front cover: AGC Yokohama Technical Center

武漢理工大學
WUHAN UNIVERSITY OF TECHNOLOGY

AGC

The 1st International Symposium on Glass Science & Technology between AGC and WUT

Jun.7th, 2021 Wuhan & Yokohama

Your Dreams, Our Challenge

Introduction

Date and Time	**June 7, 2021 (Monday) 13:00～17:20（CST）** **14:00～18:20（JST）**
Venue	**Offline: Wuhan University of Technology** **& Online: Japan** (pre-registration required)
Objective	This symposium is focused on the research, development and application of advanced glass materials and related technologies. The objective is to provide a platform for engagement and exchange about recent research in the field of glass science. The event is also an opportunity to initiate potential collaboration between WUT and AGC.
Language	The main language will be English. Translation services (Chinese <> Japanese) will be available.
Steering Committee	Professor Xiujian Zhao, Wuhan University of Technology Akio Koike, AGC Inc.
Executive Chair	Professor Haizheng Tao, Wuhan University of Technology Long Shao, AGC Inc.
Organizing Committee	Associate Professor Shouqin Tian, Wuhan University of Technology Yu Hanawa, AGC Inc. Shigeki Sawamura, AGC Inc. Qing Li, AGC Inc. Lijun Zhu, AGC Inc.
Contact Us	If you have any questions, please feel free to contact us: Long Shao long.shao@agc.com Lijun Zhu lijun.zhu@agc.com Shouqin Tian tiansq@whut.edu.cn

About State Key Laboratory of Silicate Materials for Architectures in WUT

Research Activities on Glasses in WUT

The research on glasses in WUT has a history of over 50 years, and the featured research on glasses and related materials is highlighted as follows:

1) Amorphous silicon thin film solar cells

2) Phase separation, nucleation, crystallization and glass-ceramics

3) Glass structure and theoretical or computer modeling

4) Glass properties (optical and photonic, thermal, mechanical, electrical and electronic, chemical properties, etc.)

5) Micro or nano-structured non-crystalline materials

6) Glass preparation, including sol-gel and next generation melting system of glass

7) Novel glasses and applications in photonics, electronics, energy generation and biotechnology, etc.

8) Multifunctional coatings on glasses for architectures

9) Multiscale modeling amorphous materials and application on Energy and Environment

10) Concrete and Cement materials

The group on glass research in WUT includes 13 professors, 8 associate/assistant professors, and more than100 students. We have performed about 40 projects (about 30 from government and 10 from corporations), including the important projects supported by the National Basic Research Program of China, the Natural Science Foundation of China, the Program for Changjiang Scholars and Innovative Research Team in University (PCSIRT), Ministry of Education, China. During these 10 years, the total funding is over 50 million. Under the joint efforts of group members, we have been authorized 40 patents, and published more than 500 papers in prestigious journals such as Science, Sci. Adv., Adv. Mater., Nat. Commun., Adv. Sci., J. Non-Cryst. Solids, etc. Through the close cooperation with the industrial partners, some patents on the self-cleaning glass, smart window for energy saving and amorphous thin film solar cells, for example, have been successfully commercialized.

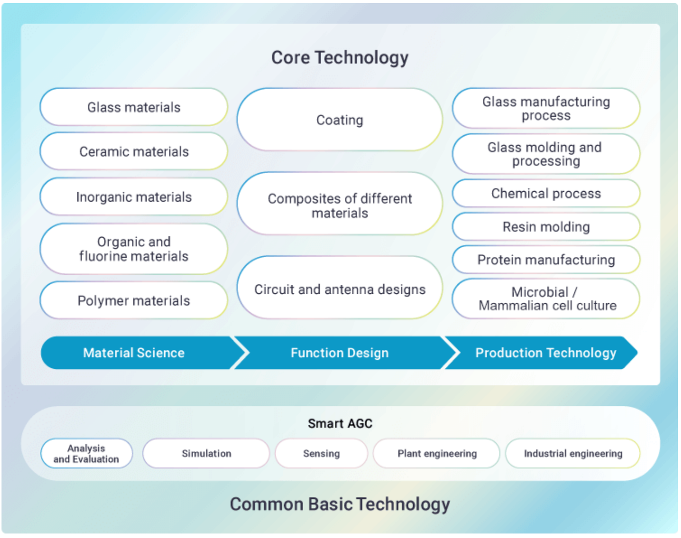
About AGC's R&D

● Three Strategic Business Categories of Research and Development

AGC will provide solutions with higher added value targeting the categories of mobility, electronics and life sciences.

● Common Basic Technology and Core Technology

AGC's core technologies consist of highly sophisticated materials science, functional design that integrates materials science to achieve more advanced functionality and production technology that enables stable production of high-quality products, based on the common basic technology that has been accumulated and deepened over many years. We also possess technologies for designing parts by assembling various materials, which we cultivated through our efforts to meet customers' expectations and our experience of utilizing various materials, and this enables us to bring out the full potential of materials.



● About Glass materials

Application of glass is expanding into various fields, such as window glass for buildings and automobiles, glass for flat panel displays (LC and organic EL), cover glass for smartphones, glass for electronic components, glass for solid electrolyte of ion batteries etc. AGC is deepening the composition design technologies for glass in order to meet the needs in these fields. We are also working on material designs from a new perspective by analyzing the structures of glass with advanced analytical and simulation technologies. Furthermore, we realized manufacturing of more advanced glass, and aim to commercialize it in a short period of time by collaborating with production technology development.

