:00

Gas Evolved Reactions during Conversion of Nuclear Waste Melter Feed to Glass

Jaroslav Klouzek1, Miroslava Hujova1, Richard Pokorny1, Seungmin Lee2, Joseph Traverso2, Michael Schweiger2, Albert Kruger2, Pavel Hrma2
1Laboratory Of Inorganic Materials, University Of Chemistry And Technology Prague
2Pacific Northwest National Laboratory, Richland, Wa 99354, U.s.a.

The conversion of nuclear waste feed in the cold cap proceeds over a wide temperature range 100-1100°C, spanning the formation of molten salts that react with feed solids, turning them into intermediate products, and ultimately producing the glass-forming melt. The gas-evolving cold cap reactions include release of chemically bonded water, evolution of CO2 and NO from the reactions of carbonates with boric oxide and dissolving silica and decomposition of NaNO3, O2 evolution from iron redox equilibrium, or production of SO2 from sulphate decomposition. This study provides quantitative Evolved Gas Analysis of several HLW feeds from room temperature up to 1150°C. We investigated the general effect of time-temperature history of the feed on its foaming, and tested several feed modifications to understand which reactions affect the evolution and collapse of the primary foam.
Keywords: Feed, vitrification, foaming, glass

REFRACTORIES
October 24th 2017, 10:40 – 11:40, Hall: Balat
Chair: **Rongxing Bei**

10:40-11:00

Activities of TC 11 - Materials for Furnaces

Rongxing Bei1, Jean-Pierre Meynckens2
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2Agc Glass Europe, Belgium

TC11 of ICG discuses advanced refractory materials and worldwide industrial experience on glass melting furnaces. The material properties (e.g. chemistry, creep, thermal expansion, refractoriness under load ...) and their impact on the glass quality, the furnace lifetime and the energy savings are reported and analyzed. Testing procedure (sampling, corrosion, exudation...) and inspection methods including nondestructive testing for refractory materials will be recommended.
In this contribution, we will report:

- Motivation of TC11
- Members, meetings and papers from last years
- Cooperation with other TC's
- Further plans

Keywords: Glass melting furnaces, refractory materials

11:00-11:20

Refractory Materials in the Global Market: How to Assess Quality and Defects Generation Potential

Simone Tiozzo, Stefano Sanchetti
Stazione Sperimentale Del Vetro

In a Globalized World where low-cost suppliers of limited renown have invaded the market of refractory materials for glass furnaces with products having extremely aggressive pricing, the chance of striking a very profitable deal today might tomorrow be counterbalanced by an equal chance of encountering service life issues ranging from questionable product quality to early catastrophic failure.
While most “Western” (European, American, etc) brands are usually perceived by customers as suppliers of reliable quality level, even when their production facilities are delocalized in “Far East” countries, most "Eastern" producers are generally met with relative skepticism over quality and performance level.
In order to avoid falling prey either of conservative prejudice on one side, or of blind trust (even towards “traditional” producers) on the other, Stazione Sperimentale del Vetro has developed an integrated analytical approach to support glass companies in making a technically grounded, conscious choice of refractories suppliers for their furnace rebuilds.
The process consists of two main steps: first a reference “performance benchmark” is created on the basis of experimental characterisations of well known materials, having demonstrated a good performance level in customer’s service conditions during past furnace campaigns.
Second, a detailed sampling and analytical plan, tailored for each specific furnace zone, is put in place to assess and compare the key performances of various products of different suppliers, both among themselves, for the identification of the best candidate, and with the reference benchmark.
Depending on the furnace zone, static or dynamic corrosion tests at various temperatures, exudation tests, alkali vapour resistance tests, blistering tests and much more are performed by SSV analysts, thus providing the glassmaker a wealth of information that can be exploited not only in the choice of supplier, but also in assessing an estimate of the future defect generation potential of furnace refractories.
Keywords: Refractory suppliers, static corrosion, dynamic corrosion, sampling plan, defect generation potential, AZS, glass

11:20-11:40

Applied Performance Tests of Various Refractory Types for Accurate Selection in Designing Glass Furnaces

Melih Üstün, E. Burak İzmirlioğlu
Şişecam, Science and Technology Center, Kocaeli, Turkey

Establishment of a glass furnace is a very complicated business, in which refractories cost over millions of dollars. That is why glass companies are

always in search for supplying cheaper refractories for saving money. However, preferring cheaper refractories might have sometimes more catastrophic results when a furnace which is constructed half price using cheaper brands causing a decrease in both campaign life and production yield. Because of this economical issue, the main question is “does the cheaper refractory meet our expectations?”. Thereby, the first step should be to define the right criteria for refractories.
In this study, the expectations are defined simply as a comparison of performance tests between the alternative cheaper refractories and actual refractories in use. Considering the place of use of the refractories there are several kinds of performance tests conducted. For the glass contact refractories (AZS and Jargal) corrosion, stone tendency, exudation and bubble tendency tests have been performed. Besides, for the crown (silica) refractories alkaline penetration and sulfate attack tests have been performed. According to the results of the performance tests, alternative refractories have been compared with the refractories in use and it has been detected that some of the cheaper alternative refractories can be used by considering the cost-performance balance.
Keywords: Refractories, performance, corrosion, quality tests

FIBER GLASSES
October 24th 2017, 10:40 – 12:00, Hall: Cibali-1
Chair: **Davide Pico**

10:40-11:10 (Invited Speaker)
In Situ Thermoplastic Coating of Melt Spun Glass Fibres
Davide Pico, Alexander Lüking, Richard Haas, Robert Brüll, Thomas Gries
Institute for Textile Technology of RWTH Aachen University, Aachen (Germany)
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The film stacking method is the industrial standard for the manufacturing of fibre reinforced thermoplastic composites (FRTCs) [1]. An alternative to this is commingling thermoplastic fibres with reinforcment fibres, e. g. glass fibres, into hybrid yarns [2]. However, the composites produced by the use of film-stacking or hybrid yarns cannot achieve an optimal impregnation of reinforcement fibres with the matrix polymer. This stens from the high melt viscosity of thermoplastics, which prevents a uniform wetting of the reinforcement fibres. Leaving some fibres is unconnected to the matrix. This leads to composite lower strength than theoretically possible. The aim of the research is the coating of a single glass filament in the glass fibre nozzle drawing process to achive a homogenous distribution of glass fibres and matrix in the final composite. The approach uses particles with a diameter from 2 to 15 µm of Polyamid 12 (PA 12) which are electrostatically charged and blown at an E glass filament in the nozzle drawing process as seen in figure. The particles adhering to the filament are melted by infrared heating

and winded afterwards. This development will allow the homogenous distribution of fibres and the matrix in a thermoplastic composite allowing a higher fibre volume content leading to improved mechanical properties. Even though the glass filaments could be coated with PA 12, a homogenous sheath could not be achieved in this investigation. Therefore, further research will focus on an improved homogeneity by reducing the agglomeration of PA 12, using dried PA 12 and enhancing the overall nozzle setup.

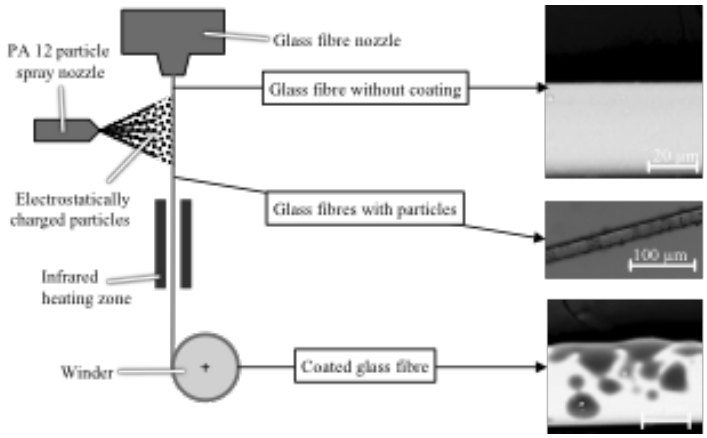

Figure: Nozzle drawing process for glass fibres with a coating of PA 12 particles and infrared heating zone

Acknowledgement of financial support – This research was funded by the Federal Ministry of Economics and Technology based on a decision by the German Bundestag

References

[1] Flemming, M.; Ziegmann, G.; Roth, S. Halbzeuge und Bauweisen. Faserverbundbauweisen. In: Springer. 1996.
[2] Wulfhorst, B.; Tetzlaff, G.; Kaldenhoff, R. Herstellung von Hybridgarnen für den Einsatz in Faserverbundwerkstoffen. In: Technische Textilien/Technical Textiles 35, S. 10–11. 1992.

11:10-11:40 (Invited Speaker)

Investigations on Reinforcing Concrete (Gfrc) Materials with SMFMZS (SrO-Mn2O3-Fe2O3-MgO-ZrO2-SiO2) System Glass Fibres

Arife Yurdakul1, Goktug Gunkaya2, Emrah Dolekcekic3, Taner Kavas4, Bekir Karasu3
1Alanya Alaaddin Keykubat University, Engineering Faculty, Metallurgy and Materials Engineering Department, Alanya, Turkey
2Anadolu University, Faculty of Fine Arts, Department of Glass, Eskisehir, Turkey
3Anadolu University, Engineering Faculty, Materials Science and Engineering Department, Eskisehir, Turkey

4Afyon Kocatepe University, Engineering Faculty, Materials Science and Engineering Department, Afyonkarahisar, Turkey

Concrete is a durable material being suitable for building countertops, planters and sidewalks as well as working well for more artistic uses such as statuary, but even something as strong as concrete can use a little help now and then. One way to increase the strength of concrete while making it lighter is to add glass fibers. Glass fiber-reinforced concrete (GFRC) consists of high-strength, alkali-resistant glass fiber embedded in a concrete matrix. In this form, both fibers and matrix retain their physical and chemical identities, while offering a synergistic combination of properties that cannot be achieved with either of the components acting alone. In general, fibers are the principal load-carrying members, while the surrounding matrix keeps them in the desired locations and orientation, acting as a load transfer medium between the fibers and protecting them from environmental damage. The fibers provide reinforcement for the matrix and other useful functions in fiber-reinforced composite materials. Glass fibers can be incorporated into a matrix either in continuous or discontinuous (chopped) lengths. The problem with using glass fibers as reinforcement for concrete is that glass breaks down in an alkaline environment and there's almost nothing more alkaline than concrete. One has heard of concrete being damaged by alkali-silica reactivity (ASR) when there is reactive silica in the aggregate. Glass is primarily silica. The original GFRC in the 1940s rapidly lost strength as the glass was destroyed by the alkaline environment. In the 1970s alkali-resistant (AR) glass fibers were perfected by Owens-Corning and by Nippon Electric Glass (NEG) leading to a rapid increase in applications. GFRC has been used for the past 30 years to produce many concrete products.

There are many glass fibers available to reinforce concretes. Glass fiber composition is so important because it may change the properties such as strength, elastic modulus and alkali resistance. Its most important property to be used in concrete is alkali resistance. The aim of the present study, first of all, was to characterize a commercially available alkali resistant glass fiber for concrete reinforcement and then to compare its alkali durability with those of the SrO-Mn2O3-Fe2O3-MgO-ZrO2-SiO2 (SMFMZS) system glasses. For such purposes, XRF, Tg-DTA, alkali resistance tests and SEM analysis conducted with EDX were employed. Further study on the SMFMZS glass samples in terms of fiber drawing revealed that magnesia-silicate related many crystalline phases were formed during the process. Determining possible crystallization temperatures of SMFMZS system glasses were carried out by the gradient furnace. Additionally, those formed crystals were fully characterized by SEM and EDX. To prevent surface and bulk crystallization during fiber drawing, the composition changes were made. Consequently, successful composition was achieved. Newly developed Zrn1 glass fibers belonging to the SMFMZS system have been produced by our group who has recently used them as a reinforcing material for GFRC samples. The microstructural behavior of Zrn1 coded glass fibers along with

the commercially available fibers in cement structure were also investigated using a scanning electron microscope (SEM). Mechanical analyses were also carried out. The highest compressive strength value of 2.594 N/mm2 was obtained with the addition of 1 % of Zrn1 glass fibers into Portland cement. Eventually, it was concluded that Zrn1 fibers can be a good candidate for reinforcing purpose in the cement leading to high strength and durability.
Keywords: Glass fiber, alkali resistance, reinforcing agent, cement, concrete, characterization, mechanical properties.

11:40-12:00
Textile Reinforcements Made of Alkali Resistant Glass Rovings in Concrete Structures
Gözdem Dittel, Till Arne Quadflieg, Andreas Koch, Thomas Gries
Institut Fuer Textiltechnik of Rwth Aachen University, Germany

Compared to steel reinforced concrete, the textiles made of alkali resistant glass fibres to reinforce concrete structures for civil applications, have many advantageous properties like high-strength, lightweight, corrosion-free, drapable and thin walled elements.
Use of AR-glass rovings as biaxial grids allows uniform properties in each direction. This leads to weight reductions as well as to economic and ecological savings. The most common manufacturing process of textile reinforcements for building industry is the warp knitting process. This process is suitable for changes in stitch type and for the substitution of single threads during the production.
Warp knitted textiles made of glass rovings enable new types of construction for a sustainable future. It can be used for fast and safe construction due to lightweight components with a high strength performance. Thin and lightweight TRC elements reduce the transport volume and thus the transport costs. Big sized TRC elements reduce the installation time and save personal costs. Due to its adequate mechanical performance and durability in alkali environments most common reinforcement material used in construction are alkali resistant glass. This material meet the growing requirements for corrosion-free and high-strength lightweight structures in the building industry. The combination of technical textiles and concrete creates stability and a high durability in lightweight and thin walled building components with a lifetime of over 100 years (non-corrosive). TRC provides a high quality surface and a CO2 reduction up to 80% in material, production, transport and mounting. It is adaptable to local standards (in terms of shapes, colors, architectural needs, etc.) The vertical extensions of cities are possible due to light weight. TRC offers the opportunities to develop sustainable solutions for global needs. This paper will give an overview on the projects about reinforcing textiles made of glass rovings researched at the Institut fuer Textiltechnik (ITA) of RWTH Aachen University.
Keywords: Textile reinforced concrete, AR-glass rovings, warp knitted reinforcing textiles

GLASS PROCESSING
October 24th,2017, 10:40-12:20, Hall: Marmara
Chair: **Jorma Vitkala**

10:40-11:10 (Invited Speaker)
Femtosecond Laser Induced Crystallization from Glasses.
B. Poumellec, J. Cao and M. Lancry.
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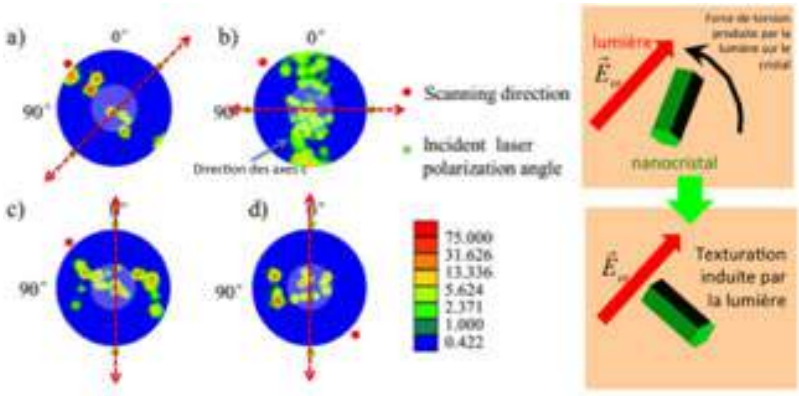
The number of utilisations to achieve with light is increasing so much and the complexity of the treatment of the light required increases so largely that the device elaboration are becoming very cumbersome, all the elementary functions being achieved by discrete devices. Therefore, it is needed urgently to render more compact the systems. In this direction, it needs to realize optical circuits, through which the light can be treated. For reaching this objective, it is necessary to know how to make waveguides, polarizers, polarization convertors, frequency converters or in term of physical properties how to make variations of average refractive index, birefringence, second order non-linear properties. One way for addressing these requirements, is to precipitate optical non-linear crystals along waveguides that can be elaborate in the same time. The technique of Direct Laser Writing with femtosecond laser is proposed in this direction.
During the presentation, I will make a short review on results published. From that and our own results in silica based glasses, I will suggest a mechanism for the thermal control of the crystallization with such a powerful laser according to the glass physico-chemical properties.
Another important aspect for integrated optics, is the control of the direction of the crystals. There is a laser parameter domain where a classical mechanism based on thermal gradient is suggested for driving the crystal orientation. In that case it is difficult to have the polar axes of the crystals in the direction of the light polarization. However, we will show in Li2O-Nb2O5-SiO2 glass that there exists another laser parameter domain where the orientation is tunable with the light polarization.
This case is described below with the help of the figure. The crystal orientation tunability is possible when crystal size is nanoscopic. Therefore, the energy should be small enough. In addition, the speed of writing should be around a few microns per second. The enclosed figure shows by using diffraction of backscattered electrons method (EBSD) the orientation of small crystals and the distribution of the polar directions (here that of the c-axes of the nanocrystals, highly optically non-linear axis, represented by the big dots (green colored zones at the periphery and red at the core)). It can be seen that their distribution lies in a plane perpendicular to the polarization of the light denoted by the red dotted lines. Due to this constraint, turning the laser polarization leads to turn the orientation of the

optical non-linear property. This is the first time that the motive action of light in crystal growth has been clearly demonstrated. Associated mechanism of action of light on crystals will be presented.



Pour en savoir plus : J. CAO, B. POUMELLEC, F. BRISSET, A.-L. HELBERT, M. LANCRY. Tunable angular dependent second harmonic generation in glass by controlling femtosecond laser polarization. J. Optical Society of America B Vol.33 (4) 2016, 741.

