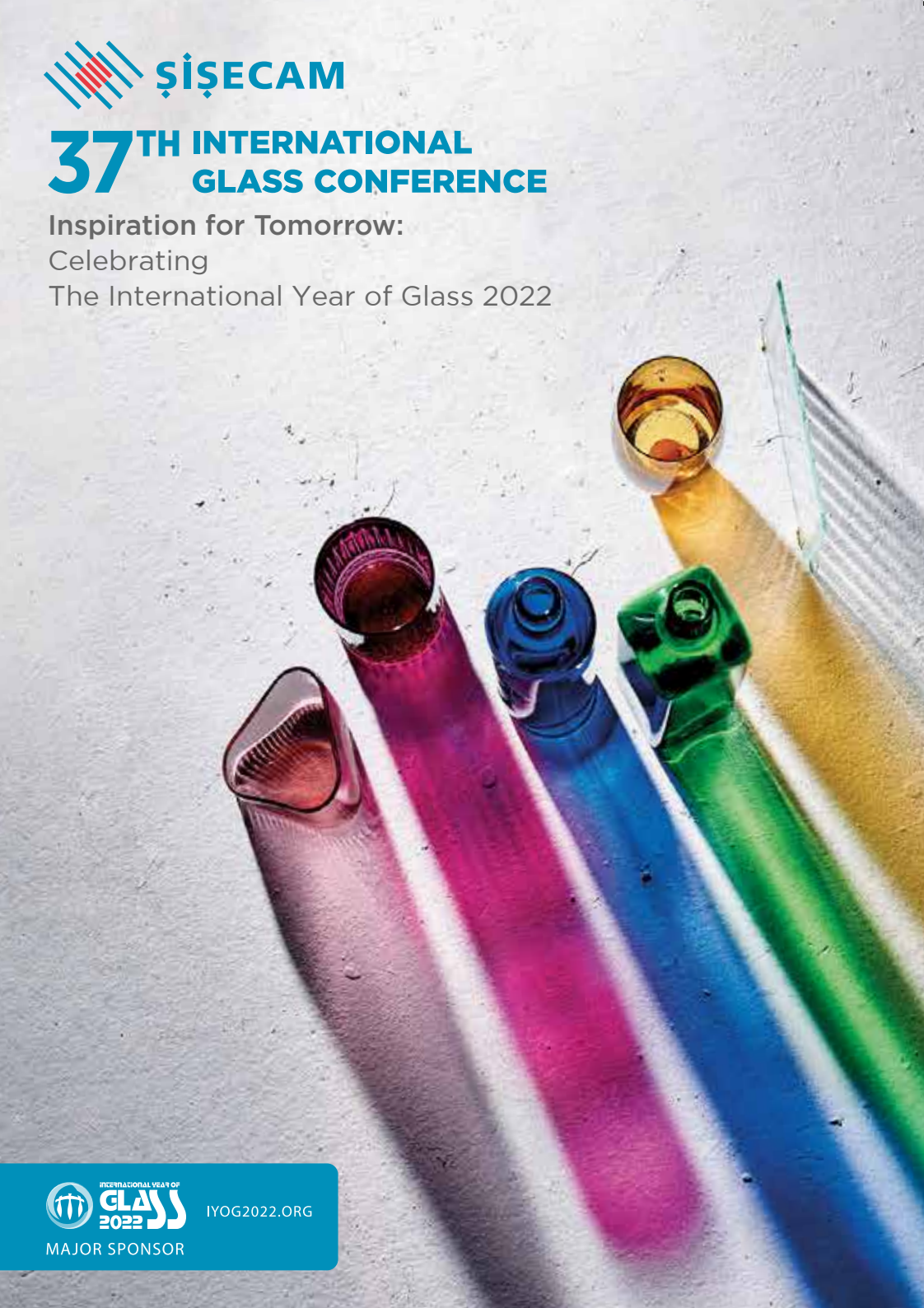
ŞİŞECAM

37TH INTERNATIONAL GLASS CONFERENCE

Inspiration for Tomorrow:
Celebrating
The International Year of Glass 2022



INTERNATIONAL YEAR OF GLASS 2022

IYOG2022.ORG

MAJOR SPONSOR

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Notice

Corresponding authors are responsible for the accuracy of their proceedings' content as well as the name, affiliation and address information of all their coauthors.

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WELCOME MESSAGE

Dear Colleagues and Guests,

Regarding the scientific and technological developments as the key drivers of the business success, Şişecam has been organizing annual Glass Conference since 1985. It was initially designed to create a scientific environment to share innovative ideas and exchange the best practices within Şişecam group.

Over decades, the Conference has evolved to become a prominent scientific platform for global glass industry by bringing academy and industry together while receiving more international attendance and contribution each year.
Glass, with its ever-expanding usage such as in construction for architectural purposes, in automotive and renewable energy systems, in electronics and communication, in biotechnology as well as with demands for higher performance in its conventional usage is more relevant than ever. As glass manufacturers, scientists and technologists, it is our duty to achieve the highest value and quality with the lowest impact on the world we live in, by finding out new and better ways of operation to achieve greater success.

After the United Nations General Assembly officially declared 2022 as the International Year of Glass, various events have begun to be celebrated all over the world to increase the awareness of glass and to highlight the connections between glass, science, technology, art and culture. With glass, we creatively shape life, make the world a better place, and protect the environment so that future generations can enjoy it. We are happy to present this miraculous material to the service of humanity and to celebrate what it has added to our lives. We believe that 37th Şişecam Glass Conference will be an excellent opportunity to celebrate International Year of Glass 2022 as well as to update and discuss the latest developments on a global scale.

Due to the ongoing Covid-19 pandemic conditions, 37th Şişecam Glass Conference will take place in a hybrid way. Our distinguished presenting participants will share their latest work on established topics as well as cutting-edge developments in emerging research areas in glass science and technology. Last but not least, it will be a fruitful conference with many collaborations in the glass science, technology and production communities.

GÖRKEM ELVERİCİ
Conference President
Chief Executive Officer,
Şişecam

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PROGRAM AT A GLANCE

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NOVEMBER 17, 2022

ISTANBUL TIME (CET +02:00)	SCIENTIFIC PROGRAM
REGISTRATION 09:00 - 10:00	MAIN ENTERANCE Great Room A
10:00 - 10:20	Welcome/Opening Remarks
10:20 - 10:30	ICG Turner Award Handover Ceremony
10:30 - 12:30	PLENARY SESSION
12:30 - 13:30	LUNCH BREAK THE CITY BRASSERIE
PARALLEL SESSIONS 13:30 - 15:20	MELTING, FORMING PROCESSES Great Room A
PARALLEL SESSIONS 13:30 - 15:20	FUNCTIONAL COATINGS (I) Great Room B
15:20 - 15:40	COFFEE BREAK FOYER A&B
PARALLEL SESSIONS 15:40 - 17:40	ENERGY, ENVIRONMENT AND SUSTAINABILITY (I) Great Room A
PARALLEL SESSIONS 15:40 - 17:30	ADVANCED TECHNOLOGY MATERIALS (I) Great Room B
POSTER SESSIONS 17:40 - 18:40	FOYER A

NOVEMBER 18, 2022

REGISTRATION 09:00 - 10:00	MAIN ENTERANCE
POSTER SESSIONS 09:00 - 10:00	FOYER A
PARALLEL SESSIONS 10:00 - 12:10	ENERGY, ENVIRONMENT AND SUSTAINABILITY (II) Great Room A
PARALLEL SESSIONS 10:00 - 12:10	ADVANCED TECHNOLOGY MATERIALS (II) Great Room B
12:10 - 13:10	LUNCH BREAK THE CITY BRASSERIE
PARALLEL SESSIONS 13:10 - 15:20	DIGITALIZATION, MATERIALS MODELING AND SIMULATION Great Room A
PARALLEL SESSIONS 13:10 - 15:20	FUNCTIONAL COATINGS (II) Great Room B
15:20 - 15:40	COFFEE BREAK FOYER A&B
PARALLEL SESSIONS 15:40 - 17:30	PRODUCT DESIGN Great Room A
PARALLEL SESSIONS 15:40 - 17:30	GLASS STRUCTURE & PROPERTIES Great Room B
17:30 - 17:40	CLOSING GREAT ROOM A

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SCIENTIFIC PROGRAM

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Istanbul Time (CET +02:00)	November 17,2022
09:00 - 10:00	**REGISTRATION & COFFEE BREAK** Main Enterance & Foyer
OPENING	**GREAT ROOM A**
10:00 - 10:10	**GÖRKEM ELVİRİCİ** *(Chief Executive Officer, Şişecam, TR)*
10:10 - 10:20	**Prof. Dr. AHMET KIRMAN** *(Chairman and Executive Member of the Board, Şişecam, TR)*
10:20 - 10:30	**ICG Turner Award Handover Ceremony** **Dr. ALEV YARAMAN** *(2003-2006 ICG President, retired Flat Glass Group President, former Board Member, Şişecam, TR)*
PLENARY SESSION	**INSPIRATION FOR TOMORROW: CELEBRATING INTERNATIONAL YEAR OF GLASS**
CHAIR	**Dr. İLKAY SÖKMEN** *(Glass Technologies Director, Şişecam, TR)*
10:30 - 11:10	**"Enhancing Furnace Performance by the Choice of Raw Materials"** **Keynote Speech:** **Prof. Dr. REINHARD CONRADT** *(President of the International Commission on Glass (ICG), Emeritus Professor from RWTH Aachen University, uniglassAC GmbH, DE)*
11:10 - 11:50	**"The Role of Glass in Buildings of the Future"** **Keynote Speech: SİMAY ARIKAN** *(Senior Director, Products Business Development and Exploration, Velux A/S, DK)*
11:50 - 12:30	**"The Future of Glass and New Glass Trends"** **Keynote Speech: Dr. MATTHIAS MÜLLER** *(Executive Vice President R&D, Schott AG, DE)*
12:30 - 13:30	**LUNCH BREAK** THE CITY BRASSERIE

PARALLEL SESSIONS GREAT ROOM A	MELTING, FORMING PROCESSES AND BULK PROPERTIES
CHAIR	**TOLGA UYSAL** *(Melting Technologies & Engineering Director, Şişecam, TR)*
RESP. MEMBER	**MELİH ÜSTÜN** *(Exec. Senior Researcher, Microanalysis, Şişecam R&D, TR)*
13:30 - 14:00	**"Innovative Glass Melting Technologies - A Patchwork of Progress"** **Invited: ASTON FULLER** *(General Manager, Glass Futures Limited, UK)*
14:00 - 14:20	**"Refractories for the Furnace of the Future"** **Dr. ROLAND HEIDRICH** *(Research & Development Manager, REFEL S.p.A., IT)*
14:20 - 14:40	**"Effect of Na_2O concentration on AZS refractories in Glass Melting"** **MELİH ÜSTÜN** *(Exec. Senior Researcher, Microanalysis, Şişecam R&D, TR)*
14:40 - 15:00	**"How Refractory Material Participate to The Future of Glass"** ***(Online)*** **Dr. MICHEL GAUBIL** *(Director Refractory Solutions, SEFPRO, FR)*
15:00 - 15:20	**"The Impact of Flow Properties and Mixed Batch and Raw Material Handling System Design"** ***(Online)*** **ROGER BARNUM & DENIS FERREIRA** *(Director, Jenike & Johanson, Inc., US)*
15:20 - 15:40	**COFFEE BREAK** FOYER A&B

PARALLEL SESSIONS GREAT ROOM B	FUNCTIONAL COATINGS (I)
CHAIR	**M. OZAN ÖZER** *(Coating Technologies Director, Şişecam, TR)*
RESP. MEMBER	**ZEYNEP AYDIN** *(Researcher, Atmospheric Coating, Şişecam R&D, TR)*
13:30 - 14:00	**"Antireflective Coatings for Glass: Particle-Based Porous Quarter Wave Coatings"** **Invited: Prof. Dr. PASCAL BUSKENS** *(Nanostructured Materials, TNO, NL)*
14:00 - 14:20	**"CVD Growth of Zinc Sulphide for IR Dome"** **Dr. MUSTAFA BURAK COŞAR** *(Lead Engineer, ASELSAN, TR)*
14:20 - 14:40	**"Digital Solutions for Resource Efficiency in Vacuum Coating"** **Dr. HARALD HAGENSTRÖM** *(Vice President Sales, Von Ardenne GmbH, DE)*
14:40 - 15:00	**"Acquiring Alkali Resistant E Glass Fiber by Zirconium Oxide Coating"** **Dr. GÖKSENİN KURT ÇÖMLEKÇİ** *(Exec. Sn. Researcher, Atmospheric Coating Tech., Şişecam R&D, TR)*
15:00 - 15:20	**"Synthesis of Well Defined Polymer Architectures and Investigating Their Biocidal Activity and Hardness on Glass Surface"** **Prof. Dr. TARIK EREN** *(Faculty Member, Chemistry Department, Yildiz Technical University, TR)*
15:20 - 15:40	**COFFEE BREAK** FOYER A&B

PARALLEL SESSIONS GREAT ROOM A	ENERGY, ENVIRONMENT AND SUSTAINABILITY (I)
CHAIR	**SERKAN ŞAHİN** *(Technology Monitoring & Implementation Director, Şişecam, TR)*
RESP. MEMBER	**CANALP KÜLAHLI** *(Researcher, Simulation, Şişecam R&D, TR)* *Şişecam R&D, TR)*
15:40 - 16:10	**"The current status of the science and commercial product of the Vacuum Insulated Glass Technology"** **Invited: Prof. Dr. CENK KOÇER** *(School of Physics, The University of Sydney, AU)*
16:10 - 16:40	**"Developing a More Sustainable Glass Recycling System"** **Invited: STEVE WHETTINGSTEEL** *(CEO & Managing Director, Krysteline Technologies Ltd., UK)*
16:40 - 17:00	**"Beyond Cullet, the Use of Secondary Raw Materials Derived from Wastes in the Glass Industry"** **CHRIS HOLCROFT** *(Technology Development Lead, Glass Technology Services, UK)*
17:00 - 17:20	**"Carbon Reduction with Electricity or Hydrogen"** **ERIK MUIJSENBERG** *(Vice President, Glass Service, CZ)*
17:20 - 17:40	**"A Promising Technique for Glass Consolidation: Cold Sintering Process"** ***(Online)*** **LEVENT KARACASULU** *(Department of Materials Science and Engineering, Izmir Institute of Technology, TR)*
17:30 - 18:30	**POSTER SESSIONS + COFFEE BREAK** FOYER

PARALLEL SESSIONS GREAT ROOM B	ADVANCED TECHNOLOGY MATERIALS (I)
CHAIR	**HALUK ERDEM** *(Atmospheric Coating Technologies Manager, Şişecam R&D, TR)*
RESP. MEMBER	**BARIŞ DEMİREL** *(Researcher, Melting Kinetics, Şişecam R&D, TR)*
15:40 - 16:10	**"Empowering Photovoltaics via Smart Light Management Technologies"** **Invited: Assoc. Prof. Dr. SELÇUK YERCİ** *(Vice President & EmPV Div. Coordinator, ODTU-GUNAM Electrical-Electronics Eng., Middle East Technical Univ., TR)*
16:10 - 16:30	**"A Novel Glass Sandwich Structure by Vacuum Infusion Process "** **FEYZA NUR YILDIRIM** *(Postgraduate Research Student, Infrastructure Group, University of Southampton, UK)*
16:30 - 16:50	**"Polyurethane Dispersion for Glass Fiber Sizing"** **AYŞE BEGÜM CURA** *(Research and Development Manager, Frimpeks, TR)*
16:50 - 17:10	**"New Trends in Smart Glass Technologies for Prospective Applications"** **BERK ALKAN** *((Research Specialist, Research and Development, Teta Glass Technologies, TR)*
17:10 - 17:30	**"Nanoparticle Coated Glass Fibers for Improved Mechanical Properties"** ***(Online)*** **MD KAWSAR AHMED** *(Graduate Researcher, Bilkent University - UNAM, TR)*
17:30 - 18:30	**POSTER SESSIONS + COFFEE BREAK** FOYER

Istanbul Time (CET +02:00)	November 18,2022
09:00 - 10:00	REGISTRATION & COFFEE BREAK Main Enterance & Foyer
PARALLEL SESSIONS GREAT ROOM A	ENERGY, ENVIRONMENT AND SUSTAINABILITY (II)
CHAIR	ÖZGÜR ACAR *(Furnace Technologies Manager, Şişecam R&D, TR)*
RESP. MEMBER	HAKAN ORHON *(Project Engineer, Batch Systems, Şişecam R&D, TR)*
10:00 - 10:30	"From Radiation Transport to Sustainable Energy Transition" Invited: Prof. Dr. PINAR MENGÜÇ *(Director of Center for Energy, Environment and Economy (CEEE), Özyeğin University, TR)*
10:30 - 10:50	"Study and Comparison of Solar Reflectors with and without Copper" A. ALPEREN GÜNAY *(Department of Mechanical Engineering, Middle East Technical University, TR)*
10:50 - 11:10	"Electrical Systems for Furnace Boosting Revisited to Improve Energy Efficiency" RENE MEULEMAN *(Electrification of the Glass Industry, Schneider-Electric, NL)*
11:10 - 11:30	"How will Glass Furnaces Look in the Future?" STUART HAKES *(CEO, F.I.C. (UK) Limited, UK)*
11:30 - 11:50	"Climate Protection: the Idea of Total Recovery Glass Furnace and the LIFE SUGAR Project" *(Online)* GIORGIO MINESTRINI *(Sales Engineer, Stara Glass S.P.A., IT)*

11:50 - 12:10	**"Experimental Facility to Simulate Melting in Cold-Top Furnaces"** ***(Online)*** **MATHI RONGEN** *(Project Manager Glass Technology, Celsian, NL)*
12:10 - 13:10	LUNCH BREAK THE CITY BRASSERIE
PARALLEL SESSIONS GREAT ROOM B	ADVANCED TECHNOLOGY MATERIALS (II)
CHAIR	**Dr. ARCA İYİEL ORHAN** *(Glass Properties Manager, Şişecam R&D, TR)*
RESP. MEMBER	**TAYGUN AKAR** *(Researcher, Glass Properties, Şişecam R&D, TR)*
10:00 - 10:30	**"Glass Quality: Factors That Affect Surface Chemistry in Glass Conversion to Vials"** **Invited: Dr. SERENA PANIGHELLO** *(Senior Scientist/SG Lab Analytics, Stevanato Group S.p.A., IT)*
10:30 - 10:50	**"Pharma Packaging: Re-Explore the Known, Designing Today's Hit with a New Perspective"** **TAYGUN AKAR** *(Researcher, Glass Properties, Şişecam R&D, TR)*
10:50 - 11:10	**"Laser Irradiated Lanthanides-Doped Tellurite Glasses for Volumetric Display Applications"** **UTKU EKİM** *(Researcher, Metallurgical and Materials Engineering, Yildiz Technical University, TR)*
11:10 - 11:30	**"Ultrafast-Laser-Writing of Buried Microchannels Inside Silicate Glass Towards Screen-Based Applications"** **Dr. SHAHLA GOLGHASEMI SORKHABI** *(Postdoc, UNAM, Bilkent University, TR)*

11:30 - 11:50	**"Optimising Photonic Glass Material for Resistance to High Energy Photon Radiation"** ***(Online)*** **Dr. OWEN MCGANN** *(Principal Technologist, R&D, Glass Technology Services Ltd., UK)*
11:50 - 12:10	**"Exploration of Enhanced Structural Performance of Annealed Glass through Innovative Combinations with GFRP"** ***(Online)*** **Assoc. Prof. Dr. MITHILA ACHINTHA** *(Senior Lecturer, School of Engineering, The University of Manchester, UK)*
12:10 - 13:10	LUNCH BREAK THE CITY BRASSERIE
PARALLEL SESSIONS GREAT ROOM A	DIGITALIZATION, MATERIALS MODELING AND SIMULATION
CHAIR	**Dr. ADNAN KARADAĞ** *(Modelling and Simulation Manager, Şişecam R&D, TR)*
RESP. MEMBER	**CANALP KÜLAHLI** *(Researcher, Simulation, Şişecam R&D, TR)*
13:10 - 13:40	**"Accelerating Glass Modeling with Machine Learning and Artificial Intelligence"** **Invited: Dr. N. M. ANOOP KRISHNAN** *(Dept. of Civil Engineering, Indian Institute of Technology Delhi, IN)*
13:40 - 14:00	**"Multiphase CFD Modeling of Bubble Removal on Refining Shelf in a Glass Furnace"** **ENGİN DENİZ CANBAZ** *(Senior Researcher, Modelling, Şişecam R&D, TR)*

14:00 - 14:20	**"How Do We Start the Decarbonization Journey to Achieve a Sustainable Solution in the World Of Glass"** **NEIL G. SIMPSON** *(Independent Consultant and Combustion Specialist, Simpson Combustion and Energy Ltd., UK)*
14:20 - 14:40	**"Numerical Investigation of the Heating Zone of a Container Glass Annealing Furnace: Effect of Bottle Layout inside the Furnace on the Heating Effectiveness of the Furnace"** **GÖNENÇ CAN ALTUN** *(PhD Student, Özyeğin University, TR)*
14:40 - 15:00	**"Modern Methods for The Digitalization of Spare Parts Supply Chain and Its Data-Centered Control"** **Asst. Prof. Dr. MUSTAFA HEKİMOĞLU** *(Department of Industrial Engineering, Kadir Has University, TR)*
15:00 - 15:20	**"The Enigma of The Pull Reduction of Low Iron Glass in Float Melting Tanks"** ***(Online)*** **DR. WOLF KUHN** *(Chief Expert Glass Process, Steel & Glass, Fives Stein, FR)*
15:20 - 15:40	COFFEE BREAK FOYER A&B
PARALLEL SESSIONS GREAT ROOM B	FUNCTIONAL COATINGS (II)
CHAIR	**Dr. TUNCAY TURUTOĞLU** *(Surface Technologies Manager, Şişecam R&D, TR)*
RESP. MEMBER	**SİNEM ERASLAN AVCIOĞLU** *(Exec. Senior Researcher, Vacuum Coating, Şişecam R&D, TR)*

13:10 - 13:40	**"How to Minimize Product Setup Times in Large Area Coate Operation"** **Invited: Dr. MARCUS FRANK** *(Head of R&D and Product Management, Large Area Coating Glass, Bühler Leybold Optics Alzenau GmbH, DE)*
13:40 - 14:00	**"Multilayer Anti-Reflective Coatings on Float Glass for Architectural Applications"** **ALPEREN SEZGIN** *(Exec. Sn. Researcher, Vacuum Coat. Tech., Şişecam R&D, TR)*
14:00 - 14:20	**"Investigation of Rheological Behaviour of Water-Friendly Black Glass Enamel for Automotive Windshields"** **SELİME ÖZTÜRK** *(Glass Coating R&D Manager, Akcoat Research and Development Center, TR)*
14:20 - 14:40	**"Broadband Infrared Antireflective Optical Coating on Chalcogenide Infrared Glass"** **EYLÜL DEMİR** *(Coating Engineer, ASELSAN, TR)*
14:40 - 15:00	**"Etching Process for the Removing Mirror Coatings on the Zerodur without Damaging the Surface"** **OĞUZHAN BULUT** *(Engineer, MGEO, ASELSAN, TR)*
15:00 - 15:20	**"Advanced Characterization Methods for High-Quality Glasses: A Review of Two New Systems Developed at TÜBİTAK UME"** **Dr. HUMBET NASIBLI** *(Head of Laboratory, Thermodynamic Metrology Lab, TUBITAK UME, TR)*
15:20 - 15:40	COFFEE BREAK FOYER A&B

PARALLEL SESSIONS GREAT ROOM A	PRODUCT DESIGN
CHAIR	**DEĞER DEMİRCAN ACILIOĞLU** *(Product Design Manager, Şişecam R&D, TR)*
RESP. MEMBER	**EDİZALP AKIN** *(Product Designer, Handcraft, Şişecam R&D, TR)*
15:40 - 16:10	**"DesignNature - Nature of Design"** **Invited: Dr. TOMEK RYGALIK** *(Product Designer, Studio Rygalik, PL)*
16:10 - 16:30	**"Things that Make You Imagine"** **TAMER NAKIŞÇI** *(Industrial Designer / Artist, Studio Nakisci, TR)*
16:30 - 16:50	**"New Business Models and the Emerging Competency Needs after Digitalization in the Design-oriented Crafts Sector (ceramic and glass) in Istanbul"** **MÜGE BIYIK** *(Ph.D. Candidate, Design, Technology and Society Studies, Özyeğin University, TR)*
16:50 - 17:10	**"Proposal of a New Method for the Production of Glass Packaging Prototypes"** **AGAH BARIŞ CAN AKSAKAL** *(Ceramics and Glass Design Department, Mimar Sinan Fine Arts University, TR)*
17:30 - 17:40	CLOSING GREAT ROOM A

PARALLEL SESSIONS GREAT ROOM B	GLASS STRUCTURE & PROPERTIES
CHAIR	**BANU ARSLAN GÜVEL** *(Melting Kinetics Manager, Şişecam R&D, TR)*
RESP. MEMBER	**BARIŞ DEMİREL** *(Researcher, Melting Kinetics, Şişecam R&D, TR)*
15:40 - 16:10	**"Improving the Mechanical Properties of Glasses from the Bottom-Up"** **Invited: Prof. Dr. MORTEN MATTRUP SMEDSKJÆR** *(Department of Chemistry and Bioscience, Aalborg University, DK)*
16:10 - 16:30	**"Metal Nanoparticle Embedded and Rare-Earth Doped Novel Oxide Glasses and Ceramics for Photonic Application"** **Dr. HAMID REZA BAHARI** *(Invited Researcher, Bilkent University (UNAM), TR)*
16:30 - 16:50	**"Quantum Dot and Lanthanide Ion Doped Photoluminescent Glasses: Next-Gen Wavelength Convertors for Opto-Electronic Applications"** **Assoc. Prof. ALİ ERÇİN ERSUNDU** *(Faculty Member, Metallurgical and Materials Engineering, Yildiz Technical University, TR)*
16:50 - 17:10	**"Enhancement of the Green Optical Emission in Tb-Doped Barium Borate Glasses through the Glass Melting Process"** ***(Online)*** **Prof. Dr. DULCE YOLOTZIN MEDINA** *(Basic Science and Engineering, Metropolitan Autonomus University, MX)*

17:10 - 17:30	**"Effect of Boron Oxide on Optical Properties of New Glasses"** *(Online)* HADJER YOUCEF *(Ph.D. Student, University Mohamed Khider Biskra, AG)*
17:30 - 17:40	CLOSING GREAT ROOM A

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LOCATION OF ACTIVITIES

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PLENARY SPEAKERS

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REINHARD CONRADT
President of the ICG International Commission on Glass
Retired Professor from RWTH Aachen University, Germany

Session	PLENARY
Date	NOVEMBER 17, 2022, THURSDAY
Time	10:30 - 11:10 (Istanbul time, CET +02:00)
Chair	DR. İLKAY SÖKMEN

Enhancing Furnace Performance by the Choice of Raw Materials

Biography

Reinhard Conradt is a retired professor from RWTH Aachen University, Germany. He has been performing glass research at Fraunhofer Institute of Silicate Science, ISC Würzburg, Germany, for six years, then served for ten as university lecturer and industry consultant at Chulalongkorn University, Thailand. From 1997-2016, he was full professor and Chair of Glass years & Ceramic Composites at RWTH Aachen University, Germany Since 2022, he is President of the International Commission on Glass ICG. His work has been committed to building bridges between science, especially chemistry, thermodynamics and kinetics, and industrial engineering.

- International Otto Schott Research Award 2001,
- Fellow of The Society of Glass Technology (SGT, U.K.) 2017,
- L. David Pye Lifetime Achievement Award (GOMD-ACerS) 2020,
- Otto Schott Memorial Coin of DGG 2021.

Abstract

The technological goal of the glass melting process is the production of a glass with a specific composition, at a desired quality level, at high production efficiency, at low specific energy consumption, and at low environmental impact. All of these issues have a direct influence on the production costs. During the past decades, the above goal was predominantly pursued by improving the design of glass furnaces. This development has, by and large, reached as level of saturation.
By their basic function, all glass furnaces are high-T chemical reactors. So, beside the features of furnace design, their performance depends on the material passing through the reactor volume. Thus, the set of raw materials used to melt a specific glass is a powerful lever to optimize furnace performance. The present talk draws the attention to this approach, pointing out its chances and limits. The choice of raw materials influences furnace performance is several ways. This is, first of all, the energy demand of z, which is a 1st law property. Second, this is the batch gas inventory contributing to the overall flue gas volume. Together with the redox potential of the raw materials, it also governs foam formation. Third, this is the reaction rate of the batch-to-melt conversion, a kinetic property depending on the mineralogi-cal nature and the grain size distribution of the raw materials. In this context, the option of batch conditioning will be addressed, too. Industrial case studies are presented clearly showing that the furnace performance can be enhanced by optimizing the above influences. The limits of such optimization measures are, however, set by raw material availability and costs.

Keywords: melting kinetics, raw materials, grain size, batch conditioning, furnace performance

SİMAY ARIKAN

Senior Director, Business Development and Exploration, Heading the "Buildings of the Future" Department VELUX A/S, Denmark

Session	PLENARY
Date	NOVEMBER 17, 2022, THURSDAY
Time	11:10 - 11:50 (Istanbul time, CET +02:00)
Chair	DR. İLKAY SÖKMEN

The Role of Glass in Buildings of the Future

Biography

Simay Arikan is the senior director of business development and exploration heading the Buildings of the Future department in VELUX Group. Arikan brings more than 18 years of diverse industry experience in quality management, technology development, innovation management, technology commercialization and business development. Today, she and her team are focusing on supporting and accelerating sustainability transitions, through research, innovation and business development activities. Working together with ecosystem partners, she works towards positioning VELUX as a visible leader of the transformation towards healthy and sustainable building designs.
Arikan holds an Executive MBA from WHU / Kellogg School of Management in Germany and USA and a BS in Metallurgical and Materials Engineering from Istanbul Technical University in Turkey.

Abstract

VELUX roof windows have been bringing daylight and fresh air into homes around the world for more than 80 years. Our products help create bright, healthy and energy-efficient places in which to live, work, learn and play. At the VELUX Group, we wish to lead the change towards healthy and sustainable buildings. We believe that buildings of the future must be designed for people, with their health in mind, for increased energy efficiency and with respect for the environment.
Cities and buildings account for an increasing share of the world's energy consumption and CO_2 emissions. To break the curve of increasing environmental pressure from buildings, we need sustainable buildings that also have a positive impact on our health and well-being.
We actually spend 90% of our time indoors and our homes are so well insulated that not enough fresh air and daylight can get in. Lack of direct sunlight also causes health issues which can contribute to feelings of tiredness, fatigue and low mood. Without action, these problems are only going to get worse. That's why it's so important for all of us to re-think the way we live indoors. From individuals to architects, from companies to governments, we all have a responsibility to do everything we can to make sure our buildings have a healthy environment. We have to start building differently, and we have to start living differently. Some solutions are simple, some more demanding, and some require fundamental changes in society.
We need an ambitious legislative framework to meet climate neutrality by 2050 but also to change the way we look at buildings today – moving beyond energy performance, to climate, environment and health. Glass and windows, used right, is one of the key enablers to achieve this goal.

Keywords: sustainable buildings, healthy buildings, climate neutrality

MATTHIAS MÜLLER
Executive Vice President R&D, Schott AG, Germany

Session	**PLENARY**
Date	**NOVEMBER 17, 2022, THURSDAY**
Time	**11:50 - 12:30 (Istanbul time, CET +02:00)**
Chair	**DR. İLKAY SÖKMEN**

The Future of Glass and New Glass Trends

Biography

Dr. Matthias Müller – Executive Vice President R&D and New Ventures, SCHOTT AG. As Material Scientist by education, he has over two decades of expertise in the specialty glass and materials industry, including experience in the field of semiconductors, solar, optical crystals and wafer technology, as well as general management and business responsibility. Today, he and his team are providing SCHOTT with new technologies, products, and businesses.

Abstract

For thousands of years, glass has accompanied humanity and contributed to society's achievements. The invention of specialty glass by Otto Schott led to the development of groundbreaking tools, including microscopes and telescopes, allowing humans to see the world differently through glass lenses.

Today, as it remains one of the most versatile materials, specialty glass is being applied to various industries, including health and life science, astronomy, energy, and automotive, enabling significant scientific and technological advancements.

Specialty glass is currently being utilized in the latest medical devices and diagnostics. This material also has the potential to support new energy sources and provide more sustainable solutions. For example, it has the capability to advance solid-state batteries for electric vehicles or contribute to new energy sources using hydrogen technology or nuclear fusion.

While specialty glass is key in finding more climate-neutral solutions, the glass industry is also taking responsibility for reducing its carbon footprint: As an energy-intensive company, SCHOTT is committed to becoming climate neutral by 2030.

Keywords: speciality glasses, sustainability, carbon foot-print, climate neutrality

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INVITED SPEAKERS

PASKAL BUSKENS

Professor Nanostructured Materials

TNO, The Netherlands

Pascal Buskens (1980) studied chemistry at RWTH Aachen University and received his PhD for research on the reaction mechanism and the development of novel catalyst systems for a C-C coupling reaction yielding allylic amines, part of which he performed at Oxford University. In 2006, he started working for DSM, first as project manager and later as R&D program manager in the functional coatings group. During this time, Pascal and his team successfully developed and commercialized antireflective coatings for glass covers of solar panels, which improve transmission of sunlight into the panel and result in an increased power output. In 2011, Pascal started working at TNO – The Netherlands Organisation for Applied Scientific Research, where he is currently principal scientist. In 2016, he received his habilitation from RWTH Aachen University for his research and teaching activities in the field of 'Nanostructured Optical Materials'. Since 2017, he combines his work at TNO with a guest professorship at Hasselt University in the Department of Chemistry. His current research interests are nanostructured optical coatings for energy efficient windows and solar panels, and nanomaterials and coatings for sunlight-powered chemical processes.

MARCUS FRANK

Head of R&D and Product Management, Large Area Coating Glass

Bühler Leybold Optics Alzenau GmbH, Germany

Marcus Frank studied physics in Erlangen, Germany and was introduced to physics of optical interference coatings while working for his PhD at the Fraunhofer Institute for Applied Optics and Precision Engineering in Jena, Germany. Subsequently he was internationally active for multiple employers in the field of large area coatings designing and developing coating products and processes for the architectural and automotive markets. Since 2018 he is responsible for product management and R&D in the Market Segment Glass at Bühler Leybold Optics Alzenau in Germany.

ASTON FULLER

General Manager

Glass Futures Ltd., United Kingdom

Aston is the General Manager of Glass Futures. He is responsible for the day-to-day running of Glass Futures and to ensure that the activities carried out across the Glass Futures programmes align with industry trends, technology, and direction.
Aston has worked in the glass industry for over 10 years. He spent 8 years with Ardagh Glass, gaining experience in furnace management, operation, maintenance and capital construction, wider plant engineering and energy management before working with British Glass and GTS on wider cullet recycling research projects, prior to joining Glass Futures.
With a keen interest in entrepreneurship and innovation, especially in relation to sustainability, Aston has over the past few years developed a passion for driving change in sustainable engineering, manufacturing and in helping open knowledge of the glass industry to a younger generation of engineers.

CENK KOÇER

VIG Principal Researcher

University of Sydney, Australia

Dr. Cenk Kocer is a research scientist with over 30 years' experience working at various research institutions around the world. He received his PhD in Physics, from the University of Sydney, in 1998. He is now lead scientist of the Vacuum Insulated Glazing (VIG) research group at the University of Sydney. His group were the original inventors of the VIG design that was commercialised in the mid-1990's. He has worked with most of the past, and current, industry groups that are developing VIG products. He has numerous publications and patents in the VIG space and works with all stakeholders to provide access to the knowledge base to educate those interested in the VIG technology. His lab facility is unique in the world since it provides the means to prototype, test, and perform numerical simulations, on most, if not all, VIG designs. His goal is to highlight the critical impact that VIG will make to the sustainability and comfort of our future homes and offices.

N. M. ANOOP KRISHNAN

Department of Civil Engineering, Yardi School of Artificial Intelligence (Joint Appt.)

Indian Institute of Technology Delhi, India

Anoop completed his Ph.D. in Civil Engineering from Indian Institute of Science Bangalore in 2015, after which, he worked as a postdoctoral researcher in University of California Los Angeles from 2015 to 2017. Prior to this, he completed his B.Tech in Civil Engineering from National Institute of Technology Calicut in 2009. In October 2017, he joined IIT Delhi in the Department of Civil Engineering, where he is currently serving as an Associate Professor and heads the M3RG. He also holds a joint position as an Assistant Professor in the School of Artificial Intelligence, IIT Delhi. He has published more than 80 international peer-reviewed journal publications and has filed 3 patents. He has founded a start-up Substantial AI Pvt. Ltd., incubated at IIT Delhi, for AI-driven materials discovery and process optimisation. He has won several awards including Indian National Academy of Engineering Young Engineer Award (INAE YAE 2020), BRNS-DAE Young Scientist Award (2021), and National Academy of Science India Young Scientist Award (NASI YSA 2021), to name a few.

SERENA PANIGHELLO

Senior Scientist/SG Lab Analytics

Stevanato Group S.p.A., Italy

Serena Panighello is a research scientist at EMEA Technology Excellence Center, Stevanato Group. Her role is mainly related to the study of glass corrosion mechanisms and container-drug interaction consultancy. She is involved on the advanced analytical services that TEC Lab offers to the Pharma customers to understand the containers properties and performances with respect to the customer needs and to mitigate and reduce the risk of interaction of containers with the drugs. She earned a PhD in Chemical Sciences at Ca' Foscari University of Venice (Italy) within a joint research program with the National Institute of Chemistry, Ljubljana (Slovenia). During the PhD she was awarded with the Paul Award for the best presentation at the New Researchers Forum during the SGT (Society of Glass Technology) annual Conference in Durham (UK).

M. PINAR MENGÜÇ

FYE Professor and the Director of Center for Energy, Environment and Economy (CEEE)

Özyeğin University, Türkiye

Professor M. Pinar Mengüç received his BS and MS from ODTU/METU in Ankara, Turkey, and his PhD from Purdue University, USA in 1985, all in Mechanical Engineering. The same year he joined the University of Kentucky, Lexington, KY and became a full professor in 1993. He was a visiting professor at Università degli Studi di Napoli Federico II, Italy during 1991; at Harvard University, Cambridge, Massachusetts, during 1998-99 academic year, and at the University of California, Los Angeles during the first half of 2022.
At the end of 2008, he was promoted to Engineering Alumni Association Chair Professor at the University of Kentucky, a title which he still holds. He has six patents and the author of more than 160 articles published in SCI journals, has co-authored more than 220 conference papers and two books. He has worked with more than 65 MS, PhD and Post-Doc researchers, and had more than 135 invited/keynote lectures delivered. He joined Özyeğin University, Istanbul in 2009 as the founding Head of Mechanical Engineering. The same year, he established the Centre for Energy, Environment and Economy (CEEE/EÇEM), which he is still directing.
His research areas include radiative transfer, nano-scale transport phenomena, applied optics and sustainable energy applications. He is an elected member of Science Academy of Turkey, a fellow of both ASME (American Society of Mechanical Engineering) and ICHMT (International Center for Heat and Mass Transfer), and a Senior Member of OSA (Optical Society of America). He is in the executive committees of several NGO, including ICHMT and Science Academy. He is one of the Editors-in-Chief Journal of Quantitative Spectroscopy and Radiative Transfer (JQSRT). Mengüç has received several recognitions, including the 2018 ASME Heat Transfer Memorial Award and the 2020 Purdue Outstanding Mechanical Engineering Award, and several other awards with his CEEE/EÇEM research group in Istanbul.

TOMEK RYGALIK

Product Designer

Studio Rygalik, Poland

Lead designer at Studio Rygalik working on architecture and products for premium companies and international brands including Cappellini, Moroso, Ghidini, Siemens, Heineken, or Ikea. An open-minded educator with broad experience and PhD in industrial design; professor at Aalto University. Founder and creative director of furniture and accessories brand TRE Product; cofounder of the interdisciplinary community DesignNature and the creative campus in Sobole.