11 :10-11 :40 (Invited Speaker)
Worldwide Glass Market and Trends – Summary from GPD 2017
Jorma K. J Vitkala
GPD / Glaston Finalnd

The Chairman of the Glass Performance Days Organizing Committee Jorma Vitkala analyzes glass industry developments and trends by reviewing the state-of-the-art as reflected by the GPD 2017 Conference. In addressing the future challenges facing glass industry solutions Jorma Vitkala makes broad-based use of the conference 180 presentations and proceedings in a special summary of the highlights of the GPD in June 2017.
The GPD has developed into the hub of the international glass industry as the leading forum for the presentations of innovations, new technologies, new industrial practices and above all energy-efficient solutions in the service of processing, construction, design and interior decorating applications. The total number of addresses at conference sessions and workshops was around 180.
Keywords: Market trends

11:40-12:00
Ablation-Cooled Laser-Material Removal and Its Application to Glass Cutting
Hamit Kalaycıoğlu1, Ö. Akçaalan1, P. Elahi1, P. Deminsky1, Ş. G. Karamuk2, F. Ömer Ilday4
1Bilkent University

2Hacettepe University
3Menlo Systems Gmbh
4Bilkent University, Menlo Systems Gmbh

Using femtosecond laser pulses for precise and thermal-damage-free material removal is very attractive; however, lited by the low ablation speeds and complexity of the required laser technology. Complexity in laser design is due to high pulse energy threshold required (~100 µJ pulses with <10 ps duration, kHz-level repetition rates, mostly solid state laser technology). Scaling up the ablation rate simply by increasing pulse energy is limited by shielding effects. Recently, we identified a new regime of laser-material interaction, ablation-cooled laser material removal, where the repetition rate has to be high enough (up to the GHz-range, depending on the material) so that the targeted spot size can not cool down substantially by heat conduction which scales down ablation threshold by several orders of magnitude and reduces thermal effects to the bulk of the target. To access this new regime, we developed burst-mode fiber laser technology which allows to reach very high repetition rates with reasonable power levels. Experimental results obtained with 9 different materials indicate that we are able to increase the ablation efficiency by an order of magnitude, despite reducing individual pulse energies by ~1000 times, to sub-µJ levels, while simultaneously reducing thermal effects. The implications are broad, ranging from the simplification of lasers for processing to extremely high-speed material processing. We recently built a compact all-PM-fiber laser amplifier system with an intra-burst repetition rate of 1.6 GHz on a 40 x 65 cm platform and used it in glass cutting trials. In these trials, we observed ablation threshold of 300 nJ pulse energy with 270 fs pulses and 20 µm spot diameter using bursts of 80, 100, and 200 pulses, each repeated at 25 kHz. Comparing to published results, we achieved an improvement of 12 to 20 times in threshold fluence and 17 to 1000 times in threshold intensity.

Keywords: Glass cutting

12:00-12:20

Expert Optical Coating Inspection Solutions

Serkan Çakır
Isra Vısıon
Expert Optical Coating Inspection Solutions

The use of coated glass has risen significantly in many applications. This is why perfect coating and highest glass quality are a must to maintain the competitive edge. Here the newly developed, fully automated optical inspection systems help. They provide operators with an easy, efficient and economic set-up for excellent defect detection and exact classification of coating and other irregularities in the surface over the entire glass sheet. The increase in processing efficiency and quality is achieved by applying

the completely new, patented multi-dimension, multi-mode and multi-view technology. A 100% in-line inspection can be guaranteed for coating, color, surface, edge and shape - all at the same time, even in mixed batches. All typical coating defects, also smallest color variations for all coating types are detected as well as inclusions of all types and other surface defects. In addition the coating is checked for inhomogeneity and color flow. The system classifies and categorizes all defects and makes a distinction of removable contaminations in the products possible. This helps to react and adjust quickly during the manufacturing process. The overall result: highest quality and maximum productivity with minimized production costs.
Keywords: Expert optical coating inspection solutions multi-dimensional inspection ensures highest quality for all types of glass coatings

GLASS STRUCTURE AND PROPERTIES
October 24th 2017, 16:00-17:20, Hall: Hasköy
Chair: **Nuri Solak**

16:00-16:20
A Light Trapping Method for Thin Film Solar Cells: Aluminum Induced Glass Texturing
Mustafa Ünal1, Aydın Tankut2, Raşit Turan3
1Micro And Nanotechnology Department, Middle East Technical University, Ankara, Turkey; The Center For Solar Energy Research And Applications
2The Center For Solar Energy Research And Applications
3Micro And Nanotechnology Department, Middle East Technical University, Ankara, Turkey; Physics Department, Middle East Technical University, Ankara, Turkey; The Center For Solar Energy Research And Applications

Thin film solar cells have the potential to decrease the cost of produced solar electricity owing to their low material usage and simple production methods compared with wafer based technologies. CI(G)S and CdTe solar cells are the best rivals against c-Si solar cell in terms of efficiency. However, the toxic and rare material usage in these technologies makes the price of produced solar electricity higher. On the other hand, a-Si:H solar cells offers low efficiency values against c-Si solar cells even though a-Si:H solar cells usage only a fraction of material (1-2 μm). To decrease the price of the produced solar electricity further, an effective light trapping scheme is essential. Aluminum induced glass texturing is one of the light trapping method used to texture substrates. There are several parameters affecting the resultant texture, which are Al thickness, annealing and etching conditions. In this study, we have managed to scatter the 50% of transmitted light from soda-lime glasses with optimized conventional AIT process so that the optical path length inside the absorber layer increases. This means the increase in the absorption probability of the light. Thus, the efficiency can be increase or material usage can be decreased. In the

etching step of the conventional AIT process, usage of HF is problematic in terms of environmental issues and aggressive etching behavior of HF. With the developed solution in GÜNAM, this problem is solved and we have managed to scatter 80% of the transmitted light from soda-lime glasses. In addition, the resultant texture formed by 0.2-1 µm sized crater whereas it is 2-5 µm craters for conventional process.
Keywords: Glass texturing, aluminum induced texturing, light management, thin film solar cells

16:20-16:40
Optical Absorption of Nickel (II) in Borosilicate Melts in Relation to the Temperature Dependence of Network Structure
Jun Matsuoka, Tamaki Ikuho, Lisa Naemura, Akihiro Yamada, Satoshi Yoshida
The University Of Shiga Prefecture

Optical absorption spectra of transition metal ions in glass depend on the basicity and network rigidity. High basicity gives low coordination number (CN). High rigidity distorts the coordination polyhedral of transition metal ions to enhance the d-d transition. In the case of glass melt, distortion by thermal vibration also affects the spectra. In this study, optical absorption spectra of Ni(II)-doped borosilicate glass melts are measured and compared with those of simple silicate and borate.
25Na2O-75SiO2, 25Na2O-75B2O3, and xNa2O-(40-x)B2O3-60SiO2 (x=10, 20, 30) glasses which contain 2mol% NiO were investigated. Absorption spectra were measured from room temperature to 1200 K in the wavelength range from 400 to 1000 nm.
Ni(II) in these glasses have three absorption bands in visible region. Octahedrally coordinated Ni(II) gives a peak around 450 nm. Planer 4-fold coordinated Ni(II) gives a peak around 560 nm. Both 4-fold tetrahedrally coordinated Ni(II) and 5-fold bipyramid Ni(II) give a peak around 650 nm. In the case of 25Na2O-75SiO2, change of CN from 6 to 4 or 5 with increasing the temperature is observed. On the other hand, in the case of 25Na2O-75B2O3, increase of the temperature once decreases CN around Ni(II), and further temperature increase gives the change to opposite side. Temperature dependence of absorption spectra in borosilicate glasses strongly depends on the composition. In the case of glass rich in boron oxide (10Na2O-30B2O3-60SiO2), most of the Ni(II) are octahedrally coordinated below Tg, and increase of the temperature above Tg gradually lowers CN. On the other hand, change of CN above Tg seems to be small in sodium rich compositions (20Na2O-20B2O3-60SiO2 and 30Na2O-10B2O3-60SiO2).
The behaviors in borate and borosilicate melts can be explained by the decomposition of 4-fold coordinated boron to 3-fold coordinated one.
Keywords: Melt, optical absorption, Ni(II), silicate, borate, borosilicate, network structure

16:40-17:00

The Origin of the Violation of Charge Conservation Low in Glass Poling-Depoling Process

Dmitry K. Tagantsev1, Andrey A. Lipovskii2, Il'ya V. Reshetov1, Valentina V. Zhurikhina1

1Peter The Great St.-petersburg Polytechnic University
2St.-petersburg Academic University

Since the 90s of XX century the TSDC (thermally stimulated depolarization current) method has been successfully used for the characterization of charge accumulation and transport phenomena in multicomponent silicate glasses. The method consists in recording the temperature, T, (or time, t) dependencies of electric current, I, in poled glasses when they are being linearly heated. Curves I-t (or I-T) look like spectra with specific bands at certain temperatures (times), with the total area (Sdepol) under all the bands being obviously equal to the total charge passed through poled glasses in the depolarization process. Positions and intensities of the bands provide information about the activation energies of migration/accumulation for all charged particles (actually, ions) participating in the polarization/depolarization process. Up to quite a recent time the TSDC spectra of poled glasses have been studied in the temperature range which does not exceed upper limit equal to 500 oC that is below the glass transition temperatures, Tg, of the glasses. In this temperature range the activation energies of the discharge processes found by most researchers coincide with the ones typical for diffusivity of univalent and bivalent ions (0.8-1.8 × 10−19 J), and the areas (Spol) under the curves I-t recorded in the polarization process proved to be smaller by 4-6 orders of magnitude as compared to the Sdepol. The problem to resolve was: why Spol Sdepol ? In other words, why Qpol Qdepol? Here, Qpol is the total charge passed through the glass sample in the polarization process, and Qdepol is the total charge passed through the glass sample in the depolarization process.

We have studied TSDC spectra of poled soda-lime glasses above Tg (up to 750 oC). It was the first TSDC study in this temperature range. In the spectra we observed extremely high bands in the TSDC spectra with Qpol ≈ Qdepol. The calculated activation energy of this process (3.2 × 10−19 J) is close to the activation energy of the viscous flow of silicate glasses. These results evidence that 1) the most part of the space charge, frozen in glass poling, discharges (or relaxes) at temperatures above Tg, and 2) the process rate is controlled by glass viscosity. A mechanism and phenomenological model of the space charge relaxation in poled glasses above Tg is proposed. In accordance with the proposed interpretation, the giant depolarization current observed above Tg and related to the relaxation of the “frozen” space charge formed during the glass polarization procedure is conditioned by the ion drift under the action of the “frozen” electric field. In the model the ions are considered spherical particles. Space charge relaxation below Tg via this mechanism which we call the viscous mechanism cannot take

place because of too high viscosity of silicate glasses in this temperature range.
The study has been supported by Russian Science Foundation grant No. 16-12-10044.
Keywords: Glass, poling, depolarization, relaxation, thermaly stimulated depolarization current, TSDC method

17:00-17:20

Luminescent Solar Concentrators Made of Near-Unity Efficient Copper-Doped Semiconductor Nanocrystals between Glasses

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2Department Of Chemistry And Vanderbilt Institute For Nanoscale Science And Engineering, Vanderbilt University, Nashville, Tn 37235, USA
3Department Of Electrical And Electronics Engineering, Department Of Physics, Unam, Bilkent University, Ankara, 06800, Turkey; Luminous, School Of Electrical And Electronics Engineering, School Of Physical And Mathematical Sciences, Nanyang Technology

Motivation

Luminescent solar concentrators (LSCs) are promising candidates for solar convertors in light harvesting applications. [1–2] In addition to being cost-effective, LSCs can be semi-transparent expanding their application area to glass window panels and building facades. Increasing the light collection area in LSCs enables additional concentration of incident solar flux onto photovoltaic (PV) cells increasing the photogenerated power.

Material

Additional increase in the efficiency of LSCs is possible through spectrally matching the photoluminescence emission of the embedded fluorophores with the peak efficiency of a desired PV device. [3] In this respect, with their well-known emission tunability, colloidal semiconductor nanocrystals (NC) are perfect material platforms as LSC fluorophores. [4] However, utilization of NCs in LSCs is limited due to optical reabsorption losses preventing the practical applications of LSCs. Here we report the development of copper-doped atomically-flat semiconductor nanocrystals made of CdSe with reduce reabsorption losses and their application on glass as LSCs.

Methods

In addition to large Stokes shift, step-like absorption profile of colloidal quantum wells (CQWs) potentially offer superior optical properties as ideal LSC materials. In this study, using nucleation doping method, we realized Cu doping in CdSe CQWs having a near-unity efficient dopant-induced PL emission. Dopant-induced emission is further tuned by the deposition of

CdS shell on these different quantum-confined structures, covering a wide range of electromagnetic spectrum from visible-to-NIR. [5] We successfully incorporated these CQWs in a polymer matrix between glasses as proof-of-concept LSC devices that surpass the performance of Cu-doped CQDs. As the polymer host material we used UV-curable poly(lauryl methacrylate) polymer casted inside a glass mold as a practical LSC device. Attaching the PV solar cells at the thin edges of LSC panels allowed us to convert the concentrated solar flux as electrical power.

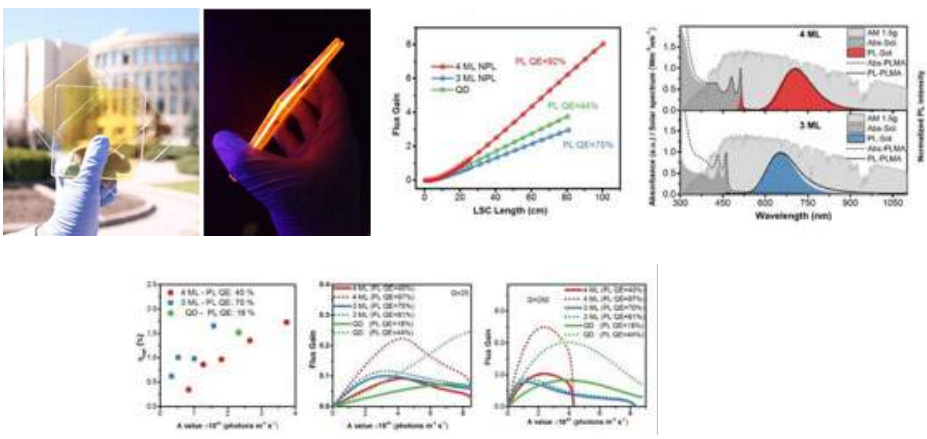
Results

Here we show that these copper-doped CQWs outperform all other NCs as LSC fluorophores. The synthesized Cu-doped CQWs achieve near-unity PL QEs (up to ≈97%). We experimentally characterized reabsorption losses and numerically modeled the performance of these CQW luminophores exhibiting the largest flux gain. The resulting high performance of these Cu-doped CQWs in LSCs is enabled by the combination of their large Stokes-shifted and tunable dopant induced photoluminescence emission in visible-to-NIR region and extraordinarily large absorption cross-section, in conjunction with their distinctly sharp absorption profile.

[1] A. Goetzberger, et al., Appl. Phys. 14, 123 1977
[2] F. Meinardi, et al., Nat. Photonics 8, 392, 2014.
[3] F. Meinardi, et al., Nat. Nanotechnol. 10, 878, 2015.
[4] L. R. Bradshaw, et al., Nano Lett. 15, 1315, 2015.
[5] M. Sharma*, K. Gungor*, et al., Adv. Mater. (DOI: 10.1002/adma.201700821).

* equal contributor

Keywords: Luminescent solar concentrators, doped nanocrystals, solar conversion, luminescent window panels, nanocrystal embedded polymer matrices, quantum efficiency, Cu doping, 2D semiconductor nanoplatelets, glass waveguides, Stokes shift, reduced reabsorption



Figure

SURFACE
October 24th 2017, 16:00-17:20, Hall: Kasımpaşa 1-2
***Chair:* İlkay Sökmen**

16:00-16:20
2D Structuring of Glass Surface: Peculiarities of Thermal Poling and Chemical Etching
Andrey A Lipovskii1, Igor V Reduto2, Alexandre N Kamenskii3, Alexey V Redkov4, Dmitri K Tagantsev3, Valentina V Zhurikhina3
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2University Of Eastern Finland, Kuopio, Finland
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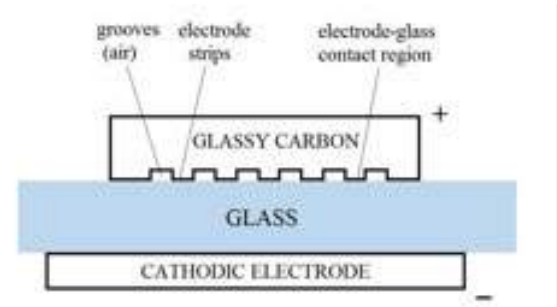
4Peter The Great St. Petersburg Polytechnic University; Institute Of Problems Of Mechanical Engineering Ras, St. Petersburg, Russia

Applying several hundred volts DC to a plate of multicomponent glass placed between two electrodes and heating it up to a temperature sufficient to activate ionic conductivity (thermal poling) provides compositional and structural modification of the subanodic region of the glass followed by volume relaxation of the poled region. We have characterized these modifications with Raman spectroscopy and analyzed the distribution of mobile cations in the poled glasses. To study structuring of soda-lime glasses surface via thermal poling we used 1) anodic electrodes presenting glassy carbon plate patterned with electron lithography and reactive ion etching and pressed to the glass surface and, 2) chromium film deposited on the glass and structured with a photolithographic technique. To compare the glass surface structuring in open (access of atmospheric species to anodic surface of the glass is allowed) and closed (the access is prevented) anode configurations, the chromium structure and the glass nearby were partly covered with 200 nm thick titania layer to arrange poling in the closed anode mode. The glass surface relief formed after the poling and after additional processing in NH4F:8H2O polishing etchant was characterized with atomic force microscopy, scanning electron microscopy and profilometry. Minimal measured lateral resolution of the thermal poling is equal to 100 nm, and relief height provided by poling can be varied from 2-3 to 180 nm. The difference in the etching rate of poled and unpoled glass region allows formation of relief structures with the height of microns range. It was found that the increase in poling voltage above 300 V distorts the relief structure and decreases relief height of both poled and etched structures because of electric discharge arising near the electrode edge and in the gap between the anodic electrode and a glass subjected to poling. Poling non-uniformities near closed-open anode interface (anodic electrode edges) result in deeper poling in the vicinity of the edges. In chemical

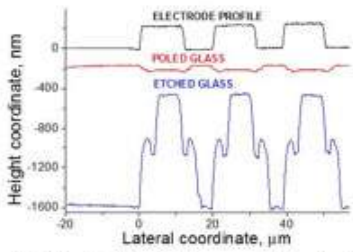
etching, these features lead to additional relief and extra stresses in those regions, the latter result in defects of the glass cleaves near the electrode edges. The absence of defects near these edges in cleaved glass samples poled in the closed anode mode indicates that the in-flow of atmospheric species rather than electric field non-uniformities is responsible for the peculiarities of glass poling near the electrode edges. Besides, thermal poling generates elastic stresses in glasses because of the relaxation of the poled volume, and the size of the stressed region essentially exceeds the size of the poled one. Visualization of the stresses via chemical etching demonstrates a similarity of the stress distribution modeled one. The peculiarities revealed should be accounted for in fabrication of relief structures on the surface of glasses with thermal poling and chemical etching.

Keywords: Thermal poling, chemical etching, surface structuring



Schematic of glass poling with profiled electrode

AFM and SEM images of profiled glasses



Peculiarities of poling/etching near electrode edges

Figure

16:20-16:40

Effective Cleaning Solution for Corroded Bottles

Semin Atilgan, Ezgi Deniz Biçer, Esra Duman, Emel Mercan, İlkay Sökmen, Emin Burak İzmirlioğlu
Şişecam, Science and Technology Center, Kocaeli, Turkey

Ion exchanged alkali and alkaline earth metal hydroxides from the glass surface form corrosion products after reacting with atmospheric gases such as CO2 and SO2 of air of which in return cause visible defects such as clouding. These crystals may cause bubbling after they are in contact with carbonaceous liquids.
An efficient cleaning process has been developed in order to avoid the problem of bubbling that occurs during the filling of carbonated beverages. For this purpose, firstly, the inner surfaces of the corroded bottles before washing, were analyzed by different surface techniques (FTIR, WLI, SEM-EDS). When the surfaces of the corroded bottles being washed with solutions prepared with different types and concentrations of acid and acid mixtures in the proper washing temperature, it has been observed that the most effective washing is obtained with tartaric acid solution to prevent bubbling. Tartaric acid has less steric effect than other acids due to its secondary hydroxyl groups which remove corrosion products from the surface of the bottles. Tartaric acid, which is naturally found in many fruits, is a weak organic acid with antioxidant properties and does not pose any risk to the glass bottles in contact with food.
Keywords: Glass surface, surface cleaning, corrosion

16:40-17:00

Effect of Dealkalization Process on Float Glass Surface

Ezgi Deniz Biçer1, Emel Mercan1, Lukas Simurka1, Hasan İsmail2, Tuncay Turutoğlu1, İlkay Sökmen1
1 Sisecam, Science and Technology Center, Gebze, Turkey
2Trakya Glass Bulgaria Plant

Dealkalization process is a thermochemical modification of glasses containing alkali ions by acidic agents. A thin surface layer that has a lower concentration of alkali ions is created for the improvement of corrosion resistance. For this purpose, sulphur containing gases are the most common agents used in glass industry.
In the present study, during the float process, air side of the glass was dealkalized by treatment of glass surface with SO3 gas in the annealing furnace. After removal of the sulfate deposits from the surface by washing with deionized water at the end of the annealing process, surface properties of dealkalized glass was compared with non-dealkalized glass. Surface compositions were examined with a precise X-ray photoelectron spectroscopy depth profile technique. Surface structure modification of dealkalized glass was evaluated by fourier transform infrared spectroscopy. Surface mechanical properties of both types of glasses in terms of hardness

and elastic modulus were studied by using indentation technique. In order to obtain refractive index values, both samples were measured by spectroscopic ellipsometry. Na diffusion behaviors of glass surfaces through the coating system were compared by using X-ray photoelectron spectroscopy.
From XPS data, it has been found that Na concentration of dealkalized glass surface was reduced through the region from surface to ~500 nm depth. Infrared spectra showed that dealkalization of glass surface leads to a shift of the band near ~1060 cm-1 which is attributed to Si-O-Si (bridging oxygen) asymmetric stretching mode to higher wavenumber. This shift is indicative of depletion of alkali from the glass surface which results in the conversion of Si-O- bonds (nonbridging oxygen) into Si-OH.
Nanoindentation data showed that hardness and elastic modulus values are slightly lower for the glass which is dealkalized. Ellipsometric measurement results revealed that the dealkalized glass has lower refractive index than the non-dealkalized glass. Although dealkalized glass has Na-poor surface, no difference was detected between the samples in terms of Na diffusion through the coating system.
Keywords : Dealkalization, thermochemical modification, glass surface, x-ray photoelectron spectroscopy, ellipsometry

17:00-17:20
All-Solid-State Electrochromic Device
Gamze Atak
Hacettepe University, Physics Engineering Department, Thin Film Preparation And Characterization Laboratory

Electrochromism (EC) is defined as a phenomenon in which color change occurs when an external voltage is applied. Because of their low power consumption (1-2 V), high coloration efficiency and optical modulation, and memory effects under open circuit conditions, EC devices have attracted attention. The electrochromic devices (ECD) have found several applications in passive and active photonic devices, architectural ‘‘smart windows’’, rear-view mirrors for cars, and information displays, variable-transmittance eyewear, sunroofs for automobiles, variable-emittance surfaces for temperature control of spacecraft and in medical imaging detectors for higher resolution [1-5].
Conventionally EC device structure may have five layers (transparent conducting oxide (TCO) layer / cathodic electrochromic layer / ion conducting layer (electrolyte) / anodic electrochromic layer / TCO layer) superimposed on one substrate or be positioned between two substrates in the laminate configuration. For a laminated device, the ion conductor is a polymeric electrolyte that can have a degrading effect on the EC layers and cause problems such as delamination and shrinkage [2]. The other configuration is an all-solid state EC device that has a thin layer of film as an ion-conducting layer like ZrO2, Ta2O5 and LiNbO3 [3, 4-6, 7].
In this study, all-solid-state electrochromic devices, which were fabricated

with a high optical modulation in our laboratory, will be explained. All thin films used in the device fabrication were deposited by RF magnetron sputtering technique. Sputtering technique is widely used due to its high deposition rate, obtained high film quality and good uniformity over large areas of the substrates. In the devices, ITO, NiO, and WO3 thin films were used as a transparent conductor, an anodic electrochromic layer, and a cathodic electrochromic layer, respectively. ZrO2, Ta2O5, and LiNbO3 oxide thin films were also employed as an ion conducting layers in the fabricated all-solid-state EC devices.

References

[1] C.G. Granqvist, E. Avendano, A. Azens, Thin Solid Films 442 (2003) 201–211
[2] A.-L. Larsson, G.A. Niklasson, Solar Energy Materials & Solar Cells 84 (2004) 351–360
[3] R.B. Goldner, F.O. Arntz, K. Dickson, M.A. Goldner, T.E. Haas, T.Y. Liu, S. Slaven, G. Wei, K.K. Wong, P. Zerigian, Solid State Ionics 70/71 (1994) 613–618
[4] A. Subrahmanyam, C. Suresh Kumar, K. Muthu Karuppasamy, Solar Energy Materials & Solar Cells 91 (2007) 62–66
[5] C.G. Granqvist, Handbook of Inorganic Electrochromic Materials, Elsevier, Amsterdam, 1995.
[6] W.F. Chen, S.Y. Wu, Applied Surface Science 253 (2006) 1907–1911 (https://doi.org/10.1016/j.apsusc.2006.03.033)
[7] J. G.H. Mathew, S. P. Sapers, M. J. Cumbo, N. A. O'Brien, R. B. Sargent, V. P. Raksha, R.B. Lahaderne, B. P. Hichwa, Journal of Non-Crystalline Solids 218 (1997) 342–346

Keywords: Electrochromism, all-solid-state device, smart glass, optical modulation, RF magnetron sputtering

GLASS PRODUCTION (GLASS TREND)
October 24th 2017, 16:00-17:20, Hall: Kasimpaşa 4-5
Chair: **Oscar Verheijen**

16:00-16:20
Glasstrend. Factors Affecting Frit Solubility in Glaze Suspensions
Arnaldo Moreno
Instituto De Tecnología Cerámica-asociación De Investigación De Las Industrias Cerámicas. Universitat Jaume I. Campus Universitario Riu Sec, Castellón, Spain

Frits, a particular type of glass, are key components of glazes used as coatings of ceramic tiles. These glazes are deposited on the tile surface by different application techniques, most of them requiring the glaze to be in form of aqueous suspension, or slip. The rheological conditions of said suspensions have often been observed to gradually change as such slips age. It is shown that ceramic frits do not remain inert in glaze slips. Rather, these frits exhibit a certain solubility in water, as a result of which they can

contribute cations to the glaze suspension, which can cause its viscosity to change as it ages. This paper shows a summary of a study conducted at Instituto de Tecnología Cerámica (ITC) focused on the determination of, on one side, which cations are more readily lixiviated from a frit, and on the other side, the key factors influencing such a lixiviation in aqueous glaze slips: type of raw material used to make the frits, milling time, solids content, suspension temperature, standing time, or stirring intensity. Relevant information has thus been obtained regarding the industrial use of the frits, which is where the problems arise. A short review on the reasons of the poor chemical stability of frits is also discussed in the presentation.
Keywords: Frits, solubility, cations, chemical composition

16:20-16:40
TopFrax™ Catalytic ceramic filters: Simultaneous fine dust separation and NOx, CO and VOCs Emission Abatement
Anja Zarah Friedberg, Francesco Castellino, Johannes Skotte
Haldor Topsoe A/s

Emissions of dust, NOx, CO and VOCs at power, glass and cement plants are being regulated around the world, requiring the installation of secondary measures for the removal of these pollutants at both existing and new plants. Different technologies are today available for the treatment of each single component. For instance, dust filters are widely accepted in the industry for the removal of 99+% particulate matter, whereas SCR and oxidation catalyst are typically employed for the treatment of flue gases containing NOx and CO/VOCs, respectively. When every single technology is installed individually, emission abatement is achieved, but at the cost of both capital and operating expenditures.
Haldor Topsoe A/S and Unifrax have combined their respective extensive expertise and knowhow within heterogeneous catalysis, fiber filter manufacturing and filtration in the new product TopFraxTM, a catalytic ceramic filter. This easy to clean and robust filter has combined simultaneous removal of particulate with NOx, VOCs and CO. The TopFraxTM filter is based on a ceramic filter that has been functionalized with nanoparticles of vanadium and titanium. The catalytic composition can be modified to suit the exact need of the customer where a Pd-based oxidation catalyst is added for VOC and CO removal. A newly developed and patent pending production process ensures that the catalytic material can be loaded uniformly in a very well defined and adjustable fraction of the filter wall. This enables the catalyst load to be designed according to the required performance, thus limiting the occurrence of undesired side reactions (e.g. SO2 oxidation). A further advantage of the catalytic filter is that potential poisons are accumulated on the filter cake, thus not reaching the active catalyst. In the present work, the case of a cement plant requiring the combined removal of NOx, VOCs while avoiding the formation of CO due to partial combustion of VOCs is presented.
Keywords: Catalytic ceramic filters, deNOx, CO/VOC removal, filtration, SCR

16:40-17:00
Thermagy (R) A New Way to Recover Waste Heat from Glass Melting Furnaces
Sven-Roger Kahl1, Maarten den Heijer2, Bert Kraaiveld2
1Ardagh Glass Dongen B.v.
2Rgs Development B.v.

Thermagy® elements use the Seebeck effect to directly convert temperature differences between the hot side inserted into the furnace and the cold side outside the furnace to generate electrical energy.
Since 2015 a project group in the Netherlands works on the application of small scale testing elements to prove the possibility to convert waste heat directly into electrical energy. After some general investigation of potential waste heat sources it was decided to develop a test element, which can be used for tests in flue gas channels and above fore hearth.
First tests in a flue gas channel have been carried out and showed a potential to create up to 3 kW per m^2 element surface. About further tests using radiation heat from a forehearth will be reported too.
Furthermore focusses the presentation on potential applications in the glass industry and gives an outlook on planned tests and possible design changes in certain areas of furnaces to achieve a maximum waste heat recovery effect.
Keywords: Heat recovery, energy saving, sustainability

17:00-17:20
Oxy-Combustion Tanks with Low Crown Design for Flue Gas Guidance above Batch Blankets: Advantages and Risks
W.Kuhn & A. Reynolds

NUCLEATION & CRYSTALIZATION
October 24th 2017, 16:00-17:20, Hall: Balat
Chair: **Melek Erol Taygun**

16:00-16:20
Up-Conversion Emission in Er-Yb Doped Transparent Oxyfluoride Nano-Glass-Ceramics
G. Gorni1, R. Balda2, J. Fernández2, J.J. Velázquez1, L. Pascual3, A. Durán1, M.J. Pascual1
1Instituto De Cerámica Y Vidrio Icv-csıc, Madrid, Spain
2Departamento De Física Aplicada I, Escuela Superior De Ingeniería,upv-ehu, Bilbao, Spain, Centro De Física De Materiales Csıc-upv/ehu, San Sebastian, Spain
3Instituto De Catálisis Y Petroleoquímica Icp-csıc, Madrid, Spain

Oxyfluoride glass-ceramics have become increasingly important in the last decades because they combine the advantages of glass processing with the

good crystalline properties, such as good mechanical, thermal and optical ones. From the pioneering work of Wang and Ohwaki in 1993 [1], concerning the efficient green and red Up-Conversion (UC) emission in Er3+-Yb3+ doped GCs containing PbxCd1-xF2 nano-crystals (NCs), many fluoride crystal phases have been studied, showing the possibility to effectively improve the luminescence of Rare-Earth ions (REI) when they are embedded in fluoride NCs. LnF3 [2] or RLnF4 [3] (R= K, Na, Li) crystals phases are especially important because the similar size of ions crystals former and the other REI used as dopants allows their incorporation into the crystals phase.
In these work, two oxyfluoride compositions doped with 0.5Er and co-doped with 2 and 4Yb (mol %) have been studied. A structural study, performed by XRD, showed the precipitation of LaF3 or NaGdF4 nano-crystals in the glass. HR-TEM and XANES techniques have allowed evidencing the Er3+ and Yb3+ enrichment in the nano-crystals and estimating their concentration in the crystal phase.
Optical measurements of Er3+ singly doped and Yb3+ co-doped samples showed UC emission (green and red) upon NIR excitation at 980 nm. A notable improve in the UC emission intensity is observed from glasses to GCs and the two-photon origin of the process was proved. Moreover, the green/red ratio of the UC emission changes with the heat treatment of GCs and a possible explication related to the REI concentration is given.
[1] Y. Wang and J. Ohwaki, Appl. Phys. Lett. 63 (1993) 3268–3270.
[2] G. Gorni et al., J. Eur. Ceram. Soc. 37 (2017) 1695–1706.
[3] A. Herrmann et al., Chem. Mater. 25 (2013) 2878–2884.
Keywords: Transparent glass-ceramics, optical properties, fluorides

16:20-16:40

The Effect of Zirconium and Lithium on Crystallization of Glass-Ceramics in Soda-Lime Silicate System

Ekarat Meechoowas, Benjamon Petchareanmongkol, Usanee Pantulap, Kanit Tapasa
Engineering Materials Division, Department Of Science Service

In this study, the crystallization of soda-lime silicate (NCS) system by re-melted soda-lime silicate glass cullet with Al2O3 CaCO3 and ZrO2 or Li2O. The ZrO2 and Li2O were added as nucleating agent. The effect of nucleating agents on the crystallization were investigated in order to study the potential usage as a parent glass for glass-ceramics. The soda-lime silicate cullet was the major raw material and the chemical composition show in table 1. The glass composition was modified with Al2O3 and CaCO3 to reduce the Na2O ratio and increase the crystallization of the glass with ZrO2/Li2O. The glass batches (%wt) of (65-x) Cullet:13Al2O3:22CaCO3:x(ZrO2/Li2O) (x = 0, 1, 2, 4, 6 and 8) were melted at 1500ºC for 3 hours. For glasses added with ZrO2 1, 2 and 4 wt% were clear and the rapid crystallization during casting was found in the glasses

with 6 and 8 wt% ZrO2. All glasses added with Li2O were clear. The crystallization was investigated by Differential Scanning Colorimetry technique (DSC). The results exhibited the exothermic peak of crystallization (TpI and TpII) .The glasses added with Li2O show the crystallization temperature lower than glasses added with ZrO2 about 90ºC. And the crystallization temperature decrease with increasing Li content. The glasses with low content of nucleating agent (Zr/Li less than 2 wt%), the exothermic peak were not significantly different. In the other hand with increasing nucleating agent the glasses added Li show the exothermic peak higher than glasses containing Zr. After heated treatment the glasses at temperature around crystallization temperature, the crystalline in the glasses were determined by X-ray diffraction technique (XRD). In conclusion, Li2O has strong effect on the crystallization in soda-lime silicate system than ZrO2 and the result will be applied for the production of glass-ceramics from soda-lime cullet.

Keywords: Glass-ceramics crystallization lithium zirconium soda-lime glass

Table: The cullet composition

Composition	SiO_2	Al_2O_3	Na_2O	K_2O	CaO	MgO	TiO_2	SrO	ZnO	Sb_2O_3
wt%	68.2	1.8 9.0	8.7	3.6	2.4	1.2	3.0	1.8	0.3	

16:40-17:00

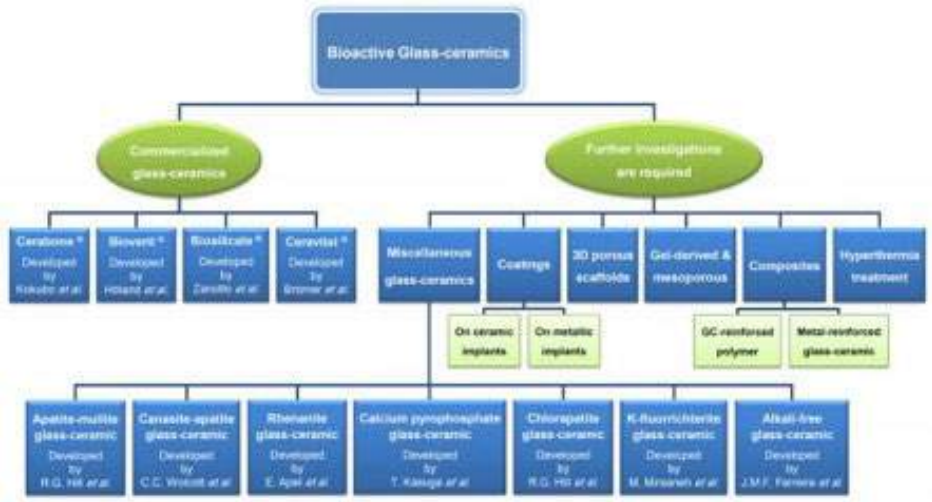
4-Decade Quest for Tough Bioactive Glass-Ceramics

Maziar Montazerian, Mina Eilaghi, Edgar Dutra Zanotto
Department Of Materials Engineering (dema), Center For Research, Technology And Education İn Vitreous Materials (certev), Federal University Of São Carlos (ufscar), São Carlos, Sp, 13.565-905, Brazil

The first bioactive glass-ceramic, Ceravital®, was developed by Brömer et al. in 1973 aiming to improve the mechanical properties of bioglass 45S5®. Later on, other bioactive glass-ceramics, such as Cerabone®, Bioverit®, and Biosilicate® were developed and commercialized. The fracture toughness of these glass-ceramics (1-2 MPa.m1/2) is still in the lower range of that of cortical bone (2-12 MPa.m1/2). Therefore, bioactive glass-ceramics have been considered for low and medium load-bearing conditions. Currently, there is an intense search for novel compositions and microstructural design to increase both their toughness (to KIC > 3 MPa.m1/2) and bioactivity. Regarding future developments, biomimetic regeneration of the complex structures of bone and teeth demands 3D porous materials for incorporation of biofactors, and mesoporous bioactive glass-ceramics are promising for this application. Another potential application is hyperthermia treatment of cancer using magnetic bioactive glass-ceramics; and several other relevant examples could be given. Due to their inherent bioactivity and improved mechanical properties, bioactive glass-ceramics continue to be key candidates in the quest for adequate bone substitutes or porous

scaffolds. There are clear signs that bioactive glass-ceramics, alone or in combination with other materials, such as biopolymers, will find a wealth of applications for bone therapy in our aging population.