MORTEN MATTRUP SMEDSKJÆR

Department of Chemistry and Bioscience

Aalborg University, Aalborg, Denmark

Morten M. Smedskjaer is Professor in the Department of Chemistry and Bioscience at Aalborg University, Denmark and head of the Glass Structure and Mechanics Group. He received his PhD degree in materials chemistry from the same university in 2011 and worked as a research scientist at Corning Inc. from 2011 to 2012. His current research focuses on the structure and mechanical properties of disordered materials. He has five granted patents and over 200 journal articles. He received an ERC Consolidator Grant in 2022 and is a fellow of both the Danish Academy of Technical Sciences and the Danish Academy of Natural Sciences. His awards include Vittorio Gottardi Prize, Sir Alastair Pilkington Award, Grundfos Prize, and Best PhD Award from the Danish Academy of Natural Sciences.

STEPHEN WHETTINGSTEEL

CEO & Managing Director

Krysteline Technologies Ltd, United Kingdom

Steve Whettingsteel is founder and CEO of Krysteline Technologies Ltd, developer of specialised engineered solutions for the waste management sector, particularly in the recovery and refinement of glass. In the 1990s Steve was working as a marine engineer on cruise ships, there was an urgent need to change and develop the way glass recycling was being handled onboard. This led to him developing "glass implosion", the unique, patented technology behind Krysteline's machinery. Since its formation in 1999 Krysteline has been exporting, with machines being sold around the world. Early customers including the British Antarctic Survey, a laboratory in the Falkland Islands, super yachts, hotels and pharmaceutical companies. Fast forward 20+ years and thanks to years of ongoing investment in research and development Krysteline has also developed an enviable reputation for high quality refined glass suitable for cullet, cement, foam glass, fertilizers, water filtration and expendable abrasives.

SELÇUK YERCİ

Vice President & EmPV division coordinator, ODTU-GUNAM

Electrical-Electronics Eng., Middle East Technical Univ., Türkiye

Dr. Selçuk Yerci received his B.S. and M.S. in physics from Middle East Technical University (METU) and Ph.D. in electrical engineering from Boston Univ. His M.S. and Ph.D. research were mainly focused on silicon photonics, in particular silicon-compatible light sources. After his Ph.D., he worked as a post-doctoral associate at the Massachusetts Institute of Technology on thin-film crystalline silicon solar cells. Dr. Yerci is currently an Assoc. Prof. in Electrical-Electronics Engineering and Micro and Nanotechnology at METU. He continues his research activities in the Center for Solar Energy Research and Applications (ODTU-GUNAM), where he is serving as the coordinator of emerging photovoltaics divisions. His recent research is focused on high-efficiency solar cells including material growth, device simulation, and device fabrication aspects. Dr. Yerci has authored/co-authored over 50 articles and holds an h-index of 22 according to WOS. Dr. Yerci received the Young Researcher Awards from the Turkish Academy of Science in 2017, Parlar Foundation in 2019, and Science Academy in 2020, and Incentive Award from TUBITAK in 2021.

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ORAL PRESENTATIONS

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ADVANCED TECHNOLOGY MATERIALS

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MAJOR SPONSOR

(Invited Speaker)
SELÇUK YERCİ
Vice President & EmPV Division Coordinator, ODTU-GUNAM
Electrical-Electronics Eng., Middle East Technical Univ., Türkiye

Session	**ADVANCED TECHNOLOGY MATERIALS (I)**
Date	**NOVEMBER 17, 2022, THURSDAY**
Time	**15:40 - 16:10** **(Istanbul time, CET +02:00)**
Chair	**HALUK ERDEM**

Empowering Photovoltaics via Smart Light Management Technologies

Abstract

A rapid shift from climate-damaging fossil fuels to clean, environmentally benign, sustainable, and renewable forms of energy is inevitable. Photovoltaics with its high-power capacity and adaptability to urban areas is expected to play a major in this transition. The steady rise of PV is expected to continue, yet its pace depends on several developments; some are inherent to the PV technology.

This plenary talk will first introduce advancements in the mainstream (viz, Si and CdTe) and emerging (perovskite, tandem, organic, etc.) PV technologies. Then, non-utility applications of PV such as Agriculture-, Building-, Vehicle-, Road-integrated, and floating PV will be discussed. A perspective on functionalization of glass to empower PV-based green energy transition such as anti-reflection, anti-dust, hydrophobic, color-filtered and luminescent will be presented. Finally, I will review the research done in ODTU-GUNAM along these directions.

Keywords: photovoltaics, thin film deposition, anti-reflection, emerging solar technologies, luminescent solar concentration

Feyza Nur Yıldırım[1], Mithila Achintha[2]
[1]University of Southampton, United Kingdom
[2]The University of Manchester, United Kingdom

Session	**ADVANCED TECHNOLOGY MATERIALS (I)**
Date	**NOVEMBER 17, 2022, THURSDAY**
Time	**16:10 - 16:40 (Istanbul time, CET +02:00)**
Chair	**HALUK ERDEM**

A Novel Glass Sandwich Structure by Vacuum Infusion Process

Abstract

Combining glass with various reinforcing materials, such as externally-bonded Glass Fibre Reinforced Polymer (GFRP), steel and timber, is used to mitigate the brittle failure behaviour of glass in civil engineering (i.e., construction) applications. The current paper presents the development of an experimental proof of concept validation using the Vacuum Infusion Process (VIP) of a novel Glass-GFRP sandwich for the civil engineering industry. The Glass–GFRP structural sandwich specimens were fabricated by combining two glass skins (top and bottom glass sheets) with a three-dimensional GFRP core. In the present work, a low-viscosity acrylic resin was used to infuse the lightweight and translucent 3D GFRP and to connect the core with the relatively thin two annealed glass sheets in a single VIP operation step. The paper shows that VIP process can be used to fabricate translucent Glass–GFRP sandwich by ensuring uniform resin wetting and avoiding the accumulation of resin. The paper shows that how a novel approach was developed for positioning and layering peel ply and the infusion mesh on two sides of the mould area. The Glass–GFRP sandwich specimens infused in this study confirm the feasibility of fabricating the proposed novel Glass–GFRP sandwich. The paper shows that by choosing appropriate combinations of temperature, humidity, and the correct ratio of mixed acrylic resin, infusion pressure in a closed mould VIP process can be used to make a practically useful Glass–GFRP sandwich. The load tests of the new Glass–GFRP sandwich specimens showed that the sandwich specimens ensured higher load capacity, flexural stiffness and post-cracked load resistance compared to equivalent thickness laminated glass commercially available in the market.

Keywords: GFRP, GFRP core, glass, sandwich, vacuum infusion process (VIP)

Ayşe Begüm Cura[1], Göksenin Çömlekçi[2]
Gülşah Kahraman[2], Mustafa Göçmentürk[3]
[1] Frimpeks, Türkiye
[2]Şişecam, Science, Technology and Design Center, Türkiye
[3]Şişecam Fiber Glass Balıkesir Plant, Türkiye

Session	ADVANCED TECHNOLOGY MATERIALS (I)
Date	NOVEMBER 17, 2022, THURSDAY
Time	16:30 - 16:50 (Istanbul time, CET +02:00)
Chair	HALUK ERDEM

Polyurethane Dispersion for Glass Fiber Sizing

Abstract
Glass fiber, in both continuous and discontinuous forms, provides a variety of options in people's modern lives, including vehicle and transportation, renewable energy, construction, chemical industry, electronics, consumer products, and so on. As an inherent component of composites, glass fibers are employed as reinforcements for organic matrices. Fiber sizing applied on the pristine glass fiber is the most crucial component involved in the production of glass fibers and their composites. In other words, in the case of glass fibers, sizing has a considerable impact on the success or failure of most reinforcement products and their composites. This is because sizing has a significant role in the processability and performance of that product. The film former and the coupling agent are the two main components of the sizing system. The film former is intended to protect and lubricate the fibers and hold them together prior to composite processing, while simultaneously promoting separation when in contact with resin, assuring complete wet-out of all filaments. Film formers are frequently the bulk of the material in a size formulation. Film formers are chosen to be as near to the required polymer matrix as possible while still meeting all of the other sizing requirements. As a result, the usual film former material range reflects the composite matrix material range. Polyvinyl acetates, polyurethanes, polyolefins, polyesters and epoxies are some of the most often used film formers. Herein, the focus is on polyurethane emulsion dispersions (PUD) used in glass fiber products used in thermoplastic composite applications. Emulsion dispersion technology allows many of the high molecular weight and water insoluble materials to be applied to glass fiber surfaces. In the study, not only the synthesis and characterization of PUD materials but also their compatibility with the binder system and the effect on the mechanical strength of the composites were evaluated.

Keywords: glass fiber, sizing, film former, PUD, isocyanate, glycol

Berk Alkan, Canhan Şen Omid Moradi
Teta Glass Technologies, Türkiye

Session	**ADVANCED TECHNOLOGY MATERIALS (I)**
Date	**NOVEMBER 17, 2022, THURSDAY**
Time	**16:50 - 17:10 (Istanbul time, CET +02:00)**
Chair	**HALUK ERDEM**

New Trends in Smart Glass Technologies for Prospective Applications

Abstract

Smart glass technologies are the product of materials science-based research that has improved its market in the most recent decades. The growing interest in this research area is mainly due to the increasing demand for effective usage of glass surfaces in exterior and interior facades and thus, demand for “smart surfaces” in architectural areas by the introduction of smart home systems. The basic expectations in the field are active and passive dynamic daylight spectrum control, privacy preservation, adjustment of the light transmittance, and thereby the contribution of these activities to energy efficiency apart from aesthetic expectations. As stated in many reports, the crucial prospect of smart glass is to minimize the energy consumption of ambient air conditioning/heating as well as indoor lighting, while over % 35 loss through. PDLC, an active smart film, by controlling the liquid crystal polarizability via electric charge brings the glass and glass-like surfaces dynamic visible light and additionally IR and UV control. PDLC smart films are in the opaque state when the applied voltage is zero. Upon non-zero voltage values, liquid-crystal (LC) droplets start to align parallel to the electric field up to the saturation point where all the available liquid crystal droplets fully polarize. Here, we focus on reviewing the emerging liquid crystal-based smart film technology from various perspectives. We pinpoint its technical limitations and advantages by categorizing it on the basis of optics, and electro-optics, so far. Given that, the most recent research and development activities to overcome current drawbacks will be exhibited comprehensively in this context. In light of this information, apart from next-generation architectural applications, and marketing strategies, new areas of usage such as agriculture, energy, and other available industries for liquid crystal-based tunable windows will be discussed.

Keywords: smart glass, polymer dispersed liquid crystal, PDLC, liquid crystals, functional coatings, electrically switchable glass

Md Kawsar Ahmed[1], Ali Bagheri Behboud[1], Arda Kurucu[1], Göksenin Çömlekçi[2], Mustafa Ordu[1]
[1]*Bilkent University, Türkiye*
[2]*Şişecam, Şişecam Science, Technology and Design Center, Türkiye*

Session	**ADVANCED TECHNOLOGY MATERIALS (I)**
Date	**NOVEMBER 17, 2022, THURSDAY**
Time	**17:10 - 17:30 (Istanbul time, CET +02:00)**
Chair	**HALUK ERDEM**

Nanoparticle Coated Glass Fibers for Improved Mechanical Properties

Abstract
Glass fibers are widely used as reinforcement material in fiber-based composites owing to their excellent mechanical performance, lightweight and cost-effectiveness. Mechanical properties of glass fibers are closely related to the surface flaw, structural defects, and impurities, and microcracks have been identified as one of the main causes of glass fiber failure. In our study, we investigated the mechanical properties of E-glass fibers by coating the surface of glass fibers with varying types and concentrations of nanoparticle coating. As a part of this process, dip-coating was utilized to coat the surface of E-glass fibers by nanoparticles solutions. Microscopic and spectroscopic analysis proved the presence of nanoparticles on the surface of glass fiber. Furthermore, tensile tests were performed on coated and uncoated fibers to compare the effects of nanoparticles as well as the concentration of nanoparticles on the mechanical properties of glass fiber. Our results demonstrate that, glass fibers coated with nanoparticle solutions enhanced the tensile strength of the fiber up to 11.7% with lower probability of failure compared with uncoated fibers.

Keywords: glass fibers, nanoparticle coating, tensile test, mechanical properties

Notes: The project has been performed with Atmospheric Coating Technologies Division of Şişecam under the TUBITAK 1004 (project #20AG001) program.

(Invited Speaker)
SERENA PANIGHELLO
Senior Scientist/SG Lab Analytics,
Stevanato Group S.p.A., Italy

Session	**ADVANCED TECHNOLOGY MATERIALS (II)**
Date	**NOVEMBER 18, 2022, FRIDAY**
Time	**10:00 - 10:30 (Istanbul time, CET +02:00)**
Chair	**DR. ARCA İYİEL ORHAN**

Glass Quality: Factors That Affect Surface Chemistry in Glass Conversion to Vials

Abstract

During the forming process of a vial from glass tube, temperatures of up to 1200°C are applied to adjust the glass viscosity. This process has a significant impact since the percentage of some elements measured on the inner surface of the vial can be higher than that measured on the corresponding glass tube.

Highly sensitive surface analytical techniques provide information on the outer glass container layer and they can help to understand mechanism/process and kinetic events that can occur during the shelf life of a pharma product.

Basic research on glass surface chemistry can be very helpful in developing knowledge and understanding that could feed into industry “Quality by Design” approaches. It is the surface, the outermost layer of a solid material that really defines the physico-chemical behavior of a container.

Keywords: vials, pharmaceutical containers, surface chemistry, corrosion

Taygun Akar[1], İlkay Sökmen[1], Ezgi Biçer[1], Tuncay Turutoğlu[1], Semin Canbazoğlu[1], Pınar Mercan[1], Hargun Singh Grover[2]
[1]Şişecam Science, Technology and Design Center, Türkiye
[2]Substantial Artificial Intelligence Pvt. Ltd., India

Session	**ADVANCED TECHNOLOGY MATERIALS (II)**
Date	**NOVEMBER 18, 2022, FRIDAY**
Time	**10:30 - 10:50 (Istanbul time, CET +02:00)**
Chair	**DR. ARCA İYİEL ORHAN**

Pharma Packaging: Re-Explore the Known, Designing Today's Hit with a New Perspective

Abstract

High chemical resistance, mechanical strength and hermeticity makes glasses an ideal material for pharmaceutical packaging. New glass package solutions should have higher hydrolytic resistance, delamination resistance, lower drug-to-container interactions and they should be storable in very low temperatures.

Although recent research studies have focused mainly on Type I borosilicate glass compositions, studies on optimizing Type II and Type III glass compositions are still of interest. Type II glass is a modified Type III soda lime silicate glass with high hydrolytic strength thanks to the dealkalization of glass surface resulting from the treatment of its inner surface with sulphur-containing gas. In this presentation, the characterization studies of Type II and Type III glass product properties with enhanced performance produced by Şişecam and research studies on the development of Type I glass composition with advanced properties will be presented.

The hydrolytic durability performance of Type II and Type III glass compositions according to international standard, as well as surface composition and surface structure modification were evaluated with a sensitive X-ray Photoelectron Spectroscopy depth profile technique and Fourier Transform Infrared Spectroscopy, respectively. In addition, studies on laboratory scale production of Type I glass composition with the desired combination of properties designed by using data-based prediction models will be presented.

Keywords: pharmaceutical packaging, vials, type 1, type 2, type 3, pharmaceutical glass containers, neutral borosilicate glass

Utku Ekim[1], Naji Vahedigharehchopogh[1], Orhan Kıbrıslı[1], Petr Kostka[2], Miray Çelikbilek Ersundu[1], Ali Erçin Ersundu[1]
[1]Yıldız Technical University, Türkiye
[2]Inst. of Rock Structure and Mech. of the Czech Academy of Sciences, Czech Republic

Session	**ADVANCED TECHNOLOGY MATERIALS (II)**
Date	**NOVEMBER 18, 2022, FRIDAY**
Time	**10:50 - 11:10 (Istanbul time, CET +02:00)**
Chair	**DR. ARCA İYİEL ORHAN**

Laser Irradiated Lanthanides-Doped Tellurite Glasses for Volumetric Display Applications

Abstract
A concept of a laser-based volumetric display has been recently developed to tackle the shortcomings of 2D screens. However, none of the proposed screen materials have so far met the criteria needed for a successful volumetric display. Herein, tellurite glasses can be seen as promising materials for photonic applications in visible and infrared region because of their unique set of physico-chemical properties including high optical transmittance in a large transmission window, high chemical durability and thermal stability, ease of large-scale production, high lanthanide ions solubility and low phonon energy enabling enhancement of up-conversion processes. We recently discovered that red, green and blue emissions as main color components can be obtained via frequency modulation of a 980 nm laser excitation source in a specially designed tellurite glass composition. This phenomenon opens the way for use of these glasses in volumetric display applications. In this work, various rare earth ions are incorporated into a highly stable Li_2O-WO_3-TeO_2 glass matrix to achieve full-color tunable emission by excitation modulated photoluminescence measurements via changing power density, pulse width and frequency parameters. Finally, a concept of the display system is tested by visualizing simple shapes such as a cross, circle, and lissajous figures via scanning a 3.0 cm^3 lanthanides-doped glass cube via dual-axis galvanometer and 980 nm NIR laser setup. The dimensions of such figures are successfully controlled/changed by modifying the flickering speed of the galvanometer's mirrors.

Keywords: tellurite glass, volumetric display, lanthanides, photoluminescence

Shahla Golghasemi Sorkhabi, Onur Tokel
Bilkent University UNAM, Türkiye

Session	**ADVANCED TECHNOLOGY MATERIALS (II)**
Date	**NOVEMBER 18, 2022, FRIDAY**
Time	**11:10 - 11:30 (Istanbul time, CET +02:00)**
Chair	**DR. ARCA İYİEL ORHAN**

Ultrafast-Laser-Writing of Buried Microchannels Inside Silicate Glass Towards Screen-Based Applications

Abstract

With its high chemical resistivity, mechanical strength, and very good refractory properties, silicate glass is an emerging optical material, with diverse applications in industrial, commercial, and consumer applications. The material offers superior impact protection and scratch resistance; thus, it is established as the fundamental material for fabricating screens of smart phones and tablets. Here, for the first time, we report a novel ultrafast laser lithography approach to create fully-opened microchannels at any desired position and depth inside silicate glass (fig.1).

We create high-aspect-ratio microchannels with various architectures inside the material without damaging the glass surface, and with very high control and repeatability. The method consists of a two-step process; (i) ultrafast laser writing and (ii) selective chemical etching. First; the ultrafast laser pulses from a Ti:sapphire laser of 800 nm wavelength and pulse width of 150 fs is focused into the glass, and energy delivery is optimized over scanning speed, acceleration, and direction parameters. In the second step, a novel highly-selective recipe is developed, based on Sodium Hydroxide (NaOH). This allows to remove the modified areas without altering the unmodified parts. Thus, we demonstrate fully-opened microchannels with aspect-ratio of > 100 inside silicate glass. Individual channels are of feature size of 15 17 µm (Fig. 1b). Further, these can be written in array patterns inside silicate, with dimensions of 1 mm 1 mm 1 mm (Fig. 1c). We believe this new laser lithography capability has significant potential towards various touch-screen display applications and smart phone sensors.

Keywords: ultrafast laser writing, microchannel, silicate, selective chemical etching

Owen McGann, Katrina Skerratt Love
Glass Technology Services Ltd, United Kingdom

Session	**ADVANCED TECHNOLOGY MATERIALS (II)**
Date	**NOVEMBER 18, 2022, FRIDAY**
Time	**11:30 - 11:50 (Istanbul time, CET +02:00)**
Chair	**DR. ARCA İYİEL ORHAN**

Optimising Photonic Glass Material for Resistance to High Energy Photon Radiation

Abstract

Radiation interactions with optical and photonic glass materials continue to be an area of significance due to the use of such materials in applications where they are deliberately, or through use, exposed to high energy electro-magnetic radiation (e.g. satellite components, fiber Bragg gratings etc.). This work explored the impact of X-ray radiation on a range of phosphate glass compositions containing varying levels of the lanthanides Er, Yb and Ce and the transition metal Mn, with the goal of identifying routes to minimise the impact of radiation. The resultant radiation effected glasses were studied under UV/Vis, FT-IR and EPR spectroscopy, in order to characterize the defects generated in each glass and their effects on the optical properties, photonic properties and network connectivity of the materials. Results demonstrated that the defects interacted with all three of the lanthanide species investigated. The presence of Ce resulted in the suppression of defect formation. This effect was attributed to the impact of Ce3+/Ce4+ redox pairs quenching radiation generated e- and h+, through a mechanism similar to that previously seen in glasses containing Fe. This apparent change in Ce oxidation state, alongside the changes seen in Yb and Er following radiation exposure, were shown to be deleterious to any photonic materials containing these elements. Results for the exposure of glasses containing Mn to radiation suggested that Mn also acted to suppresses defect formation through a similar mechanism to that seen for Ce, through the action of Mn^{2+}/Mn^{3+} redox pairs. Through producing glasses combining Ce and Mn content it was shown that adding Mn alongside Ce was effective at minimising the impact of radiation induced defects on the oxidation state of Ce. As such the addition of Mn potentially offers a route by which the deleterious effects of radiation on the overall lanthanide content of photonic glasses may be minimised.

Keywords: photonics, photonic glass, erbium ytterbium phosphate glass, radiation, high energy photons, radiation resisitance, cerium, erbium, ytterbium, manganese, EPR, EPR spectroscopy, Er, Yb, Ce, phosphate, X-ray radiation, X-ray

Mithila Achintha
The University of Manchester, United Kingdom

Session	**ADVANCED TECHNOLOGY MATERIALS (II)**
Date	**NOVEMBER 18, 2022, FRIDAY**
Time	**11:50 - 12:10 (Istanbul time, CET +02:00)**
Chair	**DR. ARCA İYİEL ORHAN**

Exploration of Enhanced Structural Performance of Annealed Glass through Innovative Combinations with GFRP

Abstract

The present paper shows that Glass Fibre Reinforced Polymer (FRP) can be used to enhance the load capacity and to prevent the brittle failure of annealed glass elements. The low tensile strength of annealed glass (~40 MPa) means that their use in buildings is limited to non-load bearing and non-structural applications such as windows panes. Due to the brittle material behaviour of glass, load resistance of a given glass member is governed by the stress state at the most highly stressed location at where the failures are usually triggered. The results of the present study show that the use of GFRP as an externally-bonded reinforcement or as an interlayer material in the vicinity of the most highly stressed location in annealed glass prevents instantaneous propagation of major cracks causing brittle failure. The results show that the delay in the failure of GFRP-enhanced regions of annealed glass result in development of many cracks prior to the ultimate failure. Consequently, the glass member show a higher load capacity and a delayed (i.e. ductile) failure compared to the respective equivalent annealed glass members those without the GFRP enhancement. Furthermore, given GFRP is a structural material, it ensures a notable load resistance even after the glass has significantly cracked. In the present paper, the increased load capacity and the ductile failure of the GFRP-enhanced annealed glass elements are demonstrated using both experimental and computational investigations involving a number of real-life examples, such as glass beams, glass panels and stress concentration features – e.g. drilled holes in glass and glass–bolted joints.

Keywords: annealed glass, ductile failure, GFRP, glass, load resistance

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MAJOR SPONSOR

(Invited Speaker)
N. M. ANOOP KRISHNAN
Department of Civil Engineering,
Yardi School of Artificial Intelligence (Joint Appt.)
Indian Institute of Technology Delhi, India

Session	**DIGITALIZATION, MATERIALS MODELING AND SIMULATION**
Date	**NOVEMBER 18, 2022, FRIDAY**
Time	**13:10 - 13:40** **(Istanbul time, CET +02:00)**
Chair	**DR. ADNAN KARADAĞ**

Accelerating Glass Modeling with Machine Learning and Artificial Intelligence

Abstract

Glasses form the backbone of our society, ranging from windshields and display screens to biomedical devices and lenses. Traditional glass discovery relies on trial-and-error approaches thereby leading to a design to deploy period of 20-30 years. To address this challenge, in this talk, we will discuss the application of artificial intelligence (AI) and machine learning (ML) in accelerating glass modeling and discovery. Specifically, three aspects where AI and ML can be used include: (i) data-driven models for glass property predictions, (ii) natural language processing (NLP) for extracting information from the glass literature, (iii) physics-informed machine learning for glass modeling. To demonstrate these aspects, three problems will be discussed. First focuses on developing interpretable ML models for predicting 25 properties of glasses made of a few among 84 elements of the periodic table. This work covers nearly the entire periodic table for glass forming elements. Second focuses on extracting information on glasses and other materials from literature to answer specific queries. We will also discuss on MatSciBERT, the first materials-aware language model. We will also discuss how MatSciBERT can be used to extract information regarding composition-property from the glass literature. Third, we will discuss on how to accelerate simulations using physics-informed ML (PIML). Here, we will discuss how interaction laws in nature can be discovered directly from the trajectory of physical systems using PIML. Altogether, the talk will cover various aspects of AI and ML that has been used to accelerate materials discovery. Finally, a brief outlook on the future prospects will be discussed.

Keywords: artificial intelligence, machine learning, glass modeling, glass propertiess

Engin Deniz Canbaz
Şişecam Science, Technology and Design Center, Türkiye

Session	**DIGITALIZATION, MATERIALS MODELING AND SIMULATION**
Date	**NOVEMBER 18, 2022, FRIDAY**
Time	**13:40 - 14:00 (Istanbul time, CET +02:00)**
Chair	**DR. ADNAN KARADAĞ**

How Do We Start the Decarbonization Journey to Achieve a Sustainable Solution in the World Of Glass

Abstract
Fining is a crucial part of the glass melting process that aims to remove bubbles resulting from batch conversion reactions. There are several approaches for an efficient fining process. Chemical approach uses fining agents that releases gas at higher temperatures to increase volume of the existing bubbles which in result, increases rising velocity of the bubbles. Furnace design also helps the fining process. Weirs, deep refiners, or shallow zones in a furnace can alter the glass currents and achieve bubble removal by escape through surface or gas dissolution in glass melt. In this study, refining shelf concept, which is a shallow zone that intents to reduce the bubble ascension time, is parametrically simulated using CFD methods. Eulerian-Eulerian multiphase model was used for glass melt and bubble flow and effect of the shelf height and length on bubble removal from the melt surface was investigated. Initial furnace design consisted of a glass bath with flat bottom. Then, the design was modified with weirs, a shelf, and finally a deep refiner. Temperature distribution, glass currents, and bubble phase removal for each case were compared and it showed that refining shelf concept significantly enhances the fining quality.

Keywords: refining shelf, fining, multiphase model, furnace design

Neil Simpson[1], Philippe Kerbois[2]
[1]Simpson Combustion and Energy Ltd, United Kingdom
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Session	**DIGITALIZATION, MATERIALS MODELING AND SIMULATION**
Date	**NOVEMBER 18, 2022, FRIDAY**
Time	**14:00 - 14:20 (Istanbul time, CET +02:00)**
Chair	**DR. ADNAN KARADAĞ**

Multiphase CFD Modeling of Bubble Removal on Refining Shelf in a Glass Furnace

Abstract
The goal/destination in some geographies may be known, however, the key to any journey is being able to establish your starting point. If incorrect, then you may take the wrong path and never achieve anything! Recent Container and Float glass case studies shows how Near Infrared in-furnace thermal imaging surveys can show you where you are currently and the output is more than a pretty picture, which is best interpreted as a CFD model and so can validate a digital twin. It is typical to initially establish if the furnace thermal profile is optimized for the furnace design. In parallel, identify any refractory hot/cold spots and inspect top of the regenerators. By utilizing the patented reflection method, it's possible to show that the "mirror" is in fact a micro layer of foam which is insulating the heat transfer to the glass. Suppressing the foam has saved energy costs up to six figures. By sealing the holes and reducing the parasitic air, can save 3-5% reduction in energy plus a corresponding reduction in CO^2! Start with the low-hanging fruit, validate models, and define a path from a known starting point. Destinations may change, but at least you know where you started!

Keywords: decarbonisation, float glass, container glass, surveys, thermal profile

Gönenç Can Altun, Oğuzhan Aşık, Altuğ Başol, Mustafa Pınar Mengüç
Özyeğin University, Türkiye

Session	**DIGITALIZATION, MATERIALS MODELING AND SIMULATION**
Date	**NOVEMBER 18, 2022, FRIDAY**
Time	**14:20 - 14:40 (Istanbul time, CET +02:00)**
Chair	**DR. ADNAN KARADAĞ**

Numerical Investigation of the Heating Zone of a Container Glass Annealing Furnace: Effect of Bottle Layout inside the Furnace on the Heating Effectiveness of the Furnace

Abstract
Annealing is a type of heat treatment process that is widely used in glass manufacturing. It serves for the elimination of the residual thermal stresses which result from the nonuniform cooling of glass during and immediately after the forming stage. In container glass manufacturing annealing process is carried out in continuous annealing furnaces. Continuous furnaces are divided into different zones which are thermally conditioned according to the requirements of the process. The heating zone of the furnace is positioned at the very upstream of the furnace where the incoming glassware into the furnace is heated up to the annealing temperature of glass. In this zone the heat is transferred to the glass surface predominantly by thermal radiation. However, convective heating also plays a considerable role. The effectiveness of the radiative and convective heating is highly important for the energy efficiency of the process. In this study the heating process inside a 3m long heating zone of an industrial-scale container glass annealing furnace is numerically simulated. The inhouse developed numerical solver calculates the transient heating of continuously moving row of bottles that are subjected to radiative heating from the furnace walls and as well as from the neighboring bottles. The convective heating effect is introduced as convective boundary condition. First, the uniformity of the heating pattern of the bottles due to radiative and convective heating mechanisms is discussed in detail. Next, the effect of the spacing between the bottle rows on the heating effectiveness was investigated. In this regard, the spacing between the bottle rows and the conveyor speed have been altered in a way that the throughput of the furnace, the number bottles processed per unit time, is kept constant. The study shows that there is an optimum spacing value between the bottle rows. For the particular bottle geometry considered in this study, the optimum row spacing value is found.

Keywords: annealing, continuous annealing furnace, radiative and convective heating, optimum spacing

Mustafa Hekimoğlu
Kadir Has University, Türkiye

Session	**DIGITALIZATION, MATERIALS MODELING AND SIMULATION**
Date	**NOVEMBER 18, 2022, FRIDAY**
Time	**14:40 - 15:00** **(Istanbul time, CET +02:00)**
Chair	**DR. ADNAN KARADAĞ**

Modern Methods for The Digitalization of Spare Parts Supply Chain and Its Data-Centered Control

Abstract

Maintenance of manufacturing equipment is one of the most critical tasks for almost all production systems and spare parts are the main inputs of almost all maintenance activities. Especially in production processes with high downtime costs, effective control of spare parts is very important as shortages can create significant economic losses. Glass manufacturing is an exemplary industrial process for high-downtime costs systems. Downtime of some equipment can deteriorate the quality of product and lead to significant economic losses due to large amounts of wasted material. With the advancement of internet technology and computer systems, modern data-centered systems are being employed for control of spare parts supply chains in many industries. In this study, we present a theoretical framework and some results of a pilot study on a data-centered spare parts inventory control system applied to a glass manufacturing facility. Our results indicate a great potential of spare parts control systems for the glass industry when it's enhanced with proper data processing algorithms.

Keywords: digitalization, supply chain management, maintenance parts

Wolf Kuhn
Fives Stein, France

Session	DIGITALIZATION, MATERIALS MODELING AND SIMULATION
Date	NOVEMBER 18, 2022, FRIDAY
Time	15:00 - 15:20 (Istanbul time, CET +02:00)
Chair	DR. ADNAN KARADAĞ

The Enigma of The Pull Reduction of Low Iron Glass in Float Melting Tanks

Abstract

Low iron, ultra-transparent flat glass is of high interest for architectural and PV applications. However, float glass plants are often forced to reduce the tank pull rate to maintain a high fining quality. This is somehow counterintuitive as one expects better fining by the increased heat transmission from combustion radiation into these ultra-transparent melts.

To understand the reasons for the fining degradation, one has to go back to the partial differential conservation equations that govern the melt convection. The detailed analysis of these equations reveals an intrinsic link between heat transport and recirculation intensity of the melt in glass tanks. It can be shown that higher heat (radiative) conductivity of the melt triggers a reinforcement of the recirculation intensity. Moreover, this effect is boosted by the higher bottom temperatures leading to lower melt viscosity. The increased recirculation intensity shortens the time for high temperature fining and degrades the glass quality.

From a thorough study of these effects, Fives drew conclusions leading to improved float and PV glass tank designs that attenuates these effects. The fining times and thus the pull rate of low iron float glass can thus be maintained on the level of ordinary clear float glass.

Keywords: Low iron glass, pull rate, fining, glass quality

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MAJOR SPONSOR

(Invited Speaker)
CENK KOÇER
VIG Principal Researcher
University of Sydney, Australia

Session	**ENERGY, ENVIRONMENT AND SUSTAINABILITY (I)**
Date	**NOVEMBER 17, 2022, THURSDAY**
Time	**15:40 - 16:10 (Istanbul time, CET +02:00)**
Chair	**SERKAN ŞAHİN**

The Current Status of the Science and Commercial Product of the Vacuum Insulated Glass Technology

Abstract

This presentation is a review of the current state-of-the-art of the background science and the commercial product of the Vacuum Insulated Glass (VIG) technology. Initially a review of the fundamental science of the VIG will be discussed and validation of the mechanical and thermal performance will be presented. The primary goal of the design of a VIG is to provide a highly insulating, highly transparent, thin profile, glazing for window applications. It is critical that the design process produces these outcomes with reliability and required service life durability. The VIG commercial product has been available since 1996, and today there are over 20 producers globally. I will review the timeline of commercialization and take a close look at the producers of today's products. This is followed by a practical critique of the available products, and the innovation in the VIG design that is under development today. It will be evident that the VIG is not an emerging technology, it can be designed to provide high insulation, with good durability and strength, and is a viable commercial product that will have a huge impact on future building efficiency in energy use.

Keywords: vacuum insulated glass, glazing, mechanical and thermal performance, product development

(Invited Speaker)
STEPHEN WHETTINGSTEEL
CEO & Managing Director
Krysteline Technologies Ltd, United Kingdom

Session	**ENERGY, ENVIRONMENT AND SUSTAINABILITY (I)**
Date	**NOVEMBER 17, 2022, THURSDAY**
Time	**16:10 - 16:40** **(Istanbul time, CET +02:00)**
Chair	**SERKAN ŞAHİN**

Developing a More Sustainable Glass Recycling System

Abstract

Contrary to popular believe it's been consistently proven impossible or practical for all glass to be recycled endlessly in a closed loop cycle as is often claimed. Annually more than 200 million tonnes of glass is produced globally, less than 40% is re-used for new glass production (remelt or glass wool) due to limited furnace capacity, quality, colour disparity, location, and economics, as a result this material ends its life in landfill as daily cover or used as a low value aggregate substitute. Economics has always been a challenge for the recycling industry, balancing high cost of recovery and processing with proportionally low cullet value. Arguably a greater challenge is the long chain CO_2 cost of delivering glass to a furnace, in many cases the true cost of CO_2 is not appreciated or understood, claimed CO_2 benefit of using cullet does not account for its recovery, recycling, transport, nor the disposal to landfill of the glass which is not suitable for remelt. Sustainable low CO_2 solutions for 100% of glass entering a recycling facility are required, not just cullet. A recent EU wide announcement to increase recycling rates to 90% is a significant and progressive step, challenging the industry to consider its strategy and drive investment. Innovation has always challenged the recycling industry to evolve, never has there been greater focus on science and innovation to achieve more with less. Innovation and progressive thinking is developing a clearer strategy for glass recycling, one focused on low CO_2. We consider how a strategy based on CO_2 will evolve a more inclusive recycling system, one focused on maximising glass recovery and reuse. A system based on glass location, type, quality and market options, while understanding the complexities and market dynamics of establish a fair and logical approach for improving cullet quality and quantity and increasing revenue and investment opportunities of glass historically landfilled or used in low value markets.

Keywords: glass recycling, foam glass, glass-based silicon fertiliser, glass, cement, containers, flat glass, pharmaceuticals, borosilicate, photovoltaic (PV) cells, low CO_2

Notes

Challenge the perception of the current glass recycling system and establish low CO_2 solutions to encourage an increase in the recovery, reuse and recycling of all types of glass no matter the quality or location.

Chris Holcroft[1], Martyn Marshall[1], Marlin Magallanes[1], Rob Werner[1], Paul Bingham[2], Hywel Jones[2], Wei Deng[2], Feroz Kabir[2]

[1]Glass Technology Services, United Kingdom
[2]Sheffield Hallam University, United Kingdom

Session	**ENERGY, ENVIRONMENT AND SUSTAINABILITY (I)**
Date	**NOVEMBER 17, 2022, THURSDAY**
Time	**16:40 - 17:00 (Istanbul time, CET +02:00)**
Chair	**SERKAN ŞAHİN**

Beyond Cullet, the Use of Secondary Raw Materials Derived from Wastes in the Glass Industry

Abstract

As the world moves to a low carbon and more circular economy it is necessary to look beyond traditional glass recycling to be able to deliver sufficient non virgin raw material to maximize recycled content and realize the resulting energy savings. Glass Technology Services have been working with colleagues at Sheffield Hallam University and the glass industry to investigate the how ashes and other waste products can be beneficiated for use as a substitute raw material in glass batch recipes. Detailed studies of the composition and variability of a range of materials have been studied and these matched to the raw material requirements of container glass manufacture. New batch recipes have been created to incorporate these materials whilst still retaining the desired properties of the finished glass in laboratory and pilot scale melts. Glass recipes using these new raw materials can reduce glass transition temperatures, enabling lower furnace temperatures and associated energy requirements Modelling has demonstrated that these new glasses have the potential to reduce energy requirements by up to 6% and CO2 emissions by up to 7%. Modelling of processing costs and a pilot scale beneficiation trial has demonstrated that the economic cost of using the recycled ash material can be similar to traditional raw materials and when energy and carbon trading costs are accounted for a cost saving is achieved. As increased focus is placed of carbon reduction and energy cost rise the adoption of these materials becomes increasingly attractive.

Keywords: recycling, secondary raw materials, circular economy, industrial symbiosis, reducing waste

Erik Muijsenberg
Glass Service, Czech Republic

Session	**ENERGY, ENVIRONMENT AND SUSTAINABILITY (I)**
Date	**NOVEMBER 17, 2022, THURSDAY**
Time	**17:00 - 17:20** **(Istanbul time, CET +02:00)**
Chair	**SERKAN ŞAHİN**

Carbon Reduction with Electricity or Hydrogen

Abstract

With the realities of global warming and plans for CO2 reduction, the interest in alternative furnace designs such as hybrid electric melting is getting more attention. The generation of electricity by renewable energy sources is, of course, a great help as it brings costs of electricity finally down and will be CO2 free. In Europe the average generation of electricity by renewable resources is already above 40% coming from wind, solar, hydro and bio. Electricity storage however is complex and expensive, while transporting energy in the form of a gas via pipes is cheaper than via electric wires. An alternative renewable energy carrier is hydrogen. Hydrogen can be generated via electrolysis using electricity: this conversion, however, is only in the effective range of 65%. After this, hydrogen can be burned in a glass melting furnace with a typical efficiency of 50%. This paper will present Glass Service a.s. (GS) thermal efficiency studies showing if the future will be more likely using electric heating or hydrogen combustion. Results of mathematical modeling show the efficiency of the different technologies. What will be the furnace design of the future?

Keywords: CFD modeling, electric, hydrogen, super boosting, CO2 reduction, furnace design, furnace of the future, control and optimization

Levent Karacasulu, Çekdar Vakıf Ahmetoğlu
Izmir Institute of Technology, Türkiye

Session	**ENERGY, ENVIRONMENT AND SUSTAINABILITY (I)**
Date	**NOVEMBER 17, 2022, THURSDAY**
Time	**17:20 - 17:40** **(Istanbul time, CET +02:00)**
Chair	**SERKAN ŞAHİN**

A Promising Technique for Glass Consolidation: Cold Sintering Process

Abstract
Until today, different low-temperature densification strategies such as cold sintering process (CSP), hydrothermal hot pressing (HHP), and reactive hydrothermal liquid phase densification (rHLPD) have been proposed that allow the densification of materials at temperatures below 400°C, broadly called as cold sintering techniques. While there are numerous studies on these methods, the works on the consolidation and densification of glasses at such low temperatures are limited. In this work, the CPS was applied to the recycled soda-lime glass powder with the aid of NaOH solutions. Monolithic samples with relative densities reaching above 95% were obtained in less than 30 min at 250˚C via CSP.