Keywords: Glass-ceramic, bioactivity, mechanical properties, biomedical



Figure

Table

Bioactive glass-ceramics	Compressive strength (MPa)	Bending strength (MPa)	Fracture toughness (MPa.m1/2)	Young's modulus (GPa)	Vickers Hardness (HV/GPa)	Bioactivity index (IB)
Ceravital	500	100-150	-	150	-	5.6
Cerabone	1080	215	2.0	118	680 (HV)	6
Biosilicate	-	210	1.0	60-80	-	> 8
Bioverit I	500	140-180	1.2-2.1	70-88	5 (GPa)	-
Bioverit II	450	90-140	1.2-1.8	70	8 (GPa)	-
Bioverit III	-	60-90	0.6	45	-	-
Cortical bone	100-200	50-150	2-12	5-20	-	-

17:00-17:20

Microwave Heat-treated Crystallization and Microstructure of ZrO2 Containing SiO2–MgO-Al2O3–K2O–B2O3–F Glass-ceramics

Mrinmoy Garai, Shibayan Roy
Materials Science Centre, Indian Institute of Technology (IIT), Kharagpur-721302, India

In understanding the effects of nucleating agent on microwave heat-treated crystallization of boroaluminosilicate glass (Si-O-Si/B/Al), the varying ZrO2

content (2, 5 and 10 wt.%) doped K2O–MgO–Al2O3–SiO2–B2O3–F (KMASBF) glasses were synthesized by double-step melt-quenching at 1550°C (for 2 h). On the basis of DSC experimental, the glasses were heat-treated at 700°C followed by 780°C (in controlled way) in microwave furnace under 40°C/min heating rate for crystallization. Over controlled crystallization, the amorphous boroaluminosilicate glasses were converted into opaque glass-ceramics. Such temperature under microwave heating is found as adequate for crystallization to evolve predominant amount of crystalline phase fluorophlogopite mica, KMg3(AlSi3O10)F2. The development of interlocked card-like and rod-like microstructure composed of fluorophlogopite mica flake crystals in ZrO2 containing glass-ceramics is interpreted by means of its capability to exhibit enhanced mechanical properties and hence, machinability. With increasing ZrO2 content higher nucleation is ascertained and thus average crystal width is increased whereas average crystal length is decreased. The experimental observations in scratch tests at a high load of 40 N indicate that the glass-ceramics with rod shaped and plate shaped mica crystals with higher width have the potential to hinder the scratching induced crack propagation. In particular, such potential of the 'fluorophlogopite mica' crystals become more effective due to the larger interfacial area with the glass matrix as well as the dendritic structure of each mica plate, which helps in crack deflection and crack blunting, to a larger extent when contains higher amount of ZrO2 content. Materials deformation through scratch propagation is observed as inversely proportional to strength of matrix and thus the trend of materials deformation is 2 wt.% ZrO2 content > 5 wt.% ZrO2 > 10 wt.% ZrO2. Glass-ceramic with 2 wt.% ZrO2 possess Vickers microhardness 5.68 GPa and increased to 6.17 and 6.64 GPa in increasing the nucleating agent content to 5 and 10 wt.%.

Keywords: Boroaluminosilicate-glass, microwave heating, crystallization, microstructure, mechanical property

NUCLEAR WASTE VITRIFICATION
October 24th, 2017, 16:00-17:30, Hall: Cibali-1
Chair: **Burak İzmirlioğlu**

16:00-16:30 (Invited Speaker)
Durability of Nuclear Waste Glasses under High pH Conditions
Daniel J Backhouse, Claire Utton, Claire L Corkhill and Russell J Hand
ISL, Department of Materials Science & Engineering, University of Sheffield, Mappin Street, Sheffield, UK

In the UK current radioactive waste disposal scenarios envisage potential co-disposal of vitrified and cemented intermediate level wastes (ILWs) and/or co-location of an ILW repository containing cemented wastes with a high level radioactive waste (HLW) repository containing vitrified wastes. These scenarios could result in vitrified wasteforms being exposed to

calcium containing high pH environments. It is therefore necessary to understand how the waste glasses will perform under these conditions. Thus we have undertaken a series of studies on model glass compositions, including the international simple glass (ISG), as well as glasses that are representative of potential vitreous wasteforms. The presence of calcium has a significant effect on performance as it leads to the formation of calcium silicate hydrate (CSH) gels which appear to limit the rapid dissolution seen in high pH conditions where calcium is not present. However distinct mechanistic differences were seen according to glass composition, with more rapid dissolution being seen for compositions that contain significant amounts of Al2O3 and/ or MgO than for compositions which do not. The implications of these compositional differences for the use of simplified glass compositions, especially ISG, as models for full waste loaded glasses will be discussed.

16:30-16:50

High-Level Waste Vitrification: Balance of Oxygen

Pavel Hrma1, Jaroslav Kloužek2, SeungMin Lee1, Richard Pokorny2, Miroslava Hujova2, Michael Schweiger1, Albert Kruger3

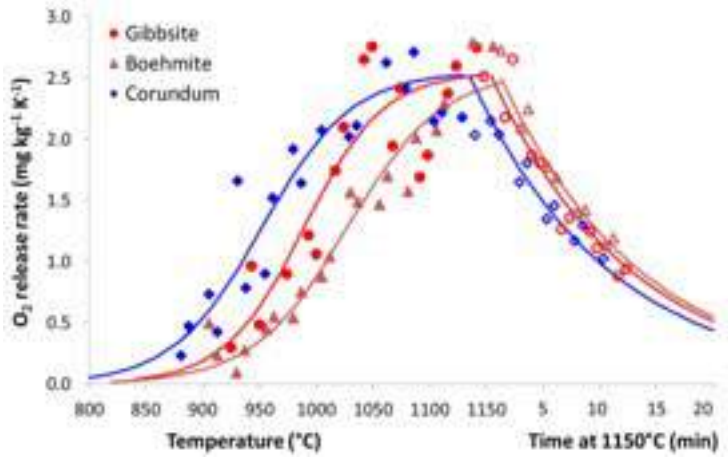
1Pacific Northwest National Laboratory

2Laboratory Of Inorganic Materials, Joint Workplace Of The Institute Of Chemical Technology Prague And The Institute Of Rock Structure And Mechanics Of The Ascr

3U.S. Department Of Energy, Office Of River Protection

The conversion of nuclear waste melter feed to glass occurs in the cold cap, a layer of reacting feed floating on molten glass. Most of the batch gases (CO2, CO, NO, NO2, O2, or SO2) are produced from oxyionic salts by irreversible reactions that occur in the porous cold-cap layer and primary foam. Oxygen is an exception. Apart from being produced and consumed by irreversible reactions, O2 is involved in reversible redox reactions of multivalent oxides, such as Fe2O3, which play major role in secondary-foam formation. Based on the stoichiometry of feed melting reactions and evolved gas analysis data from the reacting feeds that was ramp-heated to 1150°C at which it was held for 13 min, we have established a quantitative material balance of gaseous oxygen during the feed-to-glass conversion process. The O2exchange between the melt and the atmosphere is related to the approach of the iron redox ratio to equilibrium. The driving force for this process is the difference between the O2 partial pressure in bubbles, in the external atmosphere, and in the glass melt. The kinetics of the O2 exchange between the melt and the atmosphere was measured with the oxygen analyzer.

Keywords: Oxygen mass balance, feed-to-glass conversion, evolved gas, oxygen partial pressure, fe redox ratio



Figure

16:50-17:10

Iron Phosphate Based Glasses as Alternative Host Matrices for Nuclear Waste Vitrification

Mevlüt Karabulut
Gebze Technical University, Kocaeli, Turkey

Iron phosphate based glasses are being investigated as alternative host matrices for the vitrification of certain types of nuclear wastes due to their superior properties like relatively low melting temperatures, high waste loading ability and high chemical durability. Addition of iron into phosphate composition drastically improves the chemical durability of otherwise easily corroded phosphate glasses. This drastic change has been attributed to the replacement of easily hydrated P-O-P bonds by hydration resistant Fe-O-P bonds. Iron phosphate glass with base composition 40Fe2O3-60P2O5 (mol%) has been shown to have met the criteria for a glass to be considered as a host for waste vitrification. Structural properties of the base glass and single and multi-component waste containing glasses prepared by conventional melt quenching at 1200 °C will be presented. Independent of the iron source used in the starting batch, Mössbauer measurements reveal that iron ions exist with mixed valence states and the total fraction of Fe2+ ions in glass depend on melting conditions and waste components. These glasses can accommodate several waste components without a degradation in its properties. The high waste loading capability of the base glass will be related to glass structure through Mössbauer, EXAFS, XRD, FTIR, XPS and DTA/TGA investigations.
Keywords: Iron phosphate glasses, vitrification, nuclear waste

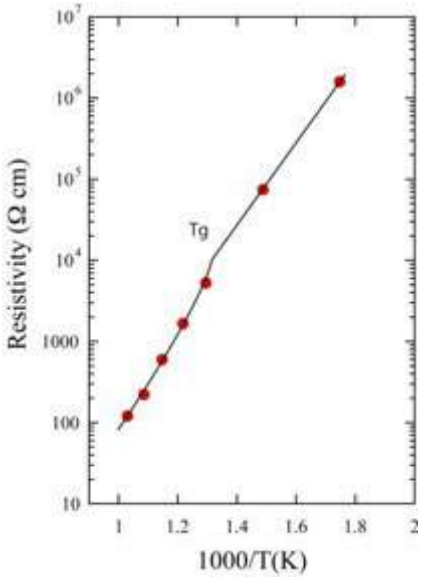
17:10-17:30

Ionic Conductivity of Borosilicate Glass and Melt Containing Simulated High-Level Radioactive Waste Elements

Tetsuji Yano, Tetsuo Kishi
Tokyo Institute Of Technology, Japan

Electric field application to glass at elevated temperature induces ionic conduction of constituent elements. High-level radioactive waste borosilicate glasses contain various elements; glass network former, network modifier and intermediates. With increasing temperature, resistance of oxide glasses reduces in logarithmic scale and the insulator at room temperature turns into ionic conductor. At near the glass transition temperature (Tg), glass networks still have strong bonds and highly viscous properties while modifier cations and sometime anions show diffusion and conduction responding to the electric field.
Borosilicate glass system, Li2O-Na2O-CaO-ZnO-Al2O3-B2O3-SiO2, containing simulated high-level radioactive wastes from reprocessing process is examined to impedance analysis from 100Hz to 10MHz at the temperature range from 300 to 700 ºC. Ionic conductivity, dielectric constants are evaluated as a function of frequency.
Figure 1 shows Arrhenius plots of DC resistivity sample. Beyond Tg, Arrehnius behavior with a constant slop is found while the resistivity shows downward-convex curve, commonly expressed by Vogel-Tamman-Fulcher (VTF) equation. When compared with soda-silicate glass and melt, the observed trend is almost similar each other.
In this presentation, the ionic conduction of waste glass is paid attention to understand the ionic mobility and conduction of waste elements at elevated temperature under the DC electric field.

Keywords: Waste vitrification, ionic conductivity, borosilicate glass



Wednesday, October 25th

GLASS STRUCTURE AND PROPERTIES
October 25th 2017, 08:30-09:10, Hall: Hasköy
Chair: **Ali Serpengüzel**

08:30-08:50
Silica Glass Fiber Optics Processing with a Pulse CO2 Laser
Nurperi Yavuz, Muhammad Rehan Chaudhry, Ali Serpengüzel
Koç University, Microphotonics Research Laboratory, Department Of Physics, Rumelifeneri Yolu, Sarıyer, Istanbul 34450 Turkey

Currently, we observe widespread usage of silicate glass as containers in food storage [1], in lighting [2], and in radioactive waste management [2]; as flat glass in buildings and transportation vessel window panes [4]; as curved glass and in optics as lenses, prisms and beam splitters [5,6]; as optical fibers in high speed data communication [7], medicine, imaging, sensing, computing, military science [8]; as substrates in photonic lightwave circuits [9], in biomedical sciences, and in microfluidics [10]. The use of glass in these various fields has been possible due to the development in the melting, drawing, cutting, welding, and fusing processes of silica [11]. Optical fiber invented in 1970's [12] is a long string of silica glass [13], with various advantages such as low optical loss, fast response, small feature size, tight confinement, flexibility, electromagnetic interference immunity, and considerably large evanescent field [14]. The cutting, manipulating, drilling, or grooving of glass with lasers without causing any microcracks or material loss, led to the extensive use of high pulse power CO2 lasers for splicing and fusing of optical fibers. We demonstrate silica fiber glass processing by using a pulsed TEA CO2 laser. The processed fiber glass can be used to fabricate various photonic components like microfiber Mach-Zehnder interferometers [15], microfiber ring resonators [16], and microfiber loop resonators [17].

References

[1] K. Marsh, B. Bugusu, J. Food Sci. Technol. 72, 3, R39–R55, 2007.
[2] X. Zhang, et al. ACS Appl. Mater. Interfaces, 7, 18, 10044–10054, 2015.
[3] S. Gin, et al. Mater. Today, 16, 6, 243–248, 2013.
[4] B. P. Jelle, Sol. Energy Mater. Sol. Cells, 116, 291–323, 2013.
[5] H.K. Choi, et al. Opt. Laser Technol. 75, 63–70, 2015.
[6] Z. Xia, et al. Opt. Mater. 53, 6–9, 2016.
[7] G. Keiser, Optical Fiber Communications. John Wiley & Sons, Inc. 2003.
[8] V. J. Urick, et al. Opt. Photon. News, 25, 10, 36–43, 2014.
[9] A. Kaneko, et al. IEEE J. Sel. Top. Quantum Electron. 5, 5, 1227–1236, 1999.
[10] K. Sugioka, et al. Lab on a Chip, 14, 18, 3447-3458, 2014.
[11] J. E. Shelby, 2005. Introduction to Glass Science and Technology. Cambridge: Royal Society of Chemistry.

[12] C. Roychoudhuri, 2008. Fundamentals of Photonics, Bellingham, WA: SPIE.
[13] J. Hecht, 2015. Understanding Fiber Optics. Auburndale, MA: Laser Light Press.
[14] B. Gouraud, et al. Phys. Rev. Lett. 114, 18, 2015.
[15] Y. Li, L. Tong, Opt. Lett. 33, 4,303–305, 2008.
[16] W. Li, P. Wang, Z. Hu, and L. Tong, IEEE Photon. Technol. Lett. 23, 12, 831-833. 2011.
[17] M. Sumetsky, et al. J. Lightwave Technol. 24, 1, 242 250, 2006.
Keywords: CO2 laser processing, optical waveguide, silica optical glass

08:50-09:10

Kramers-Kronig Relations of Chalcogenide Glasses in the Long-Wavelength Infrared Region

Woo Hyung Lee1, Jun Ho Lee1, Ju Hyeon Choi2, Woon Jin Chung3, Yong Gyu Choi1
1Korea Aerospace University, Goyang, Gyeonggi, Republic Of Korea
2Korea Photonics Technology Institute, Gwangju, Republic Of Korea
3Kongju National University, Cheonan, Chungnam, Republic Of Korea

Themal imaging cameras operating at the long-wavelength infrared region, i.e., 8 – 12 μm, are able to efficiently detect photons emitted from a homoeothermic body whose black body radiation peaks at ~10 μm. In addition to their existing military applications, demand has been sharply increasing in the field of civilian applications. In particular, a miniaturized infrared camera module that is compact enough to be integrated into mobile electronic devices, e.g., smartphone, is becoming a trend that seems almost impossible to refuse. Here, one would admit in this situation that the cost effectiveness of such a compact infrared camera plays a critical role, and in this regard chalcogenide glasses would become the material of choice when we consider their inherent compositional flexibility as to refractive index (dispersion as well) and their moldability.
In order to minimized optical aberrations associated with the corresponding lens assembly, we may need to adopt at least two or more than two lenses which differ in refractive index dispersion as well as external shape. This implies that we need to understand compositional dependence of refractive index disperion across the long-wave infrared region, which then enable engineering the relevant lenses for their proper use.
In an effort to unveil correaltions between the refractive index dispersion and the infrared absorption due to the fundamental vibrational transition of chalcogenide glasses, which is observed typically at the far-infrared wavelengths, we made use of Kramers-Kronig relations in this study. The spectral lineshpae functions of two representative chalcoenide glass families were experimentally obtained using their Raman spectra. In this talk, we want to deliver our results regarding how precisely this approach could approximate the measured refractive index values at the

long-wavelength region.
Keywords: Chalcogenide glasses, infrared camera, Kramers-Kronig relations, raman spectrum, infrared-transmitting lenses

COATINGS
October 25th 2017, 08:30-10:10, Hall: Kasimpaşa 1-2
Chair: **Seniz Türküz**