Keywords: cold sintering, amorphous, recycling, soda-lime glass

(Invited Speaker)
M. PINAR MENGÜÇ
FYE Professor and the Director of Center for Energy, Environment and Economy (CEEE)
Özyeğin University, Türkiye

Session	**ENERGY, ENVIRONMENT AND SUSTAINABILITY (II)**
Date	**NOVEMBER 18, 2022, FRIDAY**
Time	**10:00 - 10:30 (Istanbul time, CET +02:00)**
Chair	**ÖZGÜR ACAR**

From Radiation Transport to Sustainable Energy Transition

Abstract
In this presentation, the impact of thermal sciences, particularly that of radiation transfer on sustainable energy transition is discussed. Impact of fundamental transport and radiative phenomena on nano-scale applications, on energy efficiency, and to the future of renewable energy systems will be highlighted. Importance of fundamental studies as related to both at nano- and macro-level studies, and importance of innovation based critical interdisciplinary and transdisciplinary teamwork will be discussed. The presentation will also highlight the importance of design methodology to achieve both sustainability and energy transition for future industrial operations and the importance of ESG goals to develop a road map for adaptation to future climate change concerns.

Keywords: nano scale thermal sciences, energy efficiency, radiation transfer, sustainable energy, ESG goals, climate change

A. Alperen Günay
Middle East Technical University, Türkiye

Session	**ENERGY, ENVIRONMENT AND SUSTAINABILITY (II)**
Date	**NOVEMBER 18, 2022, FRIDAY**
Time	**10:30 - 10:50** **(Istanbul time, CET +02:00)**
Chair	**ÖZGÜR ACAR**

Study and Comparison of Solar Reflectors with and without Copper

Abstract

the importance of renewable energy sources. Many studies are being conducted in the industrial and academic domains to improve the efficiency and sustainability of solar energy, which is a renewable energy resource. Şişecam, a well-established glass and mirror producer, contributes to global sustainability through innovative solutions developed to support the renewable energy sector. The Şişecam solar mirror, an ultra-clear high reflectivity glass mirror designed for use in concentrated solar power reflectors, is the company's most recent breakthrough in the sector. This highly certified product features a well-designed composition that includes silver, copper and two paint layers that provide encouraging chemical and mechanical endurance as well as good reflection values. Despite the long history of production and utilization of Cu containing silvered glass mirrors, the increased precious metal prices and environmental burdens motivate researchers to focus on new strategies in order to develop Cu free mirrors for solar thermal applications. As a result, a new generation solar mirror product was developed that does not include Cu and differs from the state of the art due to its protective paint layers. In this study, which was carried out in collaboration with METU, DLR and CIEMAT, the reflectance characteristics and chemical stability of Şişecam solar reflectors with and without Cu were evaluated. In order to determine the aging properties of the mirrors, accelerated aging tests were used. Copper Accelerated Acetic Acid Salt Spray and Ultraviolet-Humidity tests were performed on samples and changes in hemispherical and specular reflectivity reflectance were evaluated and compared. The findings provide not only a numerical foundation for long-term optical performance calculations but also design objectives for the next generation of copper-free reflecting surfaces.

Keywords: solar reflector, copper free mirror, accelerated-aging testing, durability, concentrated solar power

Rene Meuleman
Schneider-Electric, Netherlands

Session	**ENERGY, ENVIRONMENT AND SUSTAINABILITY (II)**
Date	**NOVEMBER 18, 2022, FRIDAY**
Time	**10:50 - 11:10** **(Istanbul time, CET +02:00)**
Chair	**ÖZGÜR ACAR**

Electrical Systems for Furnace Boosting Revisited to Improve Energy Efficiency

Abstract

Electrical energy will play a major route in the decarbonization of the glass industry. Already today we witness a huge increased demand for electrical furnace boosting systems reaching from 10MW up to 50MW of installed power. Since the introduction of the regenerative furnaces the industry kept on improving successfully on the efficiency of combustion systems. It now becomes an obvious requirement to do the same with the whole electrical power supply systems as well. Knowing that electrical energy transfer is very efficient inside the furnace we need to make sure that we do not lose any unwanted energy efficiency outside the furnace. Combustion systems are considered to be the part of the overall furnace design. Now it's time to have the same consideration for the electrical systems: they need to be fully integrated into the overall furnace design. The unit needs be adapted to accommodate the best possible electrical system design as a wholly integrated performance. Increasing the amount of installed electrical power requires additional space, additional copper and/or aluminum. Carefully modelling the electrical system gives us valuable information on main electrical distribution equipment location, optimizing cable routing, reducing power losses, and as such lowering CapEx, OpEx, and CO2 impact of the power system at the same time The lecturer will show you some result and will increase your awareness what can and should be done in case you consider to significantly convert your furnace energy demand from fossil fuel towards electrical energy.

Keywords: energy-efficiency power-supply, electrical system design

Stuart Hakes
CEO, F.I.C. (UK) Limited, United Kingdom

Session	**ENERGY, ENVIRONMENT AND SUSTAINABILITY (II)**
Date	**NOVEMBER 18, 2022, FRIDAY**
Time	**11:10 - 11:30** **(Istanbul time, CET +02:00)**
Chair	**ÖZGÜR ACAR**

How Will Glass Furnaces Look in The Future?

Abstract
This presentation will look at the options available in glass furnace design taking into account de-carbonization as necessary. The presentation will look at current technology, emerging technology and the steps required to get to a carbon free furnace. We will examine technologies that have a chance of success and those that are unlikely to be successful.

Keywords: glass furnace design, decarbonization, renewable energy, carbon free furnaces

Giorgio Minestrini, Ernesto Cattaneo, Alessandro Spoladore
Stara Glass S.P.A., Italy

Session	**ENERGY, ENVIRONMENT AND SUSTAINABILITY (II)**
Date	**NOVEMBER 18, 2022, FRIDAY**
Time	**11:30 - 11:50 (Istanbul time, CET +02:00)**
Chair	**ÖZGÜR ACAR**

Climate protection: the Idea of Total Recovery Glass Furnace and the LIFE SUGAR Project

Abstract
The long and urgent road to the decarbonization of glass industry may pass mainly through hydrogen or electrification or carbon capture. Yet, on top of all these strategies, a precise commitment about energy saving must stand as a multiplier of all possibilities. Regenerative and oxy-fuel glass furnaces utilize about 65% of the fuel heat for the glass melting, scoring a record thermal efficiency for any industrial field, yet a significant amount of heat still goes wasted with the fumes. While the recently maddened fuel price trend steers every glass producer towards out-of-the-process solutions to exploit the residual heat, the LIFE SUGAR project (Stara Glass – coordinator, Johnson Matthey, Kinetics Technology, Stazione Sperimentale del Vetro, Università di Genova) aims at bringing back to the process the fumes heat by utilizing it to externally power a steam reforming reaction, meant to convert a part of the furnace natural gas into hydrogen, to participate the combustion. The theoretical analysis foresees about 15% energy and therefore CO2 savings, which can be even more significant in terms of CO2 containment. The presentation will show the importance of understanding the furnace heat balance, it will analyse the thermal profiles of the different types of glass melting furnaces, and the opportunities for further heat recoveries, then it will describe the technological solution and the noticeable progress reached in the still ongoing LIFE SUGAR project.

Keywords: total recovery, hydrogen, CO2 containment, sustainability, decarbonization, carbon capture, heat recovery

Mathi Rongen, Marco van Kersbergen, Oscar Verheijen
CelSian, Eindhoven, The Netherlands

Session	**ENERGY, ENVIRONMENT AND SUSTAINABILITY (II)**
Date	**NOVEMBER 18, 2022, FRIDAY**
Time	**11:50 - 12:10** **(Istanbul time, CET +02:00)**
Chair	**ÖZGÜR ACAR**

Experimental Facility to Simulate Melting in Cold-Top Furnaces

Abstract
Increasing the share of electric boosting or even converting to full electric furnace concepts enables the reduction of the CO2 footprint of glass production. Even though some glass batches are already molten in industrial cold-top furnaces, various glass batches experience difficulties when being melted in full electric furnaces. Dependent on the batch/glass redox state, reduced melting rates are observed when converting to electric furnaces. In addition, unstable melting of high-cullet batches, and popping-up batch particles (volcano phenomenon) are observed preventing smooth and stable batch melting. To understand batch melting in electric furnaces, a unique experimental set-up has been developed enabling the monitoring of the batch surface and batch–glass melt interface while heating. This experimental facility is used to study the impact of raw materials and redox state on the specific pull rate of electric glass furnaces. The presentation will show results obtained with the experimental setup that is used by glass producers and raw materials suppliers to evaluate the melting performance and behavior in electric furnace concepts.

Keywords: cold-top melting, experimental facility, melting performance in electric furnace, electric boosting, electric furnaces, melting process

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MAJOR SPONSOR

(Invited Speaker)
PASKAL BUSKENS
Professor Nanostructured Materials
TNO, The Netherlands

Session	FUNCTIONAL COATINGS (I)
Date	NOVEMBER 17, 2022, THURSDAY
Time	13:30 - 14:00 (Istanbul time, CET +02:00)
Chair	M. OZAN ÖZER

Antireflective Coatings for Glass: Particle-Based Porous Quarter Wave Coatings

Abstract
Antireflective coatings (ARCs) are applied to reduce surface reflections. Such coatings can be applied to reduce the reflection of the surface of transparent substrates like float glass, polyethylene terephthalate, poly (methyl methacrylate), and polycarbonate. Focus will be on the application of ARCs to float glass. Three main coating concepts exist to lower the reflection at the interface of a transparent substrate and air: multilayer interference coatings, graded index coatings, and quarter-wave coatings. We introduce them and discuss the pros and cons of these three concepts and zoom in on porous quarter-wave coatings comprising colloidal particles. We extensively discuss the four routes for introducing porosity in quarter-wave coatings through the use of colloidal particles, which have the highest potential for application: (1) packing of dense nanospheres, (2) integration of voids through hollow nanospheres, (3) integration of voids through sacrificial particle templates, and (4) packing of nonspherical nanoparticles. Finally, we address the remaining challenges in the field of ARCs and elaborate on potential strategies for future research in this area.

Keywords: float glass, antireflective coating, quarter-wave coating, colloidal particles, nanospheres

Mustafa Burak Coşar
ASELSAN, Türkiye

Session	**FUNCTIONAL COATINGS (I)**
Date	**NOVEMBER 17, 2022, THURSDAY**
Time	**13:30 - 14:00 (Istanbul time, CET +02:00)**
Chair	**M. OZAN ÖZER**

CVD Growth of Zinc Sulphide for IR Dome

Abstract
Zinc sulphide is a critical optical material for IR imagining applications. It has valuable transmission at long wave infrared spectrum and good mechanical stability. Zinc sulphide is mostly preferred for imagining at missiles and fighters. Germanium is the main alternative which is not suitable to use these fast-moving systems due to the high dn/DT nature. ZnS can be produced two different technologies: one of them is the sintering of the zinc sulphide powders and the other and commercial way is chemical vapor deposition. CVD growing of the zinc sulphide is formed reacting H2S gas and vaporized zinc at high temperature. In this study, we are presenting studies carried out for the growing of zinc sulphide and characterization of the growing material. ZnS is characterized for optical, mechanical, thermal, and structural properties. ZnS shows higher optical transmission value than 73% and 65% for 1mm and 10mm thickness samples at 8-10 Qm wavelength range. ZnS provides 4-point bending rupture modulus higher than 95 MPa elastic modulus higher than 70 GPa. Density, heat capacity, thermal expansion coefficient and thermal conductivity measurements well match with theoretical values.

Keywords: CVD, ZnS, optic, infrared

Harald Hagenström
VON ARDENNE GmbH, Germany

Session	**FUNCTIONAL COATINGS (I)**
Date	**NOVEMBER 17, 2022, THURSDAY**
Time	**14:20 - 14:40 (Istanbul time, CET +02:00)**
Chair	**M. OZAN ÖZER**

Digital Solutions for Resource Efficiency in Vacuum Coating

Abstract
Building glazing makes a significant contribution to reducing energy demand through coating, and closely related technology reduces the energy demand of cars. We show how production with automated algorithms can increase productivity and thus make better use of the resources employed. The plant operator can use software solutions to ensure that demanding shifts are produced stably and product changeovers run smoothly.

Keywords: digitalization, digital solutions, automatization, glass coating

Göksenin Kurt Çömlekçi
Şişecam Science, Technology and Design Center, Türkiye

Session	**FUNCTIONAL COATINGS (I)**
Date	**NOVEMBER 17, 2022, THURSDAY**
Time	**14:40 - 15:00 (Istanbul time, CET +02:00)**
Chair	**M. OZAN ÖZER**

Acquiring Alkali Resistant E Glass Fiber by Zirconium Oxide Coating

Abstract
At the alkaline conditions the hydroxyl ions attack the Si-O-Si structural network of the glass fiber and triggers the degradation process of the fibers. As Zr-O bonds are less reactive to OH– ions, ZrO2 is used to provide alkaline resistance. The alkali resistant glass fiber (AR Glass) are made of glass containing zirconium dioxide to achieve alkali resistance to be used in alkaline medium. The zirconium content shall be at least (16 %). However the production of the high content zirconia result in high energy consumption for melting. AR-glass fiber has a good chemical resistant property, but the disadvatange of it is the difficulty in fiberizing process because of high viscosity in melted glass compare with E-glass fiber, the most widely used for reinforced fiber of composite materials. In this study, it is aimed to acquired the E-glass fiber alkali resistance by coating its surface with zirconium. For this purpose, the unsized E-glass fibers were drawn and then, coated by dipping method with ZrO2. To investigate the effect of ZrO2, coated and uncoated fibers were aged in a high alkaline environment at pH 13.The surface of the aged fibers were analysed by the help of SEM. The retention of the tensile strength of the aged fibers were determined by single fiber test method. The results showed that, coating the fibers with ZrO2 resulted in acquiring alkali resistance to the fiber.

Keywords: glass fiber, zirconium oxide, nanometal oxide, alkali resistance

Göksenin Kurt Çömlekçi
Şişecam Science, Technology and Design Center, Türkiye

Session	**FUNCTIONAL COATINGS (I)**
Date	**NOVEMBER 17, 2022, THURSDAY**
Time	**14:40 - 15:00 (Istanbul time, CET +02:00)**
Chair	**M. OZAN ÖZER**

Acquiring Alkali Resistant E Glass Fiber by Zirconium Oxide Coating

Abstract

At the alkaline conditions the hydroxyl ions attack the Si-O-Si structural network of the glass fiber and triggers the degradation process of the fibers. As Zr-O bonds are less reactive to OH– ions, ZrO2 is used to provide alkaline resistance. The alkali resistant glass fiber (AR Glass) are made of glass containing zirconium dioxide to achieve alkali resistance to be used in alkaline medium. The zirconium content shall be at least (16 %). However the production of the high content zirconia result in high energy consumption for melting. AR-glass fiber has a good chemical resistant property, but the disadvatange of it is the difficulty in fiberizing process because of high viscosity in melted glass compare with E-glass fiber, the most widely used for reinforced fiber of composite materials. In this study, it is aimed to acquired the E-glass fiber alkali resistance by coating its surface with zirconium. For this purpose, the unsized E-glass fibers were drawn and then, coated by dipping method with ZrO2. To investigate the effect of ZrO2, coated and uncoated fibers were aged in a high alkaline environment at pH 13.The surface of the aged fibers were analysed by the help of SEM. The retention of the tensile strength of the aged fibers were determined by single fiber test method. The results showed that, coating the fibers with ZrO2 resulted in acquiring alkali resistance to the fiber.

Keywords: glass fiber, zirconium oxide, nanometal oxide, alkali resistance

Tarık Eren
Yildiz Technical University, Türkiyee

Session	**FUNCTIONAL COATINGS (I)**
Date	**NOVEMBER 17, 2022, THURSDAY**
Time	**15:00 - 15:20 (Istanbul time, CET +02:00)**
Chair	**M. OZAN ÖZER**

Synthesis of Well Defined Polymer Architectures and Investigating Their Biocidal Activity and Hardness on Glass Surface

Abstract
The research presented here focuses on the development of novel functional hybrid organic-inorganic architectures containing silicone, phosphonium and aminoborane. The motivation behind this work was to understand and overcome the challenges associated with the incorporation cationic surface and inorganic polymers. This task is critical for the advancement of scientific understanding, as well as the improvement and implementation of novel hybrid materials towards technological applications such as biocidal surface and high resistance to corrosion, scratching.

Keywords: biocidal activity, surface hardness, polyaminoborane, phosphonium polymers, silica nanoparticules

(Invited Speaker)
MARCUS FRANK
Head of R&D and Product Management
Large Area Coating Glass
Bühler Leybold Optics Alzenau GmbH, Germany

Session	**FUNCTIONAL COATINGS (II)**
Date	**NOVEMBER 18, 2022, FRIDAY**
Time	**13:10 - 13:40 (Istanbul time, CET +02:00)**
Chair	**DR. TUNCAY TURUTOĞLU**

How to Minimize Product Setup Times in Large Area Coater Operation

Abstract

"Closed-loop control" is a well-established concept for many engineering applications. This is also true in the field of architectural and automotive thin film coatings. Equipment manufacturers as well as coating companies develop and continuously refine automation solutions to decrease product setup and changeover times as well as production yield.

The closed loop control scheme is a common technical solution, and its principle is simple: Spectral data of a coating are measured. The spectra are reverse engineered by layer thickness variations based on a theoretical model. The result – actual layer thicknesses of each individual layer of the coating stack – is compared to the originally modelled layer thicknesses. From the derived thickness deviations, the optimized process parameters are calculated (e.g., power, reactive gas flow, magnet bar positions of individual processes) and fed back to the individual process compartments.

In the field of large area coatings, the required plurality of individual processes adds multidimensional complexity and challenges to this concept. This complexity and the varying conditions in a production environment typically result in a disappointing gap between measured spectra and theoretical model.

In this contribution some selected approaches are presented how to set up coating products efficiently by using the closed loop control concept. What optimization strategy should be applied? Which layers should be available for thickness tuning? What product parameters should be primarily met during the optimization? What are the key optimization targets? Measured reflectance spectra, transmission or even absorption or is it sufficient to just focus on the product color values as these are key product parameters?

All these questions will be discussed in greater detail and some specific examples will consider, what kind of measured and calculated data help to minimize product setup time when applying the closed loop control concept based on a reverse engineering approach.

Keywords: closed loop coater control, reverse engineering, in-situ and ex-situ metrology, product setup time

Alperen Sezgin[1], Birsel Deniz[2], Reyhan Mehmed[2]
[1]Şişecam Science, Technology and Design Center, Türkiye
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Session	**FUNCTIONAL COATINGS (II)**
Date	**NOVEMBER 18, 2022, FRIDAY**
Time	**13:40 - 14:00 (Istanbul time, CET +02:00)**
Chair	**DR. TUNCAY TURUTOĞLU**

Multilayer Anti-Reflective Coatings on Float Glass for Architectural Applications

Abstract
Multilayer anti-reflective coatings (ARCs) where thin films with high and low index are deposited sequentially on each other are being used in various applications for different industries such as architecture, automotive or energy due to their lower reflection in the visible portion of the electro-magnetic spectrum. In architectural applications such as shop fronts or display cases, aesthetical expectations along with the demand in large area products require great care during optical thin film design and process development & optimization stages. Magnetron sputtering is one of the most promising deposition techniques by means of the ability to reproduce homogeneous thin film layers especially on large areas on glass substrates. This study aims to address the key factors regarding aesthetical expectations, technical requirements of multilayer ARCs for architectural applications while highlighting the importance of optical design and challenges for large area production.

Keywords: anti-reflective coatings, magnetron sputtering, optical thin film design

Selime Öztürk[1] ,Seçil Aydın Aslan[1], Buğra Çiçek[2], Anıl Özen[3], Zeynep Aydın[3], Barış Tünay[4], Birtan Demir[4]
[1]Akcoat Research and Development Center, Türkiye
[2]Yıldız Technical University, Türkiye
[3]Şişecam Science Technology and Design Center, Türkiye
[4]Şişecam Otomotiv A.Ş. Lüleburgaz Plant, Türkiye

Session	FUNCTIONAL COATINGS (II)
Date	NOVEMBER 18, 2022, FRIDAY
Time	14:00 - 14:20 (Istanbul time, CET +02:00)
Chair	DR. TUNCAY TURUTOĞLU

Investigation of Rheological Behaviour of Water-Friendly Black Glass Enamel for Automotive Windshields

Abstract
Increasing global competition over the past decade has forced automotive industry suppliers to improve quality and efficiency. The spread of volatile organic compounds from the wide surface during the application of screen-printing paint on automotive windshield causes issues in terms of both employee health and air quality of the working environment. The main purpose of this study is to develop a new range of water-friendly black glass enamels for automotive windshields having good acid resistance, low firing temperature, good printability, stable viscosity and odorless for a screen-printing system. The speed, effectiveness, and simplicity of a screen-printing process depend on rheological characteristics including shear thinning, thixotropy, and yield stress. Both oil-based and water-friendly glass enamel have been prepared to compare the rheological behaviors such as the paste liquidity, thixotropy, and viscoelastic properties at different shear rates of prepared glass enamels by using rheometer. High-temperature microscopy analysis is carried out to get the information on transformation temperatures of the glass enamel. Thermogravimetric analysis (TGA) technique is used to determine the thermal stability and its fraction of volatile components. Scanning electron microscopy (SEM) analysis is used to characterize morphology and film thickness of the coating on windshield glass. The applicability of the new developed enamel in automotive windshield processes has been investigated through trials in the laminated production line of Şişecam Automotive Kırklareli Factory. Chemical resistance, temperature resistance and physical strength performance tests were carried out on the samples obtained in the size of automobile windshields.

Keywords: glass-ceramic; glass enamel; windshield, rheology, thixotropy, viscosity

Eylül Demir, Hasan Güllü
ASELSAN, Türkiye

Session	**FUNCTIONAL COATINGS (II)**
Date	**NOVEMBER 18, 2022, FRIDAY**
Time	**14:20 - 14:40 (Istanbul time, CET +02:00)**
Chair	**DR. TUNCAY TURUTOĞLU**

Broadband Infrared Antireflective Optical Coating on Chalcogenide Infrared Glass

Abstract

Infrared (IR) optics are used in wide-range civilian and military applications in the wavelength range higher than visible range and lower than microwaves. Related to the rapid growth in detector technology, IR materials are become point of interest for thermal imaging, sensing and detection systems. Generally, IR optics are fabricated using IR transparent crystalline materials. Commercially available materials are limited in broadband applications and categorized depending on their IR cut-off wavelengths. In these optical applications, silicon (Si) and germanium (Ge) are traditional materials used for thermal vision systems in the wavelength range of 3 and 12Qm. IR optics are also manufactured from zinc selenide (ZnSe) and zinc sulphide (ZnS) with good long wavelength transmission in the IR region. Depending on technological development, new materials are point of research for cost effective alternatives and optimization of material characteristics in next-generation systems. Among alternatives in long wavelength IR region, Ge-based and As-based chalcogenide glassy alloys present commercial advantages and also compositional engineering provides adaptation to specific applications. Compositional flexibility of these infrared glasses (IRG) offers use in wide IR range and material optimization for low thermo-optic coefficient and low dispersion in optical systems. Due to these facts, As 40 Se 60 (IRG-26) is a commercialized Ge- free IRG material popular in use 3-5Qm and 8-12Qm IR systems with athermalization property. In this work, broadband infrared antireflective (AR) optical coating is performed and characterized on 2 mm thick IRG-26 sample witness. Substrate characterization and AR coating design are done by OptiLayer coating design software. Depending on the system tooling requirements, AR layer is obtained following to multilayer coating by physical vapor deposition technique. In different wavelength range, different thin film coating materials are used for thin film coating designs. In 3-5Qm region, transmission and reflection results of the double side coated IRG-26 samples are >98 % and <0.5 %. In 8-12Qm region, these values are obtained as >97 % and <1.5 %, respectively.

Keywords: optical thin film coating, infrared glass, chalcogenide glass, antireflective coating

Oğuzhan Bulut, Hacı Batman
ASELSAN, Türkiye

Session	FUNCTIONAL COATINGS (II)
Date	NOVEMBER 18, 2022, FRIDAY
Time	14:40 - 15:00 (Istanbul time, CET +02:00)
Chair	DR. TUNCAY TURUTOĞLU

Etching Process for the Removing Mirror Coatings on the Zerodur without Damaging the Surface

Abstract
Coatings on mirrors can be damaged resulted from mishandling, contaminations, chemical reactions with some gases in the environment or peeling due to poor adhesion or high stress. In these cases, it is highly desirable to recoat of the mirror substrate. To achieve this goal, coating must be removed from substrate. This paper describes a removal process without repolishing of the substrate. Etching process procedure for the chromium underlayer mirror coatings is applied to the substrate without damage it. Only Zerodur is worked as substrate and no roughness and surface form change after etching process. The objective of this work is obtaining desired surface for recoating process which is cheaper and less time consuming compared with the repolishing of the substrate.

Keywords: zerodur, etching, coating removal, recoating, mirror, mirror coatings, reflective coatings, optical coatings

Humbet Nasibli[1], Pervin Tuzun[1], Semih Yurtseven[1], Fikret Yildiz[2], Ramiz Hamid[1]
[1]TUBİTAK UME, Türkiye
[2]Gebze Technical University, Türkiye

Session	FUNCTIONAL COATINGS (II)
Date	NOVEMBER 18, 2022, FRIDAY
Time	15:00 - 15:20 (Istanbul time, CET +02:00)
Chair	DR. TUNCAY TURUTOĞLU

Advanced Characterization Methods for High-Quality Glasses: A Review of Two New Systems Developed at TÜBİTAK UME

Abstract
In view of demands from local companies (working in the field of optical glasses and coatings) two new systems for characterization of special optical materials and thin film coatings were designed, constructed and validated at TÜBİTAK UME. The first device is aimed to measure the weak optical absorption of uncoated/coated optical components at the ppm and sub-ppm levels. The measurement principle behind this device is based on the photothermal common-path interferometry method, where a photothermal analysis of the medium under the test is performed by utilizing a pomp-probe laser beams technique. The system operates at the laser lines with wavelengths of 1064nm, 640 nm, and 532 nm. Experiments at 1064 nm wavelength with 3 mm thickness uncoated suprasil fused silica glasses and single-layer Ta2O5 coatings demonstrated that the measurement range of the device spans below 0.1 ppm. This was achieved by using of highly stabilized probe laser and detector assembly. This system is calibrated traceable to the ISO standards 11551 by means of a homemade laser calorimeter arrangement. The second device is designed to assess the laser-induced damage threshold of optical materials and coatings. The system, along with the methods described in ISO standards 21254 can perform the evaluation of the threshold value by means of the R-on-1 method, which is gaining popularity in the community due to its most robust results. The system utilizes a high-energy pulsed laser and allows to perform the durability tests at 1064 nm, 532 nm, 355 nm, and 266 nm wavelengths. Currently we are improving this system to perform the measurements in vacuum environments, which is essential for the testing and evaluation of space-grade optical glasses and coatings. This work presents an overview of these devices, evaluation algorithms, and measurement performances. The results of measurements with several high-quality optical materials and dielectric-coated mirrors will be presented and discussed.

Keywords: ultra-weak absorption, laser damage threshold, thin film, optical coatings, high-quality optical glasses

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GLASS STRUCTURE & PROPERTIES

(Invited Speaker)
MORTEN MATTRUP SMEDSKJÆR
Department of Chemistry and Bioscience
Aalborg University, Aalborg, Denmark

Session	GLASS STRUCTURE & PROPERTIES
Date	NOVEMBER 18, 2022, FRIDAY
Time	15:40 - 16:00 (Istanbul time, CET +02:00)
Chair	BANU ARSLAN GÜVEL

Improving the Mechanical Properties of Glasses from the Bottom-Up

Abstract
Oxide glasses with improved damage and fracture resistance are critically needed. Traditionally, new glass compositions have been developed through time-consuming trial-and-error experimentation. In this talk, I will discuss the recent progress in designing oxide glass compositions with improved mechanical properties from the bottom-up. Such design is building on knowledge of the deformation mechanism of glasses under high local stress, and by appropriately tailoring microstructures, glass materials with improved resistance to crack initiation and growth can be discovered. To this end, tuning of the glass chemistry is crucial to control the structural and topological transformations that occur under stress to enable energy dissipation. I will also discuss the new insights from atomistic simulations combined with topological analysis tools to unravel such stress-driven structural changes.

Keywords: oxide glass composition, mechanical properties, glass structure, atomistic simulation

Hamid-Reza Bahari[1,2], Bülend Ortaç[2]
[1]Center of Innovation for Green and High Technologies, Iran
[2]Bilkent University UNAM, Türkiye

Session	GLASS STRUCTURE & PROPERTIES
Date	NOVEMBER 18, 2022, FRIDAY
Time	16:10 - 16:30 (Istanbul time, CET +02:00)
Chair	BANU ARSLAN GÜVEL

Metal Nanoparticle Embedded and Rare-Earth Doped Novel Oxide Glasses and Ceramics for Photonic Application

Abstract
In this talk, metal nanoparticle embedded novel glass, the concept of glassy network, the unusual physical properties of such materials, their fabrication challenges and their potential application in photonic, are generally introduced to the audiences. Photoluminescence of rare earth ions doped in glassy matrix can be enhanced by metal nanostructures dispersed in the active medium through local field enhancement and/or energy transfer. Surface Plasmon Resonance (SPR) arising from metallic nanoparticles results in giant and highly localized electric fields around nanoparticles. In addition to isotropic spherical NPs, optically coupled NPs and also anisotropic NPs with sharp edges by confinement of the local surface electric field at their sharp edges are fascinating for nanometal enhanced fluorescence (NMEF) studies. Although, fabrication and characterization of metal nanostructures embedded in glass matrices have been performed by many researchers, fabrication of non-spherical metallic nanostructures in glass matrices has had remarkably little success and remains a challenge. In this talk, the concept will also be deliver to the audiences through an example of matrix adjustment thermal reduction method of synthesis of silver nanostructures in Er3+/Yb3+ activated GeO2-PbO glass matrix. The main focus of this talk is on fabrication challenges, nano/glass material structure, and optical properties.

Keywords: novel oxide glass, metal nanoparticle embedded glass, rare-earth doped, nano antena

Orhan Kıbrıslı, Naji Vahedigharehchopogh, Miray Çelikbilek Ersundu, Dr. Ali Erçin Ersundu
Yıldız Technical University, Türkiye

Session	GLASS STRUCTURE & PROPERTIES
Date	NOVEMBER 18, 2022, FRIDAY
Time	16:30 - 16:50 (Istanbul time, CET +02:00)
Chair	BANU ARSLAN GÜVEL

Quantum Dot and Lanthanide Ion Doped Photoluminescent Glasses: Next-Gen Wavelength Convertors for Opto-Electronic Applications

Abstract
Glass presence in our lives is exponentially increasing while we are going through 2022 International Year of Glass. Structural, artistic and kitchenware applications of glasses are obviously at the forefront and grasp the largest market share. However, outstanding optical properties of specially designed glasses make them extremely appealing for advanced photonic and opto-electronic applications — especially wavelength convertors which are basically quantum dot (QD) and/or lanthanide ion doped glassy materials exhibiting photoluminescent property. Wavelength conversion may occur in the UV/Vis/IR range regardless of the direction. Besides advantageous optical properties of glasses, they also offer favorable mechanical, chemical, thermal and photo resistance to extremely vulnerable QDs and lanthanide ions upon exposure to open atmosphere. Glass encapsulation of QDs and lanthanide ions provide valuable engineering solutions in regard to finally take them out of glove boxes and utilize them in real life applications. In the Glass Research Laboratory of Yildiz Technical University, QD and/or lanthanide ion doped wavelength convertors are being investigated predominantly through an engineering approach. Proof-of-concept prototypes on solid-state lighting, volumetric display and non-invasive temperature sensing are already demonstrated involving QD and/or lanthanide doped glasses and studies on luminescent solar concentrators for PV applications is still in progress. Preliminary results are quite promising and leading the way to increase glass presence in high-tech applications to provide added value products to glass industry.

Keywords: photoluminescence, quantum dot, lanthanide ion, opto-electronic

Dulce Yolotzin Medina Velazquez[1], Gabriela Verenice Arredondo Martinez[1], María Jesús Pascual Francisco[2]
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[2]Instituto de Cerámica y Vidrio (CSIC), Spain

Session	**GLASS STRUCTURE & PROPERTIES**
Date	**NOVEMBER 18, 2022, FRIDAY**
Time	**16:50 - 17:10 (Istanbul time, CET +02:00)**
Chair	**BANU ARSLAN GÜVEL**

Enhancement of the Green Optical Emission in Tb-Doped Barium Borate Glasses through the Glass Melting Process

Abstract
In this work, Terbium-doped barium borate glasses were prepared for green emission using two different methods and raw materials. In the method A, conventional route, Barium hydroxide and Boric acid were used and in method B, Barium carbonate and vitreous Boron oxide. The terbium concentration was 0.5, 1.0 and 1.5 mol% . All the glasses presented the corresponding luminescent transitions of the Terbium^{3+} ion: 5D3→7F3, y 5D4→7Fj [j=6, 5, 4, 3] and the intensity of the emission transitions increased with the terbium concentration. However, a higher luminescence was observed using the method B for all the Terbium concentrations studied compared with method A. For the glasses with 1.5 % mol of Terbium (the glasses with highest luminescence) the purity of color of the glasses synthetized with method B was above 90% and for the method A the purity was 53% (according to the CIE1931 chromaticity diagram). The results also indicate that the thermal properties remain invariable for all Terbium concentration when the new method B was implemented in contrast with method A where thermal properties changed with the Terbium concentration. This can be attributed to a higher dilution of the rare earth when method B was used, which also contributed to increase its luminescent properties. The luminescent properties observed in the glasses with method B exhibit great potential for its application as solid-state green laser LEDs.

Keywords: luminescent glasses, rare earth doped glasses, terbium

Hadjer Youcef[1], Mohamed Toufik Soltani[1], Mourad Baazouzi[1], Et Tahir Ammari[2]
[1]University Mohamed Khider Biskra_Algeria, Algeria
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Session	**GLASS STRUCTURE & PROPERTIES**
Date	**NOVEMBER 18, 2022, FRIDAY**
Time	**17:10 - 17:30 (Istanbul time, CET +02:00)**
Chair	**BANU ARSLAN GÜVEL**

Effect of Boron Oxide on Optical Properties of New Glasses

Abstract
This work reports the synthesis of Sb2O3-based heavy metal oxide glasses, By using classical routes (melting – casting) in sodocalcic crucibles. the DSC measurements have showed that the temperature of glass transition Tg is in the range [256 – 288°C].Optical band gaps and the Urbach energy were determined from optical transmission spectra to have been recorded in the wavelength range 200 and 1200 nm by UV- visible spectrophotometer. This study could open new avenues of research for applications in photonic and nonlinear.

Keywords: antimony oxide glass, rare earth, samarium, laser, thermal properties

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MELTING AND FORMING PROCESSES & BULK PROPERTIES

INTERNATIONAL YEAR OF GLASS 2022 IYOG2022.ORG

MAJOR SPONSOR

(Invited Speaker)
ASTON FULLER
General Manager
Glass Futures Ltd., United Kingdom

Session	**MELTING, FORMING PROCESSES AND BULK PROPERTIES**
Date	**NOVEMBER 17, 2022, THURSDAY**
Time	**13:30 - 14:00** **(Istanbul time, CET +02:00)**
Chair	**TOLGA UYSAL**

Innovative Glass Melting Technologies - A Patchwork of Progress

Abstract

Following a two-year design process working across the glass sector, Glass Futures is building a globally unique facility and asset(s) that are designed to produce knowledge, reports, IP and technical progress as its key output, with glass as a secondary by-product of this work.

As such the complexities of designing and producing an asset that is tailored to be technically flexible is a new approach to glass making and represents an opportunity for the global glass industry to work in a fashion that have never been tried before, we see this as beginning a new way to progress the science of glass making. By making knowledge the primary output of a glass making facility as opposed to products a new mindset can exist within the glass making community. The opportunities to capture knowledge that are simply not possible on commercial production lines will be demonstrated and the clear value of the work being carried out shown relative to the rate of change required within the global glass sector.

Following the process of designing and procuring a unique asset, the task of effectively planning an experimental programme to produce as much valuable knowledge for the largest number of stakeholders also brings about unique opportunities and challenges. With anti-trust and anti-competition laws pivotal to the success of competitive innovation, there are also ways to collaborate on pre-competitive elements of glass making that are begin opened up by way of necessity for the industry to change. This work helps to demonstrate that the global glass community has one overarching direction and that it should go towards those goals in a united fashion.

This talk will touch on the work across raw materials, refractories, furnace simulation, low carbon fuels, burner development, refining, forming, coatings, instrumentation, big data and training that all come together with such a unique and ambitious approach as the one being employed within Glass Futures. This talk aims to demonstrate that there is significantly more that unites competitors within the glass sector than divides them.

This is made possible by the inclusion of an entire supply chain from academia and manufacturers through to retailers and this talk will discuss the opportunities that exist by engaging this whole supply chain through a globally collaborative approach. The chance to run experiments con-currently on a line also give rise to more complexities around risk, IP and stakeholder management but which will pave the way for a decade of progress following the International Year of Glass.

Keywords: glass melting, simulation, experimental design, big data

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Session	**MELTING, FORMING PROCESSES AND BULK PROPERTIES**
Date	**NOVEMBER 17, 2022, THURSDAY**
Time	**14:00 - 14:20 (Istanbul time, CET +02:00)**
Chair	**TOLGA UYSAL**

How Refractory Material Participate to The Future of Glass

Abstract
Since more than 20 years' glass industry made tremendous evolutions to decrease specific energy consumption and increase glass furnace lifetime. Now the future of Glass industry future is more intensively related to low carbon emission and new trends in glass melting technologies are happening. In order to help these new trends, refractory solutions can contribute to reach these objectives. By the way, different solutions could be used such as increasing electrical energy percentage in glass melting, higher insulated furnaces at glass contact and superstructure areas, and high thermal efficiency furnace regenerator. In each step, we will discuss how refractory material are able to face these specific running conditions, as high temperature corrosion process, electrical resistivity issues, and improved energy exchange in glass furnace thermal regenerators.This talk aims to demonstrate that there is significantly more that unites competitors within the glass sector than divides them. This is made possible by the inclusion of an entire supply chain from academia and manufacturers through to retailers and this talk will discuss the opportunities that exist by engaging this whole supply chain through a globally collaborative approach. The chance to run experiments con-currently on a line also give rise to more complexities around risk, IP and stakeholder management but which will pave the way for a decade of progress following the International Year of Glass.

Keywords: refractory material, corrosion, glass furnace, thermal performances

Roland Heidrich
REFEL S.p.A., Italy

Session	**MELTING, FORMING PROCESSES AND BULK PROPERTIES**
Date	**NOVEMBER 17, 2022, THURSDAY**
Time	**14:20 - 14:40 (Istanbul time, CET +02:00)**
Chair	**TOLGA UYSAL**

Refractories for the Furnace of the Future

Abstract

The global warming is one of our planet's greatest challenges. The glass industry is working to uncouple glass production from CO2 emissions as soon as possible.

A future energy source for glass melting tanks will be green hydrogen instead of fossil fuels. Furthermore, all electric and hybrid furnaces will work with renewable energy, when available, which implies alternating electricity loads for the latter.

This technological transformation poses new challenges for furnace design. The presentation discusses properties and right choices of adequate fused cast AZS refractories.

Keywords: furnace of the future, glass melting, all electric, hybrid, refractories.