08:30-08:50
Investigation the Influence of Doping Elements on Etched Zinc Oxide Thin Films Deposited By Sputtering Technique
Alp Osman Kodolbaş1, Ümmü Mustafaoğlu2, Birsen Handem Ergün2, Nilüfer Evcimen Duygulu2, Okan Yilmaz1, Öcal Tuna3, Seniz Türküz3, Ahmet Karaaslan2
1Tübitak, Marmara Research Center, Gebze, Kocaeli, Turkey
2Yıldız Technical University, Department Of Metallurgical And Materials Engineering, Davutpaşa Campus, Esenler, Istanbul, Turkey
3Şişecam, Science and Technology Center, Kocaeli, Turkey

Control of surface morphology using magnetron sputtering conditions and post chemical process, characterization and thin film photovoltaic applications of texturized new generation Transparent Conductive Oxides (TCO) glass substrates are proposed. These substrates are crucial for the development and production of a-Si: H, a-Si: H, a-Si: H/µc-Si: H, CdTe, CIGS thin film photovoltaic.
High optical transmission, low electrical resistivity, high charged carrier mobility and high chemical stability are key parameters describing the industry standard TCO indium doped zinc oxide (SnO2:In – ITO). Lack of indium reserves, increase in ITO coated glass prices and difficulty of texturizing its surface using cheaper chemical process motivates the research and development studies on TCO's without indium. Today almost all the thin film solar cells are fabricated on ZnO: Al and fluorine doped thin oxide (SnO2:F) glass substrates.
The proposed studies hold an expansion on the new generation transparent oxide thin film range and improve the low-cost functional materials. Accordingly, the most of the studies were carried on understanding the influence of doping elements of zinc oxide on structural, electrical and optical properties. The new generation developed TCO materials are: aluminum doped zinc oxide (ZnO: Al), gallium doped zinc oxide (ZnO: Ga), magnesium doped zinc oxide (ZnO: Mg), aluminum doped magnesium zinc oxide (MgZnO: Al), indium doped zinc oxide (ZnO: In), indium doped gallium zinc oxide (GaZnO: In).These TCO thin films were deposited on float glass substrates by using sputtering method. Sputtering is an acceptable method for industrial applications with its enhanced properties such as; lower production cost, low working temperatures and easy producible. Morphological and structural properties of sputter deposited transparent

conductive oxide films can be tuned using deposition conditions; process pressure, gas mixture, gas flow rate, power, substrate to target distance etc. The optimum deposition parameters of each new generation TCO thin films was determined and surface morphology was prepared for photovoltaic applications by using chemical etching methods. In chemical etching, to achieve rough surfaces, different time and proportion of some chemicals (HF, HCl and NH4Cl) was applied on thin film surface. The achieved etched TCO thin films were applied for development of a-Si: H and micromorphous (a-Si: H/µc-Si: H) solar cells.
The TCO's deposited at R&D and PILOT scale had lowest resistivity (<10-3 Ω.cm) and maximum transparency (%80<). After TCO etching process, the expected reflectance spectrum is above %10-15 between 400–2000 nm wavelengths. Also the obtained efficiency of two photovoltaic applications reached over % 10.
Keywords: Transparent conductive oxides (TCO), texturized transparent conductive oxide, magnetron sputtering, chemical etching, thin film solar cell.

08:50-09:10
The Development of ZnO:Ga as TCO's For Thin Film Silicon Solar Cells
Okan Yilmaz1, Ümmü Mustafaoğlu2, Birsen Handem Ergün2, Nilüfer Evcimen Duygulu2, Öcal Tuna3, Alp Osman Kodolbaş1
1Tübitak, Marmara Research Center, Gebze, Kocaeli, Turkey
2Yıldız Technical University, Department Of Metallurgical And Materials Engineering, Davutpaşa Campus, Esenler, Istanbul, Turkey
3Şişecam, Science and Technology Center, Kocaeli, Turkey

High light scattering, low resistivity and low absorption performance transparent conducting oxides (TCOs) have significance for optimizing photovoltaic (PV) performance. Texturized, SnO2:F and ZnO:Al is widely used by the thin film photovoltaic industry. On the other hand, ZnO:Ga is a promising candidate for the replacement these TCO's due to performances. Pulsed-DC sputtering processes are particularly suited to use in industry due to the high volume, continuous growth processes and fast growth rates achievable. Using the pulsed-DC sputtering process, ZnO:Ga films has been deposited on glass using ZnO/Ga2O3 95/5 wt% target. The deposited and chemically texturized films were characterized for crystallinity, morphology), optical haze and electrical properties to aid optimization of material suitable for solar cells. Samples were then used in manufacture of single junction pm-Si:H solar cells, which showed comparable performances, in comparison to commercially available TCO coated glasses.
Keywords: ZnO:Ga, chemical etching, solar cells

09:10-09:30
Influence of Doping Elements on Zinc Oxide Thin Films Deposited By Sputtering

Nilüfer Evcimen Duygulu1, Ümmü Mustafaoğlu1, Birsen Handem Ergün1, Okan Yilmaz2, Alp Osman Kodolbaş2, Ahmet Karaaslan1
1Yildiz Technical University
2Tubıtak Materials Institute MAM

The usage of ZnO and its doping elements as a TCO material is increasing day by day with their enhanced properties as high optical transmission, good electrical conduction, cheap value and absence of toxicity. In order to understand the influence of doping elements on film characteristics various doping elements were investigated. They are; aluminum, gallium, magnesium and indium doped zinc oxides.
Many investigations revealed that deposition technique played a critical role on the films to achieve enhanced properties. ın the present study magnetron sputtering was selected and deposition parameters such as deposition rate, power, target-to-substrate distance (DTS), heating, pressure etc. were investigated in detail for each doped zinc oxides. The r.f. power was varied in the range of 145 to 175 W while DTS was changed from 35 to 65 mm and the gas flow (Argon) was changed from 5 to 50 sccm. 10Í10 cm sized glasses from ŞİŞECAM were used as a substrate material and 2% Al doped ZnO (Al: ZnO), 5% Ga doped ZnO(Ga: ZnO), 2 %Al-2%Mg doped ZnO (Al- Mg: ZnO) and 95 % indium doped zinc oxide (ZnO: In) were used as targets respectively. All the depositions were held without intentional heating and non-reactively. Achieved results were analyzed with the help of various characterization techniques such as; XRD, AFM, SEM, HRTEM, four point probe, optical transmittance measurement. The achieved results were used both to determine the optimum deposition parameters and to make a comparison between the effect of doping elements on thin films.
Keywords: Aluminum doped zinc oxide (ZnO: Al), gallium doped zinc oxide (ZnO: Ga), aluminum doped magnesium zinc oxide (MgZnO: Al), indium doped zinc oxide (ZnO: In),

09:30-09:50
Effect of Sputtering Power and Post Annealing Process on Properties of ZnO:Ga Thin Film
Birsen Handem Ergünhan1, Öcal Tuna2, Nilüfer Duygulu 1, Seniz Türküz2
1Yıldız Technical University, Department Of Metallurgical And Materials Engineering Davutpaşa Campus, Esenler, Istanbul, Turkey
2Şişecam, Science and Technology Center, Kocaeli, Turkey

Transparent conductive oxide films are materials used in many different technological works today. They can be used in planar solar cells, low emission window glasses, transparent heat reflectors, electrical curtain applications and touch screen technologies. Zinc oxide (ZnO) films, which are an alternative to thin films such as tin oxide (SnO2) and indium-tin oxide (ITO), which have been used commercially so frequently, have recently started to be used. Additive elements such as aluminum, gallium,

magnesium and indium can be added to ZnO films. By the influence of additive elements, the carrier concentration of ZnO films are increased and the electrical properties of thin film are improved. In the course of the growth of thin films, there are certain parameters that influence film properties. These parameters are the sputtering power, gas pressure, target-substrate distance and substrate temperature.
In order to improve the desired properties in accordance with the application area, some additional operations can be performed after the coating of the transparent conductive oxide films. Heat treatment and etching are the mainstays of these processes. In heat treatment, the thin film structure changes with temperature effect and electrical, optical and properties show improvement at appropriate temperature, time and ambient conditions.
In this study, the effect of sputtering power on the electrical, optical and structural properties of ZnO:Ga thin film was investigated. After evaluating the obtained results and determining the appropriate sputtering power, the effect of the post annealing process applied to the optical, electrical and structural properties of ZnO: Ga thin films grown in this sputtering power was investigated. Experiments to investigate the effect of applied post annealing on the electrical, optical and structural properties of ZnO: Ga thin filmin were carried out under vacuum at different temperatures and durations.
Many different techniques have been used to characterize the large area ZnO: Ga thin films. As a result of the post annealing experiments, the resistivity values of ZnO: Ga films reached 3x10-4 Ω.cm and the optical transmittance values were measured at 77%. Bandgap values increased from 3.77eV to 3.92eV. The lowest resistivity, highest transmittance, suitable surface roughness, high hall mobility and high carrier concentration values were obtained in ZnO: Ga thin film grown at 1.2kW sputtering power and annealed in vacuum at 250oC for 2 hours.
Keywords: Thin film, vacuum, post annealing, sputter, ZnO:Ga

09:50-10:10

Etched Zinc Oxide Thin Films Deposited By Sputtering Technique

Nilüfer Evcimen Duygulu1, Ümmü Mustafaoğlu1, Birsen Handem Ergün1, Alp Osman Kodolbaş2, Ahmet Karaaslan1
1Yıldız Technical University Department of Metallurgical And Materials Engineering
2Tübitak, Marmara Research Center

Transparent conductive oxide (TCO) films are photovoltaic materials with high electrical conductivity and optical properties. Among the TCO's, ZnO is highly preferred due to its high electrical and optical characteristics as well as wide band gap, easy availability and non-toxicity properties. Doping elements are added in order to enhance the properties of ZnO thin films over long spans and higher performances. Aluminum and gallium are the

most common doping elements used in photovoltaic applications. The films achieved after sputtering have poor light trapping ability due to their smooth surfaces. Therefore, ZnO:Al and ZnO:Ga thin films were textured to improve both the conversion efficiency and light scattering capability are necessary for thin film solar cells. In the present study, both ZnO:Al and ZnO:Ga thin films textured by a post-deposition wet-chemical etching in different solutions such as; HF, HCl and NH4Cl. In order to achieve high roughness values all the etching processes were carried out different time and concentration ranges. Achieved results were analyzed with the help of x-ray diffraction (XRD), atomic force microscopy (AFM), scanning electron microscopy (SEM), four point probe and optical transmittance measurement techniques. As a result of the roughening of the ZnO: Ga films with 0.1% HCl and HNO3 with ratio of 4:1 was selected as the best etching conditions. The RMS values of the films were increased from 5.75 nm to 32. 16 nm and haze from 0.65% to 1.04% and reflectance decreased from 11.37 % to 9.96%.

Keywords: Aluminum doped zinc oxide (ZnO: Al), gallium doped zinc oxide (ZnO: Ga), wet chemical etching

RAW MATERIALS

October 25th 2017, 08:30-10:10, Hall: Kasimpaşa 4-5

Chair: **Ertuğrul Yay**

08:30-08:50

Quality Assesment of Glass Cullet and Glassy Sand

Stefano Ceola, Nicola Favaro
Stazione Sperimentale Del Vertro, Italy

Nowadays cullet has become one of the main raw materials for the European glass industry: in 2015 Europe hit 73% of glass cullet recycled, with furnaces producing colored glass containers achieving more than 90 % recycling rate.

Because of the increased usage of cullet in their furnaces, glass producers have experienced an increase of defects in the final glass containers. As a matter of fact, furnace-ready cullet used in container glass production comes from treatment of municipal waste, either coming from mono-material or multi-material collection, so it can possibly be contaminated by ceramic, stones, glass-ceramic, etc. These issues are managed at present mainly by the application of improved sorting technologies in cullet treatment plants, and with a proper, updated set of Technical Specifications.

The amount of material rejected by treatment plants increases with the target quality level to be achieved by the furnace-ready cullet, especially in Italy, where the multi material collection system gives a raw cullet with large quantity of pollutants. The rejects coming from the cullet waste treatment process, like CSP and fines, are treated to produce a new type of fine cullet

called glassy sand.
Stazione Sperimentale del Vetro, during these last years, has developed an internal protocol for the assessment of the quality of cullet and glassy sand, and its suitability towards the use in the furnace; such protocol can be applied for characterization as well as for regular monitoring. The choice of the right parameter(s) to be monitored increase the effectiveness of the possible corrective actions in problematic scenarios.
Keywords: Cullet, chemical analysis, glassy sand

08:50-09:10
Benefits for Fiber Glass Producers to Use Calcium Oxide in Their Raw Material
Bernard Somerhausen1, Elise Di Marino1, Tuna Hunturk2, Stefano Ceola3
1Carmeuse Research & Technology
2Carmeuse Kimtas
3Stazione Sperimentale Del Vetro

After the Paris agreement on CO2 emission (COP 21) there is great concern among the glass producers who need to undertake suitable action to fulfill the required emission level in the years to come.
The use of calcium oxide as an alternative to calcium carbonate in fiber glass production provides important benefits for glass producers, such as carbon dioxide emission reduction, energy consumption decrease, melting kinetics increase and redox stability improvement.
This study performed by Carmeuse's partner Stazione Sperimentale del Vetro demonstrates the benefits of calcium oxide substitution on the melting kinetics of glass which could lead to a better efficiency in the glass process.
The study also shows the impact of calcium carbonate and calcium oxide purity on E-glass viscosity and surface tension at high temperature. These parameters are the most relevant for the fiberization process, enabling a smooth fiber glass production.
Finally the study evaluates the reduction of greenhouse gas emission as a direct result of the raw material substitution and indirectly as a result of the decrease in the energy required in the melting process.
Keywords: Glass, fiberglass, quicklime, lime, calcium oxide, CO2, melting

09:10-09:30
Thermal Diffusivity of Soda-Lime Silicate Powder Batch and Briquettes
Yoji Doi1, Terutaka Maehara2, Tetsuji Yano3
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3Department Of Material Science And Engineering, Tokyo Institute Of Technology, 2-12-1-s7-4 Ookayama, Meguro-ku, Tokyo, Japan

The efficiency of heat transfer through glass batch is an important factor affecting the quality and energy efficiency of glass manufacturing. In this study, thermal diffusivity and heat flux through a batch blanket of float glass starting from powder raw materials or briquettes made of powder raw materials were investigated using a large-scale top-heated laboratory furnace. In particular, we focused on the influence of briquette size on thermal diffusivity to discuss the observed heat transfer differences.
The results obtained for powder batch and briquette batches with different size (flake, small and large shape) indicated that briquette size has a large impact on thermal diffusivity and heat flux. The thermal diffusivity of a batch blanket using flake shape briquettes (2 – 5.6 mm) equaled that of powder raw materials although the briquette has the density of 2.0 g/cc, twice of that of powder batch, 1.0 g/cc, meaning that flake shape does not influence on the conduction of heat transfer. On the contrary, the thermal diffusivity of batch blanket using large briquettes (38 × 38 × 21 mm) was five times larger than that of powder batch. This result clearly shows that the contributions of convection of gas and radiative heat transfer via large continuing space between briquettes increase the heat flux through the batch blanket. In addition, the above heat flux was maximal at a time when large briquettes were not heated uniformly inside, proving that this phenomenon enables efficient top-to-bottom heat transfer through the batch blanket.
Keywords: Thermal diffusivity, raw material, Briquettes

09:30-09:50

Production of Hollow Glass Microspheres with Na2SO4 Blowing Agent by Flame Synthesis from Waste Glasses

Jozef Kraxner, Jozef Chovanec, Dušan Galusek
Vitrum Laugaricio, Joint Glass Centre Of The Iıc Sas, Tnu Ad And Fchft Stu

Hollow glass microspheres (HGMs) are a unique class of materials with number of various applications. HGMs are desirable in many industries for use as fillers for various organic and inorganic matrices, or can find applications in the medical field, for fabrication of lightweight composite materials, buoyancy materials, thermal insulation materials and for gas storage. The use of HGMs has expanded in last years for their excellent properties. The combination of heat resistance, lightweight and favorable mechanical properties offered by these new materials opens up application in aviation transport and the automotive industry. This paper illustrates the possibility of using recycled glass to obtain hollow glass microspheres with Na2SO4 blowing agent. HGMs were prepared from barium silicate glasses (tableware glasses) and soda lime glasses (automotive glasses) by flame spheroidization process in oxygen-methane (O2/CH4) flame. We

investigated the influence of glass precursors (glass powders with blowing agent) preparation, Na2SO4 concentration, melting temperature, holding time, diffusing or dissolving SO3 element into the glass of the glass powders, particle size distribution of glass precursors, feed rate of precursors into the flame, on formation of hollow glass microspheres. The amorphous nature of HGMs was confirmed by X-ray diffraction (XRD). The morphology of the hollow glass microspheres was examined by scanning electron microscopy (SEM) and the composition of the waste glass powders and the produced HGMs were determined using SEM-EDS.
Keywords: Waste glass, recycling, hollow glass microspheres, blowing agent, flame spheroidization

09:50-10:10
Value-Added Materials Production from By-Products of Glass-Sand Plants
Mustafa Özer, Hüseyin Baştürkcü, Fırat Burat
Istanbul Technical University

Silica (SiO2), which is an essential raw material for glass production, is known as the most abundant mineral on earth. It is present as massive quartz, quartzite, sand stone and quartz sand in earth crust. The determinative criteria of their use and market in the glass industry are particle size and chemical composition. Since the presence of clay, iron and titan minerals prevents the usage of silica in glass production, removal of these impurities becomes necessary. In a glass sand plant, two more materials are obtained in addition to the concentrate with low iron content. While one of them is the tailing, the other one is the byproduct (-0.1 mm) which is removed after size classification. This byproduct, which is rich in clay, generally represents the 20-25% of the plant feed. Although it is possible to use this byproduct in building trade, gas concentrate, and ceramics industries, it does not have a high economic value. Also, the location of the plant could give rise to the costs in terms of transportation leading to reduce the attraction in marketing conditions. Therefore, it becomes an obligation to stock this byproduct which causes difficulties in storage and increases the plant operation costs. In order to provide a sustainable production, evaluation of this byproduct has increased in importance. This study aims to achieve high value-added materials from the byproduct utilizing physical, physico-chemical, and chemical methods. By applying these mineral processing techniques, a concentrate containing 99.16% SiO2, 0.50% Al2O3, and 0.04% Fe2O3 was achieved. The quality of this concentrate was in the technically required limits of paint industry. On the other hand, 17.38% Al2O3 containing material was obtained which is suitable raw material for ceramic industry.
Keywords: Glass sand, iron removal, flotation, magnetic separation, oxalic acid

MELTING TECHNOLOGIES

October 25th 2017, 08:30 – 09:50, Hall: Balat
Chair: **Adnan Karadağ**

08:30-08:50
Process Optimization for Enhancement of Tableware Thermal Shock Resistance
Cevher Tol1, Dadal Arıburnu1, Türkay Yıldız1, Selahattin Çınar2, Selim Taşcı2, Hakan Erdil2, Bahtiyar Dalgıç2, Çağlar Şahin3, Zeki Alimoğlu3
1Şişecam, Science and Technology Center, Kocaeli, Turkey
2Paşabahçe, Eskişehir Plant, Eskişehir, Turkey
3Paşabahçe, Development Management, Istanbul, Turkey

Thermal shock resistance is the ability to withstand a rapid and significant temperature change and level of change in temperature. Thermal shock in glass may lead a damage as a result of a reaction to a rapid and extreme temperature fluctuation and of thermal gradient that occurs as an output of an uneven change in coefficient of thermal expansion. Glass is very vulnerable to thermal shock resistance which is a process dependent and a complicated function of heat transfer, geometry and material properties. As a matter of fact, glass thermal shock resistance is directly related to the well known production steps such as conditioning, forming and annealing and also influenced by the glass gob quality. An optimization work was carried out to enhance the thermal shock resistance by improving the gob quality which is a strong indication of the glass homogeneity and to obtain a higher quality level in conditioning, forming and annealing processes.
Keywords: Thermal shock, optimization, gob quality, conditioning, forming, annealing

08:50-09:10
Effective Implementation of Electric Boosting In Glass Furnace
Mahdie Kamali Moaveni
Simullex Gmbh

As a means of furnace output capacity increasement as well as an improvement of the glass quality, the electric boosting makes an important part of energy sources in a great number of fossil fired glass melting furnaces.
Moreover, it is an essential tool for a fast control of bottom temperature and to save energy in case of a pull variation.
In order to achieve higher efficiency regarding the glass melt flow control and glass quality improvement, the right boosting system design and positioning of the electrodes in the furnace are required as significant issues.
Parameters that should be taken into account for the choice of the optimum electrode arrangement and for the configuration of the electric boosting are amongst others the lenght, width and depth of the furnace, deep refiner

or flat bottom, colour and composition of the glass, the type of the product, the firing concept, etc.
This contribution will point the results of a case study about the effects of the boosting system, the side wall, the bottom and barrier boosting as well as the combination of them on the glass melt out.
Furthermore, it will depict the impact on the current flow, the batch shape, the hot spot, the bottom and riser temperature, the residence time, the path of the fast particles and finally on the glass quality.
In usage of the CFD Simulation method, two end fired furnaces of green container glass with different dimensions are investigated.
For each case, the electric boosting has been considered with the same electrical power and energy consumption, but in different arrangements.
The evalutation of the results illustrates the individual sollutions of an effective boost system design for different furnace categories in terms of furnace geometry.
Keywords: CFD simulation, modeling, electric boosting, furnace, melting, end-fired regenerative, electrode, transformator, configuration, convection flow current

09:10-09:30
Bubble Nucleation in Soda-Lime-Silicate Glass Containing Sulphur Compounds
Miroslava Vernerová, Lubomír Němec, Jaroslav Kloužek, Miroslava Hujová
Laboratory Of Inorganic Materials, Joint Workplace Of The University Of Chemistry And Technology Prague, Technická 5, 16628 Prague And The Institute Of Rock Structure And Mechanics Of The Ascr, V.v.i., V Holešovičkách 41, 18209 Prague, Czech Republic

Heterogeneous bubble nucleation during production of commercial glasses is one of the negative factors affecting their technical properties. In order to eliminate these bubbles we made the extensive research of bubble nucleation in soda-lime-silica glass melts at increasing temperatures. Gas chromatography and Mass spectrometry methods were used to evaluate crucial chemical reactions during the melting. The fining action of sulphates in reducing conditions started at temperatures between 1200 and 1300°C. Also, extensive nucleation of bubbles took place at relatively low temperatures. Temperature of nucleation was determined by using linear extrapolation of bubble size to the zero value. The nucleation of bubbles in variously reduced glasses has been observed at temperatures lower than 1300°C and further decreased with increasing C/SO42-. Next, we tried to clarify whether the process of bubble nucleation was affected by supersaturation of physically dissolved gases in the melt or by gases releasing during a chemical reaction. We suppose that the nucleation of bubbles SO2 at around 1300°C can be attributed to the reaction between the sulphate remaining in melts and sulphides which have been formed by reduction reactions.

Keywords: Bubble nucleation, glass melting, sodium sulphate, glass fining

09:30-09:50
Forehearth Coloring at a Glance
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5Anadolu Cam, Mersin, Turkey

The most eye-catching colors in glassware and glass packaging products which are offered to the market allure the humankind for centuries. Therefore, colored glasses have always been found in the product range of manufacturers by applying various processes.
By the help of the technologies developed in the last decade.coloring in the forehearth has become a more preferred process against the coloring of base glass in the main tank furnace.
Contrary to coloring in the main tank; coloring from forehearth has advantages such as the possibility of producing different colors in the same furnace at the same time and the flexibility to respond to customer requests in shorter periods. Furthermore, the possibility of low volume production in tableware and container production result with increasing production rates of this method.
This method is not only applied for changing colors, but also changing glass properties and gives it different effects.
Coloring forehearths contrary to conventional forehearths with flint glass production have different design and structure. Namely; there are two regions in the forehearths that do not have a coloring zone, called cooling and conditioning. In coloring ones in addition, there are three other zones in the foreground : preheating, melting and mixing.
Most of the coloring materials are sometimes used alone, sometimes with a combination of several, to obtain different colors.
This paper will give an idea about forehearth coloring, its advantages and challenges for glass manufacturers.
Keywords: Forehearth, color, tableware, container

FUNCTIONAL GLASSES
October 25th 2017, 08:30 – 09:30, Cibali-1
Chair: **Vedat Sediroğlu**

08:30-08:50
Production of Antibacterial Glass Doped with Silver, Strontium and Copper Ions by Using Conventional Melting Method
Bariş Demirel1, Melek Erol Taygun2

1Şişecam, Science and Technology Center, Kocaeli, Turkey
2Istanbul Technical University, Chemical Engineering Department, Istanbul, Turkey

Glass products are being used in our daily lives such as at windows, cars, home goods, food and drug packaging with features like recyclable, easy to clean, durability, shape and color for a long time. Glass companies add extra features/specifications to their products to increase their profits and so they can create an opportunity in the market by providing added value to their products.
On the other hand, the world population has been increasing day by day and at the same time environmental pollution became a threat for humankind. The environment is the ambient where people contact with microorganisms that is the one of the significant causing disease factors. Scientists have been developing new methods to overcome this threat. Some metal ions have functions to struggle bacteria and deactivate it their enzymes. Therefore, metal ions are encouraged to be used in glass products.
This study is aimed to investigate, produce and characterize glass materials with enhanced antibacterial property without using sol-gel coating. These glass materials will be produced by using classical melting method. For this purpose, different glass batches giving compositions that contain some specific metal ions such as silver, strontium, copper, etc. will first be prepared and then, melted to determine the suitable temperature in high temperature furnace. After the melting process, the physical, mechanical and antibacterial properties of the obtained glasses will be characterized by using different techniques.
Keywords: Glass, antibacterial, silver, strontium, copper, melting

08:50-09:10
Magnetization in Oxide Semiconductors: Dependency to Native Defects and Impurity Atoms
Musa Mutlu Can1, Shalima Shawuti2, Satoru Kaneko3, Cleva Ow-Yang2, Sanapa Lakshmi Reddy4, Mehmet Ali Gülgün2, Tamio Endo5
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Oxide semiconductors have became indispensable materials in technology due to transparency (> 90%) in range from UV to IR, and low formation enthalpies of point defects. These two phenomena attracted the recent technologies such as photo catalytic materials, sensing detectors and transparent electrodes.
In this study we mainly focused on magnetic and electrical formation

originating from intrinsic point defects and dopant atoms in oxide semiconductor lattice. The analyses proved that 1 % dopand atoms (W, Co or Eu) can influence magnetic and electrical properties, impressively [1-4]. The study include native point defects (Zni2+, VZn, Oi2-, VO2- , Oi and OZn) dependent polarized spin currents in ZnO thin films, Cobalt dopant amount relation to the magnetic formation and electrical properties influenced by rare earth elements.
The thin films were characterized employing XRD (X-ray diffraction), EDS (energy dispersive x-ray spectrometery) and XPS (X-ray photoelectron spectrometery). We characterized the defects formed in the lattice using photoluminescence (PL) analyses and showed the response of defects to the carrier density, carrier type, sheet resistivity, mobility and magneto transport in temperature range from 2 K to 300 K.

[1] M. M. Can, S. I. Shah, M. F. Doty, C. R. Haughn, T. Fırat, (2012), J Phys D: Appl Phys 45 (19), 195104.
[2] M. M. Can, S. I. Shah, T. Fırat, J Magn Magn Mater, 377, (2015) 229–238.
[3] M. M. Can, S. Shawuti, T. Fırat, S. I. Shah, J Alloy Comp, 660 (2016) 423-432.
[4] N. Akçay, G. Algün, N. Ü. Kılıç, S. Shawuti, M. M. Can, J Mater Sci: Mater in Elect, 28 (2017), 4492.
Keywords: Semiconductor, point defect, oxide semiconductors

09:10-09:30
Effects of Catalyst on Synthesis of Glass Nanopowders by Sol-Gel Process
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Sol-gel process is a method that allows to synthesize inorganic structures by chemical reactions in solutions at low temperatures. The most evident feature of this reaction is its facility of transition from liquid state to solid state. In sol-gel process, any precursors that form reactive monomer or oligomer can be utilized. First step of reaction is hydrolysis of silicon alkoxide with existence of a catalyst and the second step is condensation. In this study the effects of catalyst on size and shape of sol-gel synthesized glass nanoparticles were investigated. For this purpose, tetraethyl orthosilicate, boric acid and potassium hydroxide were used as sol- gel precursors and dissolved in ethanol. Glacial acedic acid was used for enhancing the solubilities of starting materials. Sol-gel reaction temperature and starting pH of solution were kept constant to avoid the disorder of the influence on final size. Amonium hydroxide and urea were used as catalyst with five different amount of each. Alterations were evaluated as functions of catalyst type and amount. The results were examined by scanning electron microscopy investigations, X- ray diffraction technique and particle

size distribution analysis.
Keywords: Sol-gel, glass, glass nanoparticles

CLOSING CEREMONY
October 25th, 10:30-12:30, Hall: Sadabad
Invited Speaker
Alev Yaraman

Invited Speaker
A Special Moment in Time: Arrival of the Glass Age
David Pye2, Manoj K Choudhary1
1Owens Corning Science & Technology, Granville, Ohio, USA
2NY State College of Ceramics at Alfred University, NY, Alfred, NY, USA

The presentation will emphasize that we are at a special moment in time for the global community of glass scientists, technologists, educators, manufacturers, and artists to declare with certainty and pride the arrival of the Glass Age.
Glass has played a major role in advancing civilization and mankind throughout the recorded history and is one of the most transformative materials of all times. In this talk, we will begin with a review of the impact glass has made in diverse fields including arts/aesthetics, architecture, astronomy, communications, energy generation and conservation, medicine, transportation, and, especially important in other branches of science. Following this review, we will focus on the present day impact of glass including its role in ushering the communications revolution. Next, we will describe what to expect in the future for the role of glass and show that the unique properties of glass make it an indispensable material to handle the major challenges and opportunities in areas such as healthcare, cleaner air and water, safety and security, and more efficient communications. We will conclude the talk by positing we have an unprecedented opportunity to herald the Glass Age and outlining steps that the international glass community should take to make it a reality.
Keywords: Glass age, impact of glass, glass and civilization , future of glass

Poster Presentations

Crystallization and Glass Ceramics
PP-01
Oxyfluoride Glass-Ceramic Optical Fibers Doped with Nd3+
G. Gorni1, R. Balda2, J. Fernandez2, I. Iparraguirre2, J.J. Velázquez1, Y. Castro1, L Pascual3, G. Chen4, M. Sundararajan4, M.J. Pascual1, A. Durán1
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Glass fibers play a crucial role in the modern era, for example as optical fibers in the telecom applications [1]. The growing interest in glass-ceramics (GCs), i.e glasses than undergo a controlled crystallization, showed in the last decades the potential of this new class of optical materials, whose properties, especially the optical ones, improve significantly thanks to the controlled crystallization of certain crystal phases.
Oxyfluoride glass-ceramics (OxGCs) [2], that combine oxide matrices with low phonon energy fluoride crystals, showed the possibility to increase the optical efficiency of the Rare Earth ions (REi) making them really attractive for photonics applications [3]. Most results of OxGCs doped with REi are about their optical properties as bulk materials while glass-ceramic optical fibers are almost absent in literature [4], [5].
This work describes the preparation and both the structural and optical properties of glass-ceramic optical fibers doped with Nd3+. Glass fibers were firstly drawn employing the single crucible method, and then heat treated to convert them into GC fibers. Finally, a SiO2 cladding was deposited by the sol-gel method.
A detailed structural characterization performed by XRD, HRTEM and SAXS showed that phase separation in the as made glass fibers is precursor for crystallization and the crystallization mechanism is a diffusion-controlled process that limits the precipitation of LaF3 nano-crystals (NCs) to a size of 9-15 nm.
The luminescence measurements clearly showed the incorporation of Nd3+ ions in the NCs in the GC optical fibers. Site-selective emission and excitation laser spectroscopy allows isolating the emission of Nd3+ ions in LaF3 NCs allowing reproducing the same luminescence properties of pure Nd3+ doped LaF3 crystals.
The GC optical fibers and the corresponding GC bulk materials present comparable structure and optical properties so, it can be concluded that the properties can be reproduced independently on the drawing process.

References
[1] G.P. Agrawal, Fiber-Optic Communication Systems, Fourth Edition, Wiley, 2010.
[2] Y. Wang and J. Ohwaki, Appl. Phys. Lett., 63 (1993) 3268–3270.
[3] G. Gorni et al., J. Eur. Ceram. Soc., 37 (2017) 1695–1706.
[4] E. Augustyn et al., Opt. Mater. 34 (2012) 944–950.
[5] M. Reben et al., Opt. Applicata, 42 (2012) 353-364.
Keywords: Glass-ceramics, optical fibers, fluorides

Crystallization and Glass Ceramics
PP-02
Ionic Transport in Mixed Network Former Li2O-P2O5-GeO2 Glass-Ceramics
Luka Pavić1, Kristina Sklepić1, Željko Skoko2, Gregory Tricot3, Petr Mošner4, Ladislav Koudelka4, Andrea Moguš-Milanković1
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In the recent years, novel glass-ceramic materials are being investigated for their potential application as solid electrolytes in batteries. The goal in such studies is to enhance the ionic conductivity of Li-ion batteries along with the improvement of stability and safety. Recently, glass systems with mixed glass network formers are being considered as promising materials for these requirements. In this work, mixed glass former system with the composition 40Li2O-(60-x)P2O5-xGeO2, x = 0-25 mol% was chosen for the investigation of the effect of crystallization on electrical properties. It was previously found that in glass system with same composition the dc conductivity increases for three orders of magnitude. The observed effect is a result of gradual incorporation of GeO2 into phosphate network which leads to facilitated Li+ ions mobility. Therefore, our interest was to investigate how various steps of crystallization influence the electrical transport in these glasses. Depending on the composition and according to DTA curves, the temperature and time of heat-treatments were determined for each starting glass. With increasing GeO2 content single and multi-crystalline phase glass-ceramics were obtained and were structurally characterized by XRD, MAS NMR and SEM. Impact of structural changes on the electrical transport was explored in details with impedance spectroscopy. For GeO2-free glass-ceramic a slight increase in the electrical conductivity was evidenced in comparison to the non-treated glass. Further, conductivity decreases for heat-treated glasses containing up to 20 mol% of GeO2 which is related to the reduction of Li+ concentration in residual glass matrix since the Li-based crystalline phases were formed. On the other hand, for the glass-ceramic with the highest germanium content an

increase in the conductivity is observed. This effect is probably due to the formation of well-defined crystallites which pronounces easy conduction pathways for Li+ ion transport within crystalline grains and along grain boundaries.

Keywords: Glass-ceramics, electrical transport, structure, mixed glass former effect

Glass Formation, Transition, Relaxation and Modelling
PP-03
Glass Formation in V5+ Containing Tellurite Systems

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The glass formation was investigated in TeO2-PbCl2-V2O5 and TeO2-BaCl2-V2O5 systems. The relatively large glass forming area in both systems is adjacent to the TeO2-corner of the ternary diagram. The addition of small amount of vanadium gives a strong reddish colour to the TeO2-Pb/BaCl2 glasses, V5+ concentrations exceeding a few percent causes so strong tint that the glasses look black and are very low transparent even in infrared region. The glass transition temperatures (Tg) fall in the interval of 240 to 280 °C for TeO2-PbCl2-V2O5 and 260 to 340 °C for TeO2-BaCl2-V2O5 systems. The thermal stability of glasses is sufficiently high to obtain bulk samples at least 5 mm thick. The optical transparency of prepared samples strongly depends especially on V5+ concentration. The transparency region of glasses containing higher concentrations of V5+ falls into the interval of 1.7 – 5.0 μm approximately, while the short-wavelength absorption edge of binary glasses without V5+ is below 400 nm. The transparency reaches up to 70% and is negatively affected by the presence of OH- impurities manifested by strong absorption band located around 2.9 μm. The density measured by hydrostatic method is around 4-5 g/cm3 in both systems. In addition to good thermal stability, the prepared glasses exhibit also a good resistance against moisture and/or water corrosion.

Keywords: Tellurite glasses, glass formation, vanadium, infrared transparency

Glass Formation, Transition, Relaxation and Modelling
PP-04
Partly Quenched Ionic Liquids as a Simple Model to Ionic Glasses.