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Session	**MELTING, FORMING PROCESSES AND BULK PROPERTIES**
Date	**NOVEMBER 17, 2022, THURSDAY**
Time	**14:40 - 15:00 (Istanbul time, CET +02:00)**
Chair	**TOLGA UYSAL**

Effect of Sodium Concentration in Glass on AZS Refractory Corrosion

Abstract

In this study, the corrosive and erosive effects of glass samples prepared using different Na2O ratios on refractory materials were investigated comparatively. Within the scope of the studies, both glass cullet and glass batches containing lower and higher Na2O by weight were subjected to corrosion tests with two types of fused-cast AZS refractories that are directly in contact with the molten glass in the melting end. The test temperature was determined as 1450°C, and at this target temperature, the refractory materials remained in contact with the molten glasses for 72 hours. At the end of the experiments, the amount of wear and glassy phase transformation of the AZS refractory samples, which are in contact with the molten glass cullet and glass batch samples separately, were measured and compared to one another. After the tests, the microstructures of two types of fused-cast AZS refractory materials were examined by SEM and the compositional changes in their glassy phases from the glass contact surface to the interior area were also analyzed.

Also, thermochemical calculations were performed by using “Equilib” and “Phase Diagram” modules of FactSage 8.2 to predict the melting behavior of the glasses and to simulate counter-cross inter-diffusion reactions at the interface between refractory and glass. During calculations, FToxid database was used for possible solid and liquid oxide phases, whereas FactPS database was selected for the possible gas formations. The modeling results were also compared with the data obtained by SEM-EDS analysis.

Keywords: refractories, corrosion, electron microscopy

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Session	MELTING, FORMING PROCESSES AND BULK PROPERTIES
Date	NOVEMBER 17, 2022, THURSDAY
Time	15:00 - 15:20 (Istanbul time, CET +02:00)
Chair	TOLGA UYSAL

The Impact of Flow Properties and Mixed Batch and Raw Material Handling System Design

Abstract
The theory for gravity driven solids flow has been developed, but it is not well-known by many silo designers. As a result, in the glass industry mixed batch and raw materials often flow unreliably out of surge bins and furnace feed systems, leading to costly defects and losses of production. Given the proximity of mixed batch handling to the furnace, ambient temperatures can cause hard buildup in any areas that are stagnant. In addition, stagnant areas tend to accumulate one or more batch ingredients preferentially due to segregation, which can give rise to variations over time as the material is recovered. As a result of these aspects, the flow performance of the system is of considerable interest. Vast amounts of time and money are spent with only marginal success on flow promoting devices, such as bin vibrators, dischargers and air cannons. The technology for the design of bins and hoppers to eliminate flow problems involves first testing the material to be handled to determine its flow properties. Based on these flow properties, analytical methods are used to calculate limiting conditions for gravity flow, and then engineering judgement can be used to select a suitable hopper and feeder configuration to ensure reliable flow. Among those flow properties, cohesive strength and wall friction are most important to characterize flow behaviors, and hence should be used as a basis for design. Hopper features such as shape, angles, outlet size, materials of construction and surface finish can be specified to achieve the desired outcome. This discussion will present the importance of the two mentioned properties, how to properly measure them and their impact on bin and hopper designs. Examples will be provided, showing problematic and successful arrangements in comparison.

Keywords: flow properties, cohesive strength, wall friction, handling systems design, flow behavior

ŞİŞECAM

37TH INTERNATIONAL GLASS CONFERENCE

Inspiration for Tomorrow:
Celebrating
The International Year of Glass 2022

PRODUCT DESIGN

INTERNATIONAL YEAR OF GLASS 2022
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(Invited Speaker)
TOMEK RYGALIK
Product Designer
Studio Rygalik, Poland

Session	**PRODUCT DESIGN**
Date	**NOVEMBER 18, 2022, FRIDAY**
Time	**15:40 - 16:10** **(Istanbul time, CET +02:00)**
Chair	**DEĞER DEMİRCAN ACILIOĞLU**

DesignNature - Nature of Design

Abstract
We live in times of realization that as humanity we have made many mistakes while developing our civilization. Therefore, there is a growing need to reset the values and development goals, and act swiftly and effectively. This requires the ability to both learn and unlearn in entirely new ways, going deep to the sole purpose of why we are here on the planet, and what we can do cleverly joining forces with nature. Glass industry is not an exception. How can we design and produce responsibly?

Keywords: nature, product design, environmental, glass industry, civilization

Tamer Nakışçı
Studio Nakışçı, Türkiye

Session	**PRODUCT DESIGN**
Date	**NOVEMBER 18, 2022, FRIDAY**
Time	**16:10 - 16:30 (Istanbul time, CET +02:00)**
Chair	**DEĞER DEMİRCAN ACILIOĞLU**

Things That Make You Imagine

Abstract

What if there was a way to see the world differently?

Investigating on the global success of our past and current collections with Sisecam, I will try to take people into a different way of looking at the world and question our relationship with the objects and spaces that we occupy. The talk will cover the topic of emotional design, while looking at the subject from an industrial design perspective.

As a designer, you focus on users' needs in their interactions with your products or services. However, I believe that design has the power to restore our consciousness and change our perspective about the things around us; and that the role of the designer in the coming age is more about inspiring people rather than a form of self-expression. Accordingly, I'm trying to wake people up, and take them back to a stage where they believe everything is possible, and the future is blank.

Combining good design and manufacturing techniques with the implementation of user engagement in the creative process, the timespan of a product and the emotional connection that you establish with the user can be extended. Which leads to longer lasting and more meaningful products, endless new scenarios, and a deeper connection with the brand.

Keywords: future, creativity, sustainability, consciousness, inspiration

Müge Bıyık, Alpay Er
Özyeğin University, Türkiye

Session	PRODUCT DESIGN
Date	NOVEMBER 18, 2022, FRIDAY
Time	16:30 - 16:50 (Istanbul time, CET +02:00)
Chair	DEĞER DEMİRCAN ACILIOĞLU

New Business Models and the Emerging Competency Needs after Digitalization in the Design-oriented Crafts Sector (ceramic and glass) in Istanbul

Abstract

New business models and the emerging competency needs after digitalization in the design-oriented crafts sector (ceramic and glass) in Istanbul

The research aims to examine the new business models that have emerged after digitalization in design-oriented craft-based businesses in Istanbul, which use glass and ceramics as materials, and to determine the required competencies for their sustainability. The research was carried out by Özyeğin University as part of the Kale Design and Art Center's Innovation Project.

The craft network that continues to exist in Turkey allows designers to collaborate with craftsmen in business projects to produce designed products without opening their ateliers. In order to develop effective policies to support their sustainability, it is essential to examine the transformation of business models in design-oriented craft initiatives since both the concepts of craft and the designer have undergone a paradigm shift with digitalization.

Ten semi-structured face-to-face interviews were conducted with "designer-makers" and ecosystem stakeholders in this qualitative study. Each business model was analyzed using the "Holistic Business Model" by Li (2020), explicitly developed for examining the digital transformation of business models in creative industries. The competency needs for implementing new business models have been determined concerning the ESCO classification.

The research contributes to understanding the interaction of the crafts (ceramic and glass) and design sectors at new business models that have emerged with digitalization in Istanbul. It also presents the competencies necessary to maintain and support the existing design knowledge and capacity in the design-oriented craft network.

Keywords: digitalization, creative industries, design, craft, business models, skills

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Şişecam, Research, Development & Quality, Türkiye

Session	PRODUCT DESIGN
Date	NOVEMBER 18, 2022, FRIDAY
Time	16:50 - 17:10 (Istanbul time, CET +02:00)
Chair	DEĞER DEMİRCAN ACILIOĞLU

Proposal of a New Method for the Production of Glass Packaging Prototypes

Abstract
Offering glass prototypes to customers is of great importance when selecting the best glass packaging design among the alternatives developed in accordance with briefs. All prototypes, whether built by manual modelling or using cutting-edge 3D printers, can be made from a variety of materials, except glass. Nevertheless, it is difficult to imitate glass due to its unique qualities, such as its transparency. Furthermore, prototypes made from other materials will not have the same look and feel as the final glass packaging. In order to eliminate these concerns, the Hot Glass Studio in the Ceramic and Glass Department at the Mimar Sinan Fine Arts University aimed to offer glass prototypes to customers who demand new designs, using its own method. Inspired by the glass casting technique called Pâte de Verre, used in glass art, the method developed for the course Industrial Glass Project, offered in partnership with the Glass Packaging Design Department at Şişecam, will allow for the production of the prototypes of bottles, jars, etc. in the desired quantity. This paper will describe the method developed, provide examples of the glass prototypes produced in accordance with different design projects, and specify the purpose, scope, and limits of the method.

Keywords: glass packaging, prototype production, new method

ŞİŞECAM

37TH INTERNATIONAL GLASS CONFERENCE

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POSTER PRESENTATIONS

Göktuğ Günkaya, Ayşenur Sarı
Anadolu University, Türkiye

Session	POSTER SESSION
Date/Time	NOV' 17, 2022, THURSDAY (17:30 - 18:30)
Date/Time	NOV' 18, 2022, FRIDAY (09:00 - 10:00)
Hall	FOYER

Coloring of Waste Artistic Glasses Used for Blowing Technique in Workshop Conditions

Abstract
The use of colored glasses is an important feature for artistic and industrial glass production in terms of providing functionality and aesthetic properties to the product. Depending on the use of raw materials and/or metal oxides added to the glass batch, different colors and tones can be produced. Wide usage areas can be created with the color variety obtained. It is necessary to understand the targeted color and the processes of creating that color correctly. The aim is directly proportional to the creation of different glass recipes and has led to the production of glasses in different color types and shades. In this study, investigations were made on the coloring of hot blowing glass wastes for artistic use by using a certain amount of raw materials. One of the most interesting results that was reached by the experiments was the obtainability of different glass color tones depending on the peak temperature with the same glass composition. Experiments were carried out for various artistic applications with heat treatment at different peak temperatures by using the same glass composition. As a result, it was seen that various color tones from transparent to white were obtained by adding raw materials to the transparent waste artistic glass for glassblowing. Artistic glass products were carried out by using the developed composition.

Keywords: glass, coloring of glass, waste blowing glass, waste glass coloring

Ali Serpengüzel
Koc University, Türkiye

Session	POSTER SESSION
Date/Time	NOV' 17, 2022, THURSDAY (17:30 - 18:30)
Date/Time	NOV' 18, 2022, FRIDAY (09:00 - 10:00)
Hall	FOYER

Laser Light Scattering from Microspheres

Abstract
We review experimental laser light scattering and theoretical Lorenz-Mie scattering from liquid or solid dielectric, and solid semiconductor microspheres. Liquid dielectric spheres were microdroplets of amorphous salt solutions and hydrocarbons. The liquid microspheres were excited with focused laser beams at their equator. The solid microspheres are composed of polymer, glass, sapphire, diamond, and silicon. The solid microspheres were excited with optical fiber half couplers (OFHCs) manufactured from single mode optical fibers or optical waveguides manufactured using femtosecond laser processing. Generalized Lorenz-Mie theory (GLMT) is applicable to the simulation of both focused laser beam edge excitation and guided wave excitation of the microspheres. Microspheres are the building blocks of three-dimensional integrated photonics. Microsphere based lightwave circuits are applicable to fiber optics and integrated photonics. Microspheres lead themselves to various lightwave circuit applications, such as channel dropping filters, tunable filters, and optical modulators.

Keywords: fiber glass, optical fiber, optical waveguide, optical resonator, laser, light scattering, photonic architecture

Oğuzhan Aşık, Gönenç Altun, Altuğ Başol, Mustafa Pınar Mengüç
Özyegin University, Türkiye

Session	**POSTER SESSION**
Date/Time	**NOV' 17, 2022, THURSDAY (17:30 - 18:30)**
Date/Time	**NOV' 18, 2022, FRIDAY (09:00 - 10:00)**
Hall	**FOYER**

Numerical Investigation of the Cooling Zone of a Container Glass Annealing Furnace: Effect of the Ventilation Fan Speed on the Cooling Effectiveness of the Furnace

Abstract
Annealing is a type of heat treatment process that is widely used in glass manufacturing. It serves for the elimination of the residual thermal stresses which result from the nonuniform cooling of glass during and immediately after the forming stage. In container glass manufacturing annealing process is carried out in continuous annealing furnaces. Continuous furnaces are divided into different zones which are thermally conditioned according to the requirements of the process. The heating zone of the furnace is positioned at the very upstream of the furnace where the incoming glassware into the furnace is heated up to the annealing temperature of glass. Downstream of this zone a number of cooling zones are positioned where glass objects entering into the cooling zones are gradually cooled off at a carefully adjusted rate. Cooling zones of the furnaces are usually equipped with ventilation fans which both enhance convective cooling rate and also ensure a uniform air temperature inside the furnace. In this study the cooling process inside the cooling zone of an industrial-scale container glass annealing furnace is numerically simulated. The inhouse developed furnace model calculates the transient cooling of continuously moving row of bottles fed into the cooling zone. The effect of the ventilation fan is also included in the computational model and realistic furnace wall temperatures are derived by considering the convective and radiative heat transfer effects inside the furnace. First, the uniformity of the cooling pattern of the bottles inside the zone is discussed in detail. Finally, the computational furnace model is utilized to investigate the effect of the ventilation fan speed on the cooling pattern of the bottles inside the zone.

Keywords: annealing, continuous annealing furnace, cooling section, fan speed

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Session	POSTER SESSION
Date/Time	NOV' 17, 2022, THURSDAY (17:30 - 18:30)
Date/Time	NOV' 18, 2022, FRIDAY (09:00 - 10:00)
Hall	FOYER

MD Simulations of New Generation Controlled Release Phosphate Glasses

Abstract
Phosphate glasses can be used in many fields, from medicine and cosmetics to fertilizers, due to their properties. Especially for controlled-release fertilizers, phosphate glasses are ideal with their easily controllable chemical durability. Şişecam has done extensive research on the structural properties and dissolution behavior of controlled release phosphate glass fertilizers. In this work, different phosphate glasses with different phosphate and metal oxide combinations are planned to be structurally studied by using molecular dynamics (MD) simulations.

For MD simulations, LAMMPS software is used to create a simulation box with the given atoms of different percentages for creating the glasses. Buckingham and Stillinger-Weber potentials are used for calculating the interactions between ions and O-P-O and P-O-P interactions. After creating the glass with the melt and quench method, the glass obtained will be put into a water box to observe the dissolution rates. The results will be studied by comparing X-ray Powder Diffraction (XRD) and other properties of MD simulation. In addition, dissolution rates obtained from MD simulation will be evaluated comparatively with the results of previous experimental studies.

Keywords: molecular dynamics, glass structure simulations, controlled release fertilizer, phosphate glass

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Session	POSTER SESSION
Date/Time	NOV' 17, 2022, THURSDAY (17:30 - 18:30)
Date/Time	NOV' 18, 2022, FRIDAY (09:00 - 10:00)
Hall	FOYER

Modeling of The Effect of Fe_2o_3 in Flat Glass Composition on Optical and Color Parameters of Glass

Abstract
Glass materials are important in terms of architecture as well as being important for engineering science. With the development of architecture, with the design and construction of buildings of different designs; glass has begun to take place more in architectural structures and is now used at a level to cover all exterior facades of buildings. Thus, glasses of various properties and colors are needed.
The effect of metal oxides in the flat glass composition on the optical and color parameters of the glass is known. One of the most known and commercially used methods for coloring glass is the coloring process with the help of colorants added to the glass blend during glass production. A large number of experimental studies are carried out on a laboratory scale before the production phase is started for the targeted color and optical properties. Since continuous analysis and control is required to reach the targeted values, this whole process takes a lot of time and a serious workforce is needed. With the development of computer technology, glass science has turned to data analytics-based approaches. One of the most important strategies for data-driven modeling will be to model the existing compositional properties of glass using datasets, using artificial intelligence and especially machine learning algorithms.
The aim of this doctoral thesis is; It is the estimation of the optical and color parameters of the glass with the help of various statistical methods and data-based artificial learning techniques, based on the Fe_2O_3 ratio in the flat glass production data to be provided by ŞİŞECAM. At the same time, the relationship between the Fe_2O_3 ratio and the optical and color parameters of the flat glass material will be investigated. In addition, the test results created with the large data set on the material properties of the glass material will be revealed with the samples to be provided by ŞİŞECAM, and the relationship between the Fe_2O_3 ratio and the material properties will be examined.
Thanks to the work to be done with artificial learning techniques, research engineers will be able to quickly reach a conclusion about the optical and color parameters of the glass, based on the Fe_2O_3 ratio, instead of carrying out the process with many experimental studies in the current process. Thus, the number of labor-intensive laboratory studies will be reduced.

Keywords: glass, optical properties, color, modelling

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Indian Institute of Technology Delhi, India

Session	**POSTER SESSION**
Date/Time	**NOV' 17, 2022, THURSDAY (17:30 - 18:30)**
Date/Time	**NOV' 18, 2022, FRIDAY (09:00 - 10:00)**
Hall	**FOYER**

Machine Learning Based Predictions and Explanations of Glasses Properties as a Function of Composition, Testing, and Processing Parameters

Abstract
Glass manufacturers require accurate predictions of glass properties to make tailored glasses. Deciding the processing temperature for glasses or testing them under various conditions is a cumbersome process. Although the literature has different equations to achieve this objective, they are specific to some glass compositions. In this work, we take glass properties like density, refractive index, loss tangent, dielectric constant, and hardness of glasses at different testing and processing conditions available in INTERGLAD. We train machine learning models to predict these properties as a function of processing temperature, testing temperature, and wavelength. The influence of composition, testing, and processing parameter on these properties of glasses is explained using the game theory-based approach of SHAP analysis.

Keywords: glass, machine learning, processing, testing

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Session	POSTER SESSION
Date/Time	NOV' 17, 2022, THURSDAY (17:30 - 18:30)
Date/Time	NOV' 18, 2022, FRIDAY (09:00 - 10:00)
Hall	FOYER

An Innovative Approach to Analysis of Glass Furnace Data for the Energy Efficiency Purpose

Abstract

The glass industry is an energy-intensive industry. Thus, fuel consumption and energy efficiency become even more important considering global energy prices. Measured data in any process (e.g. chemical or mechanical) tends to be noisy. To keep the reliability of the process high, it is required to avoid corruption of measurement and noisy measurement. In this regard, the novel approach purposed to obtain more reliable data from glass furnaces. The approach includes a promising technique for the optimization of raw measurements based on the process model. Also, it allows detection and elimination of errors in the measurements during the process, as well as to determine whether the measurements are redundant or not. This study investigates the feasibility of using this technique in glass melting furnaces. The whole glass melting furnace is divided into three sections including the melting zone, combustion zone, and regenerator. Mass and energy conservation equations are applied for all of these parts. These parts are modeled using lumped parameters. Then, using experience from previous works in the chemical industry processes, the feasibility of using the same technique in the glass melting process is discussed. It is concluded that this method is useful in the glass industry to detect measurements hidden and uncovered errors which will result in lower energy consumption and higher glass quality.

Keywords: glass furnace, data analysis, reliability, energy efficiency, mass balance, energy balance

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Session	POSTER SESSION
Date/Time	NOV' 17, 2022, THURSDAY (17:30 - 18:30)
Date/Time	NOV' 18, 2022, FRIDAY (09:00 - 10:00)
Hall	FOYER

Estimation of Tempering Effects on Optical Spectra of Low-E Glass Coatings with Artificial Neural Networks

Abstract
Strengthened low-emission (Low-E) glass products to be used in the construction and automotive industries are obtained by depositing virtually invisible nano-scale multilayer coatings, followed by a thermal tempering process applied on the glass. The tempering process is necessary for the safety and strengthening of the glass, however, the optical behavior of the glass exhibits changes that can't be foreseen upon the tempering. This comprises a big problem since the prediction of the reflectance and transmittance behavior of glass is a major product development stage. It is therefore imperative to model the effect of heat treatment on optical spectra for practical manufacturing of desired optical quality. In this paper, heat treatment effects, i.e. the functional change in the optical spectra characteristics due to heating, are modeled with artificial neural networks, trained on particularly collected pre and post-heating measurements of various Low-E glass coatings. Experiments conducted on Low-E glass coatings exhibit the efficiency of this method on several datasets, with various coating architectures. A task-specific data augmentation technique is implemented to leverage the scarcity of training data and made the model generalizable to predict the optical performance of various coating architectures. As a result, our model shows promise with the preliminary results to potentially replace the trial and error method in the manufacturing process.