Hasan Tatlipinar
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Glasses are very important class of disordered material that exist in nature. They are important for scientific researches and industrial applications. Although there are many experimental researches the theoretical studies are growing recently due to advancing in computation techniques. Theoretical studies for disordered structures are mostly based on microcrystalline disordered model and topological disordered models. By taking into account that glass structures are obtained from liquids by rapid cooling process, modified liquid state theory may be useful to model glass structure. With this motivation, partly quenched ionic liquid theory is introduces. This model consist of multi component ionic species. Some components may be taken as a frozen cage or matrix, while the other may be chosen as a mobile particle depending of their physical properties such as big or small ionic size and variety of electrical charges. As an example for the two and three component partly quenched ionic liquid systems distribution functions and correlation functions are evaluated.

References

1 The Structure of Non-Crystalline Materials, Liquids and Amorphous Materials. Yosiho WASEDA, McGraw-Hill,1980.
2- Liquid State Theory for Some Non-Equilibrium Processes. James A GIVEN and George STELL, Condensed Matter Theories. Vol:8, pp:395-410, 1993.
3- Structure of ionic fluids in equilibrium with a microporous ionic matrix. TATLIPINAR, H; PASTORE, G; TOSI, MP. PHILOSOPHICAL MAGAZINE LETTERS Volume: 68 Issue: 6 Pages: 357-361 Published: DEC 1993.
Keywords: Ionic glasses, modeling, partly quenched disorder.

Glass Formation, Transition, Relaxation and Modelling
PP-05
Calculation of the Structural Entity Distribution on Alkali-Silica Glasses

Ovidiu DUMITRESCU, Dorel RADU
University "politehnica" Of Bucharest, Faculty Of Applied Chemistry And Materials Science, Department Of Oxide Materials Science & Engineering And Nanomaterials

The structure of vitreous oxide systems can be evaluated at different structural levels, depending on the degree of complexity considered. By introducing alkali oxides M2O (M = Li, Na, K, Rb, Cs) in the SiO2 glass, some of the Si – O – Si bridges are broken, thus appearing a series of structural units having different geometries and structural compositions. These consist of structural entities of type Q¬n, having the formula Si(Ob)n(Onb)4-n, in which Ob represents a bridged oxygen atom and Onb a non-bridged oxygen. The size of the Qn structural units is below 1 nm. The paper presents a thermodynamic model to calculate the distribution of these structural entities Qn for glasses with various chemical compositions. The obtained results were compared to experimental data obtained using

the 29Si MAS-NMR method.
Keywords: Alkali-silica glasses, structural entities Q¬n, distribution calculation

Glass Properties
PP-06
Optical, Electrical and Dielectric Properties of V2O5 Containing Tellurite Glasses
Petr Kostka1, Marián Kubliha2, Ondrej Bošák2, Mohamed Aachri3, Benjamin Ammar3, Nikola Bašinová1, Roman Jackiv4, Svetlana Lukić-Petrović5
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5Department Of Physics, Faculty Of Sciences, University Of Novi Sad, Trg Dositeja Obradovića 4, 21000 Novi Sad, Serbia

Optical, electrical and dielectric properties of tellurite glasses in TeO2-PbCl2-V2O5 and TeO2-BaCl2-V2O5 systems were investigated using temperature dependent absorption spectroscopy, low-temperature photoluminescence spectroscopy, ac/dc electrical conductivity measurements, and modular spectroscopy. Base glasses and those doped with RE3+ ions (Er, Tm, Pr, Nd) were prepared by conventional melt-quenching method. Optical absorption spectroscopy was used to determine the basic optical properties such as transparency region. It allowed also the identification of intrinsic and extrinsic absorption bands and estimation of the optical band gap. The latter value is compared to the activation energy of processes responsible for electrical conductivity obtained from Arrhenius plots of its temperature dependence. It is compared also with the position of the broad photoluminescence band of the host glass observed at low temperatures. In case of RE3+ doped samples, the relatively narrow RE3+ related emission bands are superposed on this broad band.
Keywords: Tellurite glasses, absorption spectroscopy, low-temperature photoluminescence spectroscopy, electrical conductivity, band gap

Glass Properties
PP-07
Soft Glasses Doped with Rare-Earth Ions and the Indirect Excitation Mediated By the Host
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3Institute Of Photonics And Electronics, Cas, Chaberská 57, 182 51 Prague 8, Czech Republic

In this work we compare two glassy networks – SiO2 glass and, as a soft glass, TeO2-ZnO-TiO2 glass, both doped with Tm3+ ions. The influence of the nature of the host and the position of its short-wavelength absorption edge on excitation processes responsible for Tm3+ and host-glass related emissions was investigated under two conditions. In the first case, the excitation wavelength overlaps with one of Tm3+ absorption bands and in such case the Tm3+ ions are excited directly by absorption. In the second case, the selected excitation wavelength overlaps with the absorption edge of the host glass – first the host glass is excited and then the energy is transfered from the host glass to doped-in Tm3+ ions (indirect excitation via network of the host). The broad luminescence band emitted by the excited host glass and located at approximately mid-band-gap energy of the host can be observed. The relatively narrow Tm3+ related emission bands are superposed on host-glass luminescence and they are accompanied by Stokes-shifted absorption dips appearing at higher energies in their close proximity. These dips present a direct evidence of the energy transfer from the host glass to doped-in Tm3+ ions.
Keywords: Tellurite glasses, rare-earth ions, excitation, photoluminescence

Glass Properties
PP-08
Properties of Ion-Exchanged Glasses
Hande Gover, Russell J. Hand, Adrian Leyland
The University of Sheffield

This project involves investigation of the effects of ionic species, process time and temperature on the enhancement of mechanical properties of ion-exchanged strengthened soda lime silica glasses. Ion exchange is mainly a diffusional process, which takes place in a molten salt by exchanging larger alkali ions for smaller ones to generate surface compression below the glass transition temperature. In the current work, a single-side ion exchange process has been used. In addition to ion exchange involving

potassium, equivalent potassium containing glasses have been prepared to deconvolute the effect of potassium on mechanical properties. Observations will be made whether the features are a direct consequence of ion exchange or due to the potassium in the glass composition. SEM-EDX has provided concentration versus. depth profiles of exchanged ions. FTIR and Raman spectroscopies have been used to investigate the structural differences between ion-exchanged glasses and the glasses that contain potassium. Physical and mechanical property evaluation has also been conducted. Results and their relationship to the treatment conditions will be compared and discussed. Nanoindentation has also used to compare hardness and elastic modulus of treated and untreated glass samples.
Keywords: Soda lime silicate, ion exchange, nanoindentation

Glass Properties
PP-09
Measurement of Transition Metals in Soda-Lime-Silicate Glasses by Using Electron Spin Resonance (ESR) Spectroscopy
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Electron spin resonance (ESR) spectroscopy does not appear to have found a wide use when compared with other structural analysis methods, especially spectroscopy techniques, utilized in the glass industry. The method, however, provides a good means for supporting the structural information obtained from other spectroscopic methods. Because of its ability to detect and differentiate the paramagnetic ions at low concentrations, ESR spectroscopy is commonly used as a quantitative and qualitative analysis method for evaluating transition metals.
This study showed the possibilities of demonstrating the behavior and interaction of paramagnetic 3d transition metal ions using ESR spectroscopy for the soda-lime-silicate based glasses. The first part of this study showed the existence of paramagnetic (Fe^{3+}, Cr^{3+}, Mn^{2+} and Cu^{2+}) transition metal ions in soda-lime-silicate glass and their spectral trends studied at addition levels up to 2.0 mol%. Additionally, ESR spectra of Fe^{3+}-Cr^{3+}, Fe^{3+}-Mn^{2+} and Fe^{3+}-Cu^{2+} added soda-lime-silicate glass samples were studied to show the inclusion of the different transition metals on Fe^{3+} containing glass. The second part of the study showed that the approach to quantify the ESR spectra with the concentration of metal ions addition into the soda-lime-silicate glass composition in order to lighten the locations of Fe^{3+} ions.
Keywords: Electron spin resonance (ESR) spectroscopy, soda-lime-silicate glass

Glass Properties
PP-10
Ion-Exchangeable and Photoetchable Photo-Thermo-Refractive Glass for Photonic Applications
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Nowadays, commercially available photoetchable materials are Foturan (Schott, Germany) and PEG3 (Hoya, Japan) that are used for fabrication of microreactors, various sensors, “lab-on-a-chip” devices. However, these materials possess low optical characteristics, which limits their applications in optics, photonics, and plasmonics. For example, the diffraction efficiency of volume holograms recorded in Foturan and PEG3 does not exceed 10%. On the other hand, photo-thermo-refractive (PTR) glass are well-known material for developing holographic elements with diffraction efficiency up to 99%. PTR glass is a multicomponent one that changes its refractive index after an exposure to the near UV radiation and the subsequent heat treatment. The latter step leads to the formation of silver nanoparticles and nanocrystalline NaF-AgBr phases in the glass host causing the refractive index variations.
In this work, we present the results of studies on ion-exchangeable and photoetchable properties of PTR glass. PTR glass based on the Na_2O–ZnO–Al_2O_3–SiO_2–F–Br system doped with CeO_2, Sb_2O_3, SnO_2, and Ag_2O was synthesized for further investigation. Irradiation of the samples were carried out by either high-pressure mercury lamp or pulsed fs Ti:Sapphire laser (790 nm), pulse energy range was 10-100 μJ. Changing the exposure and heat treatment parameters promoted variations in the size and concentration of nanocrystalline phase.
The rate of chemical etching glass ceramics in the 3N HF solution greatly exceeds that for glass. It can be explained by a good solubility NaF crystals in hydrofluoric acid and nanoscale effect. We present hollow channel formed in the bulk of PTR glass by fs laser irradiation, subsequent heat treatment, and chemical etching (Fig. 1). Such hollow structures can be used for developing various sensors and “lab-on-a-chip” devices based on PTR glass.
The presence of sodium in PTR glass composition allows one to focus on the ion exchange technology that is widely used in last time for formation of silver clusters and plasmon nanoparticles. Combination of photoetchable and ion exchangeable properties of PTR glass could open prospects for developing new microfluidic and plasmonic devices. Silver ions in the ion exchange layer of PTR glasses can be transformed into either luminescent silver molecular clusters or plasmonic silver nanoparticles by adjusting temperature of subsequent heat treatment. Such structures can be used for developing integrated microfluidic-plasmonic sensors.
For this purpose, we realized luminescent clusters and plasmonic

nanoparticles inside of the hollow structures etched in volume of the PTR glass by Na+ Ag+ ion exchange and subsequent thermal treatment (Fig. 2). Thus, developing microfluidic structures and "lab-on-a-chip" devices opens up new prospects through integration of the devices with luminescent and plasmonic nanostructers that can be formed in the hollow structures etched in the volume of PTR glass.

Keywords: Photo-therno-refractive glass, chemical etching, ion exchange

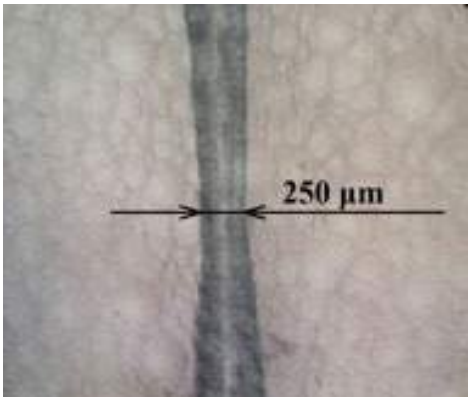

Figure 1&2

Glass Properties
PP-11
Mixed Ion-Polaron Charge Transport in Silver Zinc Phosphate Glasses Containing WO3 and MoO3

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The subject of this study is to investigate the influence of the addition of two different transition metal oxides, WO3 and MoO3, to silver zinc phosphate glasses. Such glasses, due to their mixed ion-polaron transport, exibit interesting electrical properties which are of interest as potential cathode materials in solid state batteries. Two different conductions, ionic and electronic, contribute to total conductivity in these glasses. Ionic conductivity depends on the mobility and concentration of silver ions, whereas electronic one follows small polaron hopping mechanism. Glasses of general composition (30-0.5x)Ag2O-(30-0.5x)ZnO-40P2O5-xTMO (TMO = WO3, MoO3, 0≤x≤60 mol%) were studied. Their electric properties were studied with impedance spectroscopy in a wide frequency (10-2-106 Hz) and temperature (303-513

K) range. Method used for structural analysis was Raman spectroscopy while the fractions of reduced state transition metals were determined by EPR and SQUID measurements.
Impedance spectroscopy measurements revealed different conductivity trends in studied glass series. In series with added WO3, DC conductivity decreases with the addition of WoO3, reaching minimal value between 30-40 mol% of WO3. With further increase of WO3 content above 40 mol%, DC conductivity rapidly increases due to increase of polaronic contribution to total conductivity. On the other hand, MoO3 glasses show a different trend. Addition of MoO3 to silver zinc phosphate glasses results in linear decrease in DC conductivity up to 50 mol% of MoO3 which shows that in this compositional range DC conductivity strongly depends on the decrease of silver ion concentration. At 60 mol% of MoO3 the glass is purely polaronic and the conductivity increases as a result of easy conduction pathways for polarons.
Keywords: Mixed ion-polaron glasses, electrical conductivity, impedance spectroscopy, structure

Glass Properties
PP-12
The Influence of the Structural Compactness on the Some Glass Properties of the Na2O–Al2O3–B2O3 System
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In the Na2O–Al2O3–B2O3 system, six glasses were synthesized having the (35–x) Na2O·xAl2O3·65B2O3 molar composition, where x = 0; 5; 10; 12.5; 15; 17.5. For these synthesized glasses the following physical properties were measured: density; refractive index; linear thermal expansion coefficient; glass transition temperature. The structural compactness, the molar volume and the volume of oxygen ion, considered as structural characteristics for the first level of analysis (atomic), at a sub-nanometric scale, were also calculated.
The correlation analysis of the properties indicated that these structural characteristics, even at this atomic level, sub-nanometric, influence the physical properties considered at a macroscopic scale.
Moreover, the dependency graphs show a series of particular points (return points) that suggest structural transformation areas generated by the [BO3] ---> [BO4] and [AlO6] ---> [AlO4] transformations, according to the chemical composition of the glasses.
Keywords: Na2O-Al2O3-B2O3 glasses, structural compactness, properties, correlations, sub-nanometric scale.

Glass Properties
PP-13
Structural Features of Zirconia Doped Mineral Glasses
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Mineral glasses and fibres are attractive materials for a wide range of technical applications. Due to the high temperature stability, good mechanical properties and chemical durability these materials are used as a heat and acoustic insulation, reinforcing material in composites and the storage of waste. To increase the thermal stability of mineral glasses, zirconium compounds are added into the initial synthesis mixture, which also significantly increase the chemical resistance of glass to alkali.
Many researchers studied the glass structure for decades. It was shown that the basic structural unit of the silicate glass is a [SiO4]4- tetrahedron. The silicon-oxygen tetrahedrons are linked to each other through their corners. The presence of modifiers (for example, zirconium) in their structure leads to the creation of non-bridging oxygens and structural species that affect the final glass macroscopic properties. In this work, we studied zirconia doped mineral glasses using Raman, XPS, 29Si MAS NMR spectroscopy and showed relationship with their properties.
Mineral glasses containing 0-7% ZrO2 were prepared using basalt rock from the Siltsevskoe deposit (Carpathians, Ukraine) and zircon ZrSiO4. The synthesis mixture was homogenized at 1600 °C for 24 h and then quenched in water.
Raman spectra of obtained glasses have two broad bands in 350-650 cm-1 and 800-1200 cm-1 regions. The band at 350-650 cm-1 can be assigned to bending vibration mode of Si-O-Si and Si-O-Al linkages. The maximum of this band (about 510 cm-1) does not change its position with the change of zirconia concentration. However, a drop in the intensity of this band with the increase of ZrO2 content has been observed. At the same time, the band at 800-1200 cm-1 corresponding to antisymmetric stretching vibrations of the bridging Si-O-Si bonds within [SiO4]4- tetrahedra does not vary in intensity. The Si2p XPS spectra consist of a sharp single peak at 102.5 for initial glass without ZrO2 and at 102.0-102.5 eV for zirconia doped glasses. According to the literature, the Si2p binding energy for SiO2 is in the range of 103.2-103.8 eV. For ZrSiO4, the Si2p energy is 101.8 eV. It can be seen that the Si2p binding energies for modified glasses take an intermediate position between the silica and zirconium silicate. 29Si MAS NMR spectra of all glasses have one broad peak. The increase in peak width is due to the presence of iron in the glasses. The peaks are systematically shifted by 2-3 ppm downfield for modified glasses as compared with the glass without zirconia. This shift is most likely due to incorporation of zirconium atoms in the silicon-oxygen glass lattice. The incorporation of zirconium into the glass structure leads to an increase of non-bridging oxygen. Zirconium causes “loosening” of the glass structure and a drop in

the tensile strength of glass fibre.
The reported study was funded by RFBR according to the project № 16-33-00231 mol_a.
Keywords: Mineral glass, glass structure, zircon doping, spectroscopy

Others
PP-14
Green Maintenance - a Study on Tribological Performance of Eco-Friendly Lubricants in Pumping Systems
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Green manufacturing, green maintenance is a must for sustainable future. Pumping systems account for nearly 20% of the worlds electrical energy, therefore pumps are one of the most important equipment for industry, agriculture and municipality. Every operating equipment have potential for environment pollution cause during operation and maintenance. In pumping systems,
lubricants have potential of soil and water pollution in case of possible leakages. Therefore using ecofriendly lubricants in pumping systems could be a good prevention for sustainable future. Pumps bearings need to be lubricated as any rotating equipment, and for this purpose they have an oil sump for lubricant filling.
Usually mineral or synthetic oil are used for bearing lubrication. In case of oil leakage in sealing system of pump; soil or water could contaminated with oil. In last decades ecofriendly lubricants have enlarged usage area because of their excellent lubricity,
biodegradability, good viscosity–temperature characteristics, and low evaporation loss. This study focused on the effects of using ecofriendly pure vegetable based lubricants instead of mineral oil in pumping system bearings. Although vegetable based oils have good tribological properties, nowadays it is studied on additives to improve their thermal susceptibilities. But nowadays they are not commercial. So in this study commercially pure canola and cotton seed oil was experimented with traditional mineral oil. This study aims to reduce the contamination of water and soil by pump lubrication system leakages.
Keywords: Green maintenance, eco-friendly lubricants, pumps

Others
PP-15
The Usage of Ceramic Glazes in Artistic Glass Techniques
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In our modernized society, day by day, human being were looking for different techniques also in the field of glass. Experiments were carried out

by considering the compatibility of these techniques and materials with the properties of glass. In this context ceramic glazes are suitable candidates because of their high temperature durability and thermal expansion similarity to use with glass. For this purpose the blue colored glazes which has 1000 °C and 1200 °C firing temperatures were added to glass for decoration oriented purpose. The glazes were applied on the glass surface and between the glass surfaces by fusion and glass blowing techniques. Different effects were obtained according to the technique and application method. Color change from blue to light green was one of these impacts. Experimental studies were showed that 1000 °C firing glaze were resulted better than the 1200 °C firing glaze. Artistic glass works have been prepared by using ceramic glaze as decorative agent in glass blowing and and glass fusion techniques.
Keywords: Glass decoration, glass blowing technique, glass fusion technique, ceramic glaze in glass decoration

Surface Properties and Coatings
PP-15
Deposition of ITO Thin Films by Large Area DC Magnetron Sputtering
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Among transparent conductive oxides (TCO), indium tin oxide (ITO) is widely preferred because of its unique properties such as high transparency in the visible region and low resistivity. The main goal of this study is to grow ITO thin films with good electrical and optical properties on large area substrates. The growth of ITO with excellent electrical and optical characteristics by DC magnetron sputtering on small area such as microscope glass (2 x 2 cm2) is very well controlled [3-4]. However, growth of ITO on large areas, required by industrial needs, is quite complicated. Recently, we improved the growth method in our large area rectangular magnetron sputtering system by employing a heating during deposition process. As large as 60x90 cm2 area ITO thin films were grown at heated substrates without necessary ex-situ heat treatment with electrical, optical and mechanical characteristics comparable to state of the art ITO thin films.
Keywords: ITO, large area coatings, magnetron sputtering

Refractories
PP-16
Investigation of Corrosion Behaviour of Al2O3–ZrO2–SiO2 (AZS) Refractory Using In Tableware Glass Furnaces
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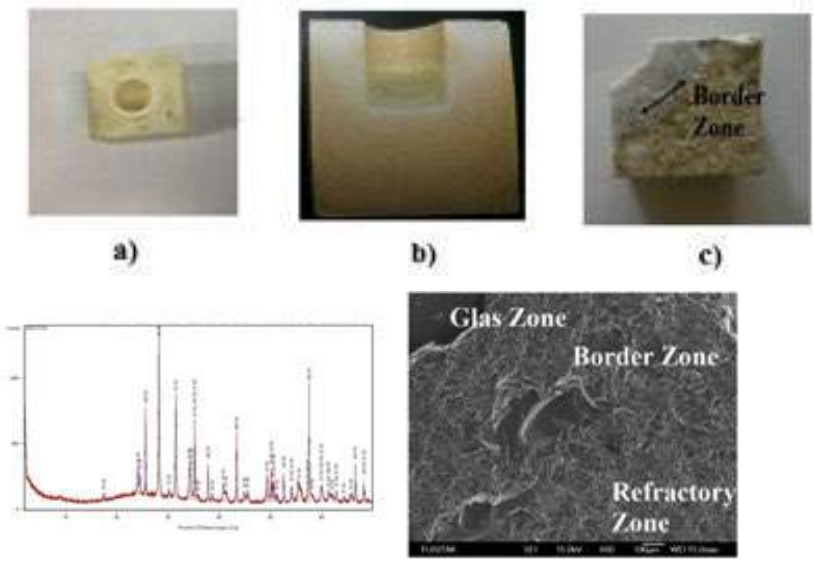
2Akçansa Çimento San.ve Tic. A.Ş.

Glass furnaces have the highest costs in the Glass Manufacturing Sector Equipment. Furnace costs are categorized by setup, operation and maintenance costs. Refractory industry is making hard work for glass industries technical requirements design and development with low costs. In this study, corrosion resistances of AZS refractory, which are used in glass furnace, are investigated. The slug attack experiment test was made at 1550°C (which is the reel operational temperature for industrial glass furnaces in general) during 72 hour. An intense slag region comprising dissolution and infiltration areas was observed at the interfaces (Fig. 1). X-ray diffraction (XRD) analysis and SEM investigations of fired samples were carried out to compare the effect of glass penetration on refractory (Fig 2-3). The mechanism of the glass penetration of AZS was examined, and the penetration layer was chemically analyzed.
As shown in Fig. 3, slag is extremely limited in the spreading area. It was determined that, the chemical analysis result of AZS refractory, taken from the border zone, the ratio of the Al2O3 and ZrO2 are compatible with the refractory composition.
AZS refractories, which have a long lifetime and glass quality improver, are mostly using at the bottom of glass furnace melting area, at side walls..etc. for its effective performance. Because of all these areas are under; high temperature, molten glass moving corrosive effects , both and alkali gas chemical attacks in furnace. Due to these reasons, using AZS refractories are increasing the glass furnace's lifetime. So, AZS type refractories using are looks suitable at these zones in the glass furnaces.
Keywords: Electron microscopy, X-ray diffraction, slag penetration, AZS refractories



Figure

Surface Properties and Coatings
PP-17
Synthesis and Characterization of Boron Nitride Thin Films on Glass Substrate
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Boron nitride (BN), one of the high-tech products of boron, is a material with superior properties such as refractory properties at high temperatures, high thermal shock resistance, high thermal conductivity, electrical insulation, chemical and mechanical stability, lubrication and easy process ability. Thanks to this features thin h-BN coatings find applications in several fields such as protective coating for oxidation, humidity and corrosion. In this study boron nitride thin films on glass substrates were manufactured from boric acid and urea solution by dip-coating sol-gel technique. Different concentrations of metanolic boric acid solutions were studied to form BN thin film coatings on glass substrate. The impregnated thin films produced via this technique were heated to 550 °C at a rate of 5°C/min for 2 h in a furnace with N2 atmosphere. Scanning electron microscopy (Zeiss Supra 40VP) was employed to investigate the BN coating morphologies. The phases of the nitridation products were characterized by X-ray diffraction (XRD, Panalytical, Empyrean). Surface roughness of thin films was determined by using Atomic-Force Microscopy (AFM). The best molar concentration of thin films was decided according to the structural and roughness properties of manufactured samples.
Keywords: Boron nitride, thin film, dip-coating, surface properties

Surface Properties and Coatings
PP-18
Mesoporous Sol-Gel Based Silica Thin Films with Ordered Pore Orientation as Antireflective Coatings on Glass
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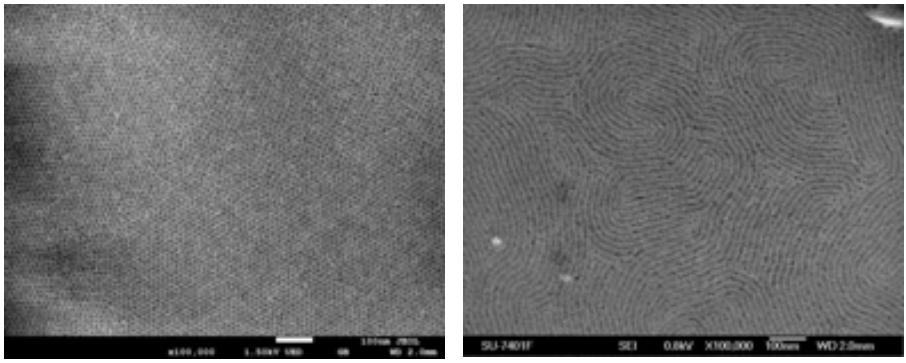
3Rıse Research Institutes of Sweden, Measurement Technology

Antireflective coatings on glass have increasing applications, on e.g. cover glass of PV modules, display glass, spectacle lenses or window glazing's. Sol-gel derived mesoporous coatings can be tuned both in terms of porosity and thickness, thus allowing tuning of the refractive index. Additionally, the sol-gel approach is bottom-up, which facilitates easy upscaling. In the current work we present dip-coated mesoporous SiO2 coatings of different pore orientation and film thickness prepared on

microscope glass slides and silicon wafers. The silica coatings were derived from TEOS (tetraorthosilicates) mixed with ethanol and diluted HCl. Hexagonal and cubic pore ordering of the thin films with a pore size in the range of 5-10 nm were obtained, confirmed by SEM, images in Figure 1 and 2. The thin films were characterized in terms of non-contact profilometry, stylus profilometry, nanohardness, scratch resistance, UV-Vis-NIR transmittance and UV-Vis-NIR reflectance. The thicknesses of the studied films varied from 100 nm up to several hundreds of nm without jeopardizing the film homogeneity. All the mesoporous films exhibited higher transmittance than the uncoated glass substrate. The film with hexagonal pore orientation has a somewhat higher nanohardness than the cubic one, however, no difference was found in the scratch resistance for the films with the different pore orientations.

Keywords: Mesoporous silica, hexagonal, cubic, antireflective coatings, thin film



Figure

Surface Properties and Coatings
PP-19
Studying Optical and Film Formation Properties of Silver Doped Polymer Composites Using Spectroscopic Techniques

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In this study, film formation, optical, morphological and electrical properties of pyrene (P) labeled polystyrene (PS) latex/silver nanoparticles (AgNPs) (PS/AgNPs) were investigated by using spectroscopic methods such as steady state (SSF) and fast transient (FTRF) fluorescence techniques and UV-vis (UVV) technique separately. In the range of (0-50% wt.) of AgNPs, nine different proportions of PS/AgNPs composites were prepared. Then, PS/AgNPs films which are dried at the room temperature were obtained in the powder form by using drop casting method. Film samples were

separately annealed above glass transition temperature (Tg) of PS ranging from 100 to 280 0C for 10 minutes. Fluorescence emission spectrum, fluorescence decay curve and transmittance of each PS/AgNPs were measured in order to observe how film formation is processed. It is observed that increment of AgNPs content in composites made the emission spectra narrower. It was also seen that increasing AgNPs content in the range of (3-30% wt.) were given rise to florescence enhancement and reduced lifetimes. However, above 30% wt. of AgNPs content virtually did not alter the florescence emission spectrum and the intensity decreased considerably with annealing temperature. On behalf of below 30% wt. of AgNPs content, void closure and inter-diffusion process which are distinguishable film formation processes were seen in florescence data. The stages of the film formation process were modeled and activation energies were calculated for each sample of below 30% wt. of AgNPs content. The electrical conductivity was measured as a function of AgNPs content and only slightly increment of electrical conductivity was observed with the increase in AgNPs content. In order to make a comparison with optical data, scanning electron microscope (SEM) images were taken to each sample and the results were found coherent.

Keywords: Silver nanoparticles, PS latex, electrical conduction, percolation, fluorescence, film formation, fluorescence lifetime.

Surface Properties and Coatings
PP-20
Film Formation and Optical Percolation Behaviors of PS/MWCNT Nanocomposite Films Depending on PS Particle Size

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In our present research, the particle size effect of polystyrene (PS) latex on film formation properties and optical percolation behavior of nanocomposites composed of PS latex and multi-walled carbon nanotubes (MWCNTs) was studied by performing photon transmission (UV-vis) experiments and scanning electron microscopy (SEM) measurements. The PS particles with different sizes which have diameters of 382 nm, 480 nm, and 560 nm respectively, were synthesized through an emulsion polymerization technique. Three different mixture sets, each containing different amounts of MWCNT in the range between 0 and 20 wt%, were prepared by latex technology. PS/MWCNTs nanocomposite films were prepared from these mixtures on glass substrates via drop-casting method and dried at 40 C in the heating oven. Each dried sample was then annealed at varying temperatures between 100 C and 250 C for 10 min. In order to monitor the film formation behavior of prepared nanocomposite films, transmitted light intensity, Itr, was measured after each annealing step. As a result, film formation process for the nanocomposite films

containing 382 nm of PS particles observed in the presence of (0-7.5 wt%) MWCNT content while PS/MWCNT nanocomposite films including 480 nm and 560 nm of PS latex particles accomplished the film formation in the presence of (0-5 wt%) MWCNT. Film formation was not observed above these ranges for all nanocomposite films. The scattered light curves of three latex systems presented a typical percolation behavior and a similar optical percolation threshold of Rc=1.5 wt%. Energies of voids closure and inter-diffusion were not change much with increasing of MWCNT indicating that film formation process is not affected by MWCNT content in the nanocomposite films. SEM images of nanocomposite films were found to be consistent with optical results.

Keywords: Polystyrene, multi-walled carbon nanotubes, polymer nanocomposites, nanocomposite coatings, film formation, percolation

Surface Properties and Coatings

PP-22

Formation of Transparent Bactericidal ZnO Coatings on Glass Surface.

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This study is devoted to the development of thin and uniform ZnO coatings having high transparency in visible spectral range and the strong bactericidal activity against different bacteria.

The coatings were prepared by polymer-salt method on the glass surface. Aqueous solutions of zinc nitrate and the solution of polyvinylpyrrolidone (PVP) in propanol-2 were mixed at room temperature. The dipping method was used for the formation of composite Zn(NO3)2-PVP coatings on glass samples. After drying the coated samples were subjected to thermal treatment up to 550oC. The thicknesses of dried composite and oxide coatings were 360-380 and 120-150 nm, correspondingly.

To determine the bactericidal properties of the coatings the technique based on diffusion in agar was used. As a test bacteria the representative of gram-positive bacteria Staphylococcus aureus ATCC 209P and a representative of gram-negative bacteria Escherichia coli ATCC 25922 were used. Antibacterial effectiveness was evaluated by formation's determining of inhibited areas in nutrient agar, which is formed on the surface of the inoculated bacteria.

Formation of the structure and properties of ZnO coatings proceeds during thermal treatment. The evolution processes, which take place during thermal treatment, are complicated and include the PVP and Zn(NO3)2

decomposition and ZnO formation. The data of spectral measurements and XRD analysis show that prepared coatings consist of small (10 nm) ZnO nanoparticles. Prepared coatings demonstrate bactericidal effect against gram-positive bacteria Staphylococcus aureus ATCC 209P and gram-negative bacteria Escherichia coli ATCC 25922 in the natural lighting and in the darkness also. It is necessary to note that antibacterial effect appeared significantly stronger in the condition of natural lighting. Based on this experimental fact, it is possible to conclude that some part of observed antibacterial activity is related to the photochemical process on coating surface.
Keywords: Transparent bactericidal coatings on glass surface, polymer-salt method, oxide materials, optical spectra.

Useful Tourist Information

Time
Turkey is 3 hours ahead of Greenwich Mean Time (GMT + 3)
Health & Safety
Emergency telephone numbers; Police 155 Medical 112 Fire 110
Climate and Clothing
In late October, the weather in Istanbul is generally cool and slightly overcast. Daily temperatures average 18 C (64 F). Temperatures tend to drop in the evening, so a jacket is recommended.
Cuisine and Restaurants
Turkish cuisine is among the most varied and extensive in the world, and fine restaurants offering the classics of Turkish cuisine as well as modern interpretations of classic favorites dot the Istanbul culinary landscape. Istanbul, with a restaurant almost literally at every turn, is a real culinary treat, and a snacker's paradise. Whether you try the variations of Kebabs, or the fresh fish from the Bosphorus or the numerous kinds of fresh vegetables, you are guaranteed the delicious dining experience. One can also find delicious but less expensive tastes for budget conscious attendees. In every part of the city there are small cafés and restaurants and kiosks serving excellent food in the lower price category. If you're looking for a taste of the world, international cuisine is available at enticing locations across Istanbul, historic and modern, many with breathtaking views of the Bosphorus. As always being said, cosmopolitan Istanbul is not only a meeting place of cultures for centuries but also a meeting place of cuisines.
Medical Services
Having travel insurance is highly advisable. For minor problems, it's customary to ask at a chemist/pharmacy (Eczane) for advice. Ensure you know the generic name of your medicine; the commercial name may not be the same in Turkey. The word for hospital is 'Hastane'. Usually doctors in Turkey speak English.
Money
The unit of currency is the Türk Lirası (Turkish Lira; TL). Coins come in amounts of 1, 5, 10, 25, 50 kuruş and 1 lira, and notes in 5, 10, 20, 50, 100 and 200 Türk Lirası. Central Bank of the Republic of Turkey http://www.tcmb.gov.tr/yeni/eng/Banknotes in Circulation and Their Security Features http://www.tcmb.gov.tr
ATMs
Automated teller machines (ATMs, cashpoints) are common in Istanbul. All of the banks and some smaller banks have ATMs. Virtually all of them offer instructions in English, French and German and will pay out Turkish liras when you insert your bank debit (cash) card. ATMs will also pay cash advances on Visa and Mastercard. The limit on cash withdrawals is generally TL 600 to TL 1000 per day, though this varies from bank to bank.

Changing money

There is 24-hour exchange bureaux (döviz bürosu) in the arrivals halls at International Airports that offer rates comparable to those offered by bureaux in the city. US dollars and euros are easily changed at exchange bureaux. They are also often accepted as payment without being changed. Rates are similar whichever bureau you go to, with the possible exception of those in the tourist precinct of Sultanahmet. Bureaux are open long hours (at a minimum, between 9am and 7pm). You will usually need to show your passport when changing cash. As Turkish liras are fully convertible, there is no black market.

Credit cards

Most hotels, car-rental agencies, shops, pharmacies, entertainment venues and restaurants will accept Visa and Mastercard; Amex isn't as widely accepted as the others and Diner's isn't accepted often. Budget hostels and hotels, and basic eateries usually accept cash only.

Traveller's cheques

If you have traveller's cheques, you will have to change them at a bank or post office. Exchange bureaux do not handle them. You'll need to show your passport.

Taxes & Refunds

Turkey has a value-added tax (VAT) known as the katma değer vergisi (KDV). Don't forget to ask the shopkeeper for the Global Refund Check for your purchase over 100 TL + VAT in one store. Some shops display a blue, grey and white 'Tax Free Shopping' sign in their window, conveniently signalling that they are participants in the refund scheme. When you leaving Turkey, latest in three months following your shopping simply show your purchases, 'tax free' invoices and passports to customs officials, where staff will stamp the receipts to confirm that you are leaving the country, have your Global Refund invoice/check stamped. You have several choice to collect your refund. You can have immediate cash at your nearby Cash Refund Office, or mail your customs validated check to Global Refund-Turkey within 90 days for direct crediting of a chosen credit card or a bank cheque to be sent to your address. Atatürk Airport Cash Refund Office or İşbank open every day – 24 hours. Sabiha Gökçen Airport İşbank open every day – 24 hours. Karaköy Harbor İşbank open every day – 24 hours.

Turkish Conventions

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