Keywords: low-e, machine learning, thin film, artificial neural networks

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Session	**POSTER SESSION**
Date/Time	**NOV' 17, 2022, THURSDAY (17:30 - 18:30)**
Date/Time	**NOV' 18, 2022, FRIDAY (09:00 - 10:00)**
Hall	**FOYER**

Preparation of Ultrathin Transition Metal Oxide and Dichalcogenide Semiconductors Films Using Atomic Layer Deposition System for UV Photonic and Optoelectronic Applications

Abstract
Due to its large electron affinity, broadband gap, variety of valence states, and layered structure, molybdenum oxides (MoO3) have attracted a lot of attention as one of the transition metal oxides that may be used in sensors, optics, catalysis, electronics, energy sources, and biological systems. Using an atomic layer deposition (ALD) technique using Bis (t-butylimido) bis (dimethylamino) molybdenum (VI) as a Molybdenum (Mo) source, we created ultra-thin Molybdenum oxide (MoO3) for this investigation. We prepared the films at temperatures of 100, 150, and 250 °C to better understand the impact of depositing temperatures. The ultra-thin films were then naturally collided after being annealed for 15 minutes at 600 0C in the air. From 1, 3, and 9 nm, various film thickens have been arranged. Energy-dispersion X-ray spectroscopy and scanning transmission electron microscopy were used to evaluate the morphological and elemental characteristics. The thickness of the films grows as the deposition temperature rises. We discovered extremely homogenous thin films with tiny particle sizes using atomic force microscopy. With an electron mobility of 9.80E+2 cm2/V, the thickness films exhibit n-type semiconductor characteristics. These results were analyzed and interpreted in the context of MoO3 surface evaporation, melting, and/or temperature-dependent atomic inter diffusion, providing new insight into the electrical uses of ALD MoO3. The application of atomically thin transition metal oxides in nonlinear electrical and photonic devices, as well as their integration, may be advanced by the findings of this study.

Keywords: Nanostructured thin films, atomic layer deposition, MoO3 ultrathin film, optoelectronics

Zürbiye Capku
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Session	**POSTER SESSION**
Date/Time	**NOV' 17, 2022, THURSDAY (17:30 - 18:30)**
Date/Time	**NOV' 18, 2022, FRIDAY (09:00 - 10:00)**
Hall	**FOYER**

Spin wave modes observation in YIG thin films with PMA

Abstract
Magnetic insulating materials with perpendicular magnetic anisotropy bring an innovation to the existing spin related technologies and magnonic applications. In particular, YIG magnetic insulators with perpendicular magnetization are potential candidates for the upcoming new generation magnetic memory and logic devices. In this context, YIG thin films with perpendicular magnetic anisotropy (PMA) gain a considerable importance in spin-torque devices, magnonic transistors and magneto-optic applications. Bulk and thick YIG materials were extensively investigated in the literature. In this work, we have reported for the first time, that YIG thin films with perpendicular magnetic anisotropy on Si (100) substrates have been successfully obtained by pulsed laser deposition. Unlike the literature, it is an original study with a non-garnet substrate and without the use of any additional layer or doping material. Si is very cost effective and enables the use of YIG magnetic insulator to be widely used in many areas where garnet substrates are not suitable. Compressive strain induced by the lattice mismatch of YIG/Si structure leads to the lattice distortion, which is the main reason for the perpendicular magnetic anisotropy in YIG thin films. Our study revealed that the structural and magnetic properties of YIG thin/ultra-thin films on the silicon substrate can be adjusted by controlling the thickness and annealing process. YIG thin films with PMA on Si substrates pave the way for cheaper and compatible fabrication process. We anticipate that our study not only offers a basis for fundamental understanding and technological applications but also will inspire future considerations about PMA in magnetic iron garnets.

Keywords: Magnetic anisotropy, spin waves, ferromagnetic resonance

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Organically Modified Superhydrophobic Silica Aerogel Thin Film as Anti-Reflective Coating on Glass Applications

Abstract

The principle of AR coatings is based on the elimination of destructive interference between the air-coating and the coating-substrate interfaces. Transparent thin films on glass require a refractive index lower than that of glass, which can be satisfied with only a few materials. Porous materials with pore sizes small enough to prevent Rayleigh scattering provide refractive index tunability. In this manner, silica aerogel is very well suited as anti-reflective film. In this study, the changes in surface coverage, hydrophobicity, and transmissivity of hybrid silica aerogels synthesized with different concentration of methyltrimethoxysilane/tetraethyl orthosilicate (MTMS/TEOS) monomers and methanol (MeOH) as solvent were investigated upon chemical modification with hexamethylisilazane (HMDS). HMDS solution was used to modify the refractive indices along with the hydrophobicity of the aerogel thin films. The transmittance of glass samples spin-coated with unmodified (25%TEOS:~87%, 50%TEOS-96%, 75%TEOS-97% @550 nm) and modified silica aerogel has been observed that higher than untreated glass (~91%@550 nm). After the modification of silica aerogel thin film with HMDS, the transmittance of the coated glass was not negatively affected, only the interference was observed due to the thickness of the aerogel layer. We can stabilize the waning hydrophobicity of the aerogel thin film due to TEOS by surface modification with HMDS. The contact angle decreases with TEOS concentration (25%TEOS:131°, 50%TEOS:98°, 75%TEOS:40°); however, we succeed in increasing the contact angle with HMDS modification up to 130 ° for aerogel thin film with poor hydrophobicity (75%TEOS). The silica aerogel films became much denser and more hydrophobic with the modification, without any adverse effect on the transmittance in the UV-Vis region. To conclude, silica aerogel films fabricated on glass substrate with TEOS and HMDS can provide anti-reflection and anti-fogging property, simultaneously.

Keywords: anti-reflective coating, sol-gel method, silica aerogel thin film, surface modification

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Enhanced the Glass Thermochromic Properties by Tuning the Metal Insulator Transition Properties of VO_2 Thin Films with the Synergetic Combination of Oxygen Vacancies, Strain Engineering, and Tungsten Doping

Abstract

With the help of an intensive high vacuum sputtering system, we can control the interface of multilayer thin films for high-performance solid-state devices. Vanadium oxide (VO_2) is considered one of the most commonly strongly correlated metal oxides that has a low phase transition temperature near 68 °C for thermochromic applications. The tuning of MIT parameters is a crucial point to use VO_2 within thermoelectric, electrochromic, or thermochromic applications. In this study, the effect of oxygen deficiencies, strain engineering, and metal tungsten doping are combined to tune the MIT with a low phase transition of 20 °C in the air without capsulation. Narrow hysteresis phase transition devices based on multilayer VO_2, WO_3, $MoO.2WO.8O_3$, and/or MoO_3 oxide thin films deposited through a high vacuum sputtering are investigated. The deposited films are structurally, chemically, electrically, and optically characterized. Different conductivity behaviour was observed, with the highest value towards $VO_{1.75}/WO_{2.94}$ and the lowest $VO_{1.75}$ on FTO glass. $VO_{1.75}/WO_{2.94}$ showed a narrow hysteresis curve with a single-phase transition. For the first time, the effect of oxygen deficiencies and strain engineering are combined to tune the phase transition of VO2 thin film near 20 °C in the air without encapsulation. Increasing the oxygen vacancies could increase the interfacial strain between each layer and the other which could enhance the surface resistance of these multilayer structures. By introducing an interfacial strain across these layers, an enhancement in the MIT of VO_2 is observed. In this former sample, $MoO.2WO.8O_3$ was used for the first time as an anti-reflective and anti-oxidative layer. The results showed that the MoO_3 bottom layer is more suitable than WO_3 to enhance the electrical properties of VO_2 thin films. This work is applied to fast phase transition devices. This structure can be implemented for many hot applications in energy and thermochromic.

Keywords: DC&RF sputtering system, thin films, vanadium oxide, thermochromic, phase transition device, metal–insulator transition

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Borosilicate Glasses for Fiber Optics

Abstract
Fiber-optical elements (fiber-optical bundles, fiber-optical plates, focons and twisters) find a wide application in medicine, electronics, motor industry and other branches of national economy. The optical fiber includes light-guiding core, reflective and protective coats. The main material for manufacturing of rigid optical fiber is optical glass. The suppression of glass crystallization processes in the production of optical fiber is a difficult technological problem. It demands performance of the experimental works connected with optimization of glass compositions for light-guiding core, reflective and protective coats. Experimental compositions of glass for optical fiber have been developed. The ratio of glass optical constant for light-guiding core and reflective coat provides the numerical aperture of 1.03. Thermomechanical strength is reached by minimal distinction of the temperature coefficient of linear expansion (TCLE) between the glass for light-guiding core and protective coat. It's 0,6·10-7 K-1. Required geometrical parameters of the optical fiber and stability of fiber drawing are achieved by the coordination of glasses on viscosity characteristics. The coordination of glass on viscosity characteristics is determined by a temperature interval of its change in the range of 1010–104 Pa·s. Glasses can be ranged as follows depending on the size of the given interval: light-guiding core–reflective coat–protective coat. Glasses for an optical fiber of the developed compositions are resistant to crystallization in the range of 600–1100 oC at their heat treatment during 24 h, do not interact with each other at the border of the reference junction in the fiber drawing and matched to each other to the refractive index, size of TCLE and viscous characteristics. This provides the increase of the light transmission of the finished fiber optic element and the decrease by 10–12 % yield of substandard product in comparison with industrial peers.

Keywords: borosilicate glasses, fiber optic, fiber optical plates, light-guiding core, refractive index, viscosity, temperature coefficient of linear expansion, structure

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Radiophysical Properties of Borosilicate Glasses Modified with Fe_2O_3, NiO, TiO_2, ZrO_2, $La2O_3$

Abstract
There are 3 groups of materials by the nature of interaction with ultra hig frequency (microwave) radiation: radio-transparent, radio-absorbing and radio-protective. Materials, including glass, that weaken the electromagnetic radiation of the microwave range by reflecting and absorbing the energy of electromagnetic radiation are called radioprotective. The main purpose of such materials is to reduce the impact of negative microwave radiation to the maximum permissible values. The purpose of this work is to study the effect of iron, nickel, zirconium, titanium and lanthanum oxides on the ability of alkaline borosilicate glasses to attenuate electromagnetic radiation of the ultra high frequency range. According to the research results, it was found that among the oxides of TiO_2, ZrO_2, La_2O_3, the highest attenuation of electromagnetic radiation in the range of 13-18 GHz is provided by glass samples including 5 mol. % ZrO_2 or 7.5 mol. % TiO_2. In our opinion, this fact is associated with the formation of some groupings in the glass structure, which cause the origin of losses (deformation and resonance), which lead to attenuation of the electromagnetic radiation of the microwave range. Introduction of La_2O_3 into the compositions of the studied alkaline borosilicate glasses in the amount of 2.5–7.5 mol. % has no significant effect on the attenuation of the electromagnetic wave energy in the range of 13-18 GHz. According to the results of modification of alkaline borosilicate glasses with Fe_2O_3 and NiO in the amount of 2.5–15.0 mol. % it is established that the real and imaginary parts of the dielectric permittivity increase with an increase in the concentration of Fe_2O_3. With an increase in the concentration of NiO, the actual part of the dielectric constant practically does not change, and the value of the imaginary part decreases. In general, this makes it possible to talk about a higher ability of iron oxide to attenuate electromagnetic radiation of the microwave range.

Keywords: radioprotective glass, absorbance, electromagnetic radiation, attenuation of the electromagnetic radiation, structure, permittivity

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Effects of Complex Modifiers on the Properties of Basalt Glasses

Abstract
Basalt glass is the basis for continuous fiber and require improvement of its technological properties, since basalts and other igneous rocks do not ensure the stability of the chemical composition. The technological problems can be solved, and the performance characteristics of the fiber can be increased through modifying components included into the basalt glass. To obtain systematic data on the effect of components on the properties of basalt glasses, glasses of the MgO–CaO–Fe_2O_3–Al2O3–SiO2 system were synthesized using chemical reagents. B_2O_3 of up to 8 wt.% was introduced as a modifying component. It has been established that an increase in the content of Al_2O_3 increases the strength from 125 to 180MPa, but leads to an increase in the duration of the glass formation stage, melt viscosity and liquidus temperature. On the contrary, additionally introduced B_2O_3 inhibits crystallization and accelerates glass melting processes. It has been established that there is a ratio of these components, which ensures the optimal combination of technological properties and the mechanical strength of glasses, which is 140–160 MPa. The established influencing patterns of the composition are applied to the development of compositions based on andesite-basalt. Kyanite-sillimanite concentrate and alumina were used as aluminum-containing components, colemanite and boric acid were used as boron-containing components. According to the study of the elastic-strength properties of modified versions of basalt glasses, it was found that the use of basalt andesite-kyanite-colemanite compositions makes it possible to increase the mechanical strength of glasses by 20%. Increased strength of basalt glass will deliver high-strength basalt fiber, which is in demand in the production of composites.
The introduction of a complex of modifiers makes it possible to adjust the composition of basalt glass and, as a result, to stabilize its technological properties.

Keywords: basalt glass, modification, fiber, strength

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Oxyfluoride Glass Ceramics Co-Doped Ho_2O_3 and Tm_2O_3

Abstract

Oxyfluoride glass ceramics activated with rare earth elements (REE) can be used as upconversion luminescent materials for optoelectronics and laser technology. When developing such materials, it is important to optimize glass composition, which, on the one hand, causes high spectral and uminescent characteristics, and, on the other hand, makes the glassy state more stable when fluorides and oxides of REE with a molar content of several hundredths of a percent are introduced. At the same time, oxyfluoride glass activated with REE combines the low energy of fluoride phonons with mechanical stability of oxide matrices. The REE of such materials partially enter both the glass and crystal phases. The fusible glass-forming system PbO–PbF_2–CdF_2–GeO_2–SiO_2 co-doped Ho_2O_3 and Tm_2O_3 was chosen here for the synthesis of initial glasses. The oxyfluoride glasses were synthetized according to traditional glass technology in an electric silicate furnace at 900oC, with holding it at the maximum temperature for 30 min. The samples were annealed at a temperature of 300°C. According to the X-ray diffraction, it was confirmed that the initial glasses were amorphous. To form the crystal structure of the original glasses, they were subjected to secondary heat treatment at 350°C/30h + 360°C/40h. X-ray diffraction patterns of the obtained glass ceramics indicate that there have been PbF_2 crystals. It is shown that the diffraction peaks are shifted relative to the reflections of a nominally pure PbF_2 crystal, indicating the distortion of the crystal structure and a change in the crystal lattice parameter, namely, the incorporation of Tm^{3+} ions into the PbF_2 crystal lattice. It has been established that the increased content of Ho_2O_3 in the original glass samples promotes the formation of a crystalline phase during the secondary heat treatment of glasses. At the same time, according to spectroscopic data, Ho^{3+} ions practically are not almost present in the crystalline phase.

Keywords: oxyfluoride glass, glass ceramics, thulium oxide, holmium oxide

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Influence of the Granulometric Composition of Silica Sand on the Glass Formation Process During the Melting of Flat Glass

Abstract
Large-scale production of sheet glass with silica sand has a problem with the depletion of developed deposits. This requires the development of new deposits, the quality of silica sand of which does not meet the established requirements. Developing rational quartz sand conditioning technology needs not only studying its characteristics, but reasonable determining the boundaries of quality indicators. It is necessary to take into account certain important indicators to implement the quartz sand melting processes. Chemical, phase and granulometric composition have a decisive influence on the glass-making processes and the quality of glass. Silica sand of the deposits of the Republic of Belarus differ significantly in the content of Fe_2O_3 in different layers along the thickness of occurrence (between 0.02 and 0.20 %), the grain composition has vast amount of large and small fractions. The latter are distinguished by a high content of coloring components. The influence of the granulometric composition of silica sand on the glass-making processes was therefore studied. The batch of the composition of flat glass was treated with heat, in the preparation of which silica sand of various granulometric composition was used. When making electron microscopy and electron probe microanalysis, data were obtained on the effect of temperature-time regimes on the grain size of residual silica and the degree of homogeneity of the glass melt at the stage of glass formation. It has been established that at 1300–1350°C, there is a significant change in the structure of the samples both in case of using fine grains of sand and larger ones. When using a fine fraction of sand, particles of 50–80 Qm formed aggregates, which slow down their dissolution. In the structure of samples obtained using silica sand with a fraction of 0.315–0.8 mm, there are melted silica particles of 100–200 Qm with the transition zones around them, which are a glass phase with an increased concentration of SiO_2.

Keywords: silica sand, glass formation, flat glass

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The Using of Digital Glass Printing Method in Art and Design Education

Abstract
The digital glass printing process has been rapidly spreading as an important revolution for over 20 years. It is used increasingly in interior architecture, glass furniture sand glass tiles, especially in the outer shells of architectural structures. In the future, it is a candidate to be the dominant printing method. Although there are three digital glass printing machine manufacturers in the world; up to 1500 machines are actively used. These machines, which 20 of them in our country, stem from the fact that artists are not yet familiar with this method. Digital printed glass surfaces are used in interior and commercial interface in our country but intensively had started to use in America. While in Europe and America; limited amount of artists use this technique but there is nobody yet to use in Turkey. This technique, which has a lot of superiority compared to the alternative of Serigraphic Printing Method; provides the artists with infinite possibilities. In this paper; methods, machines, using areas and artistic possibilities are introduced comparatively. Experiences made with the machine at the Mimar Sinan Fine Arts University Digital Printing Atelier and the student responses received during the 'Digital Printing Methods' course for 7 years are shared.

Keywords: glass, digital printing, glass education

Tourist Information

Time
Turkey is 3 hours ahead of the Greenwich Mean Time (GMT + 3)

Health & Safety
Emergency telephone number: Medical 112

Climate and Clothing
In late November, the weather in Istanbul is generally cool and slightly overcast. Daily temperatures average at 18 oC (64 oF). Please note that temperatures might noticeably drop during night time, so bringing a suitable outerwear is recommended.

Cuisine and Restaurants
Istanbul's culinary landscape is among the most varied and extensive in the world, and there are many restaurant alternatives offering the classics of Turkish cuisine as well as several exemplary interpretations of international cuisine. In every part of the city there are small cafés, restaurants and kiosks serving excellent food in the lower price category. The attendees, regardless of their gustatory aim will not lose too much time before discovering a satisfying option.

Please note that the adjacent shopping mall houses a big food court, individual restaurants and several cafes, and the working hours (10:00 AM to 22:00 PM) suitably cover and extend beyond the conference schedule except for the breakfast.

Medical Services
Having travel insurance is highly recommended. For minor problems, it's customary to ask at a chemist/pharmacy (Eczane) for advice. Make sure you know the generic name of your medicine; the commercial name may not be the same in Turkey. The word for hospital is 'Hastane'. Most doctors in Turkey can communicate in English.

Money and Currency Exchange
The unit of currency is the Türk Lirası (Turkish Lira; TL). TL is fully convertible to other currencies and there is no black market. There are many currency exchange offices scattered throughout the city, as well as the ones at each city airport. The ones at the airports operate 24/7 whereas the others typically operate between 9:00 AM and 7:00 PM. Finally, there is one exchange office inside the adjacent shopping mall. At each location, the instantaneous buying and selling prices will be listed on electronic boards. Indicative exchange rates between TL and other national currencies can be accessed from several online platforms. One reliable link is https://www.isbank.com.tr/EN/prices-and-rates/foreign-exchange-rates/Pages/foreign-exchange-rates.aspx

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 generally vary from TL 2000 to TL 3000 per day, though the exact number varies from bank to bank.

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 is perhaps the least accepted card system. 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 typically cash them. You will 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 participate in the refund scheme. When you are leaving Turkey, simply present your 'tax free' invoices and passports to the customs officials. The staff in charge will stamp the receipts and your Global Refund invoice/check. They will process the refunds for purchases that have been made up to 3 months prior. You have several choices 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 Isbank is open 24/7. Sabiha Gökçen Airport Isbank branch is open 24/7. Karaköy Harbor Isbank branch is also open 24/7.

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