----------------------- Symposium Program -----------------------

Jun.7th (Meeting room: Room No.6 of East Teaching Building in WUT,
Online Meeting via Microsoft Teams with AGC)

Time (CST)	Topic	Speaker
13:00-13:10	Opening Remarks	**Kanoh** Takako AGC
13:10-13:20	Greetings / General Speech from AGC	**Sugimoto** Naoki AGC
13:20-13:30	Greetings / General Speech from WUT	**Zhao** Xiujian WUT
13:30-14:00	Toward hard and highly crack resistant aluminosilicate glasses	**Tao** Haizheng WUT
14:00-14:30	In-situ Raman mapping of glass under a Vickers indenter	**Yoshida** Satoshi AGC
14:30-15:00	Ultra-strong transparent glass ceramics for mobile devices	**Zhang** Jihong WUT
15:00-15:10	Coffee break	
15:10-15:40	Pressure control of fluctuations in glass	**Ono** Madoka AGC
15:40-16:10	VO_2 based thermochromic glass	**Tian** Shouqin WUT
16:10-16:40	Anisotropic structure and properties of alkali metaphosphate glass	**Inaba** Seiji AGC
16:40-17:10	Formation, structure and properties of melt-quenched metal-organic framework (MOF) glasses	**Qiao** Ang WUT
17:10-17:20	Concluding Remarks	**Koike** Akio AGC
17:20-17:30	Group Picture (Online & Offline)	
18:00-20:00	Dinner @Wuhan	

Scientific Abstracts & Speaker Biographies

Toward hard and highly crack resistant aluminosilicate glasses

Haizheng Tao

Wuhan University of Technology

Abstract

High hardness and high crack resistance are usually mutually exclusive in glass materials. Through the aerodynamic levitation and laser melting technique, we prepared a series of aluminosilicate glasses, and found a striking enhancement of both hardness and crack resistance with increasing Al_2O_3 or MgO. Based on the structural analyses, we propose an atomic-scale model to explain the mechanism of synergetic enhancement in hardness and crack resistance for the aluminosilicate glass, which provides a roadmap for designing and fabricating both hard and highly crack resistant glass materials.

Potential applications

Hard and tough glasses are particularly desired in many fields such as vehicles, civil engineering, and electronic devices.

Biography

Haizheng Tao is a Professor of State Key Laboratory of Silicate Materials for Architectures at Wuhan University of Technology (WUT). He received his Ph.D. from WUT in 2004. He is the author of over 200 international peer-refereed papers and 31 granted patent. He is the vice chair of Special Glass Branch of the Chinese Ceramic Society. His current research interests focus on glasses and amorphous materials for optical window, buildings and energy storage.

In-situ Raman mapping of glass under a Vickers indenter

Satoshi Yoshida

AGC Inc.

Abstract

Contact damages in glass are classified into plastic deformation and crack initiation. Since a surface defect reduces strength of glass, we should understand both structural origin of cracking and detail mechanism of deformation in glass. The indentation test using a sharp diamond indenter has been exploited to model the contact damages of glass against foreign bodies, e.g. gravel or ballast. Using a Vickers indenter, for example, we can obtain a permanent imprint with various types of cracks. However, deformation mechanism under the indenter and dominant factors for cracking is still unclear at present. This is probably because we lack information on structural changes of glass under complex stress states.

In this study, we focus on in-situ structural changes of glass under a Vickers indenter using a micro-Raman spectrophotometer coupled with a self-made indentation equipment. Using this set-up, structural changes of glass under a Vickers indenter were successfully determined through in-situ Raman spectra. It was found that the Vickers indentation induces transient and permanent structural changes in glass, and that the structural change varies from point to point of the glass under the indenter.

Potential applications

High strength and tough glass not only for mobile phone but for future unknown applications.

Biography

Satoshi Yoshida graduated from Kyoto University, Japan, and got his B.E.(1993), M.E.(1995), and Ph. D.(2003) from Kyoto University. In 1995, he started to work as an assistant professor of Department of Materials Science in the University of Shiga Prefecture (USP), Japan. From 2007 to 2020, he worked as an associate professor at USP. During the year 2004-2005, he also worked as a visiting professor of the University of Rennes 1, France. Dr. Satoshi Yoshida was awarded the 14th Otto Schott Research Award (2016) from Ernst Abbe Fund and the CerSJ award for Academic Achievements in Ceramic Science and Technology from the Ceramic Society of Japan. His main research topic is deformation and fracture behavior of oxide glasses.

Ultra-strong transparent glass ceramics for mobile devices

Jihong Zhang

Wuhan University of Technology

Abstract

Chemical strengthened glass for mobile display cover materials have attracted much attention. Transparent glass ceramics can be a promising alternative because the internal nanocrystals provide better hardness and the inhibition of crack growth. In this research, transparent glass ceramics containing nepheline ($KNa_3(AlSiO_4)_4$), and lithium disilicate ($Li_2Si_2O_5$)/ petalite ($LiAlSi_4O_{10}$) nanocrystals were investigated. The Vickers-hardness could be ~ 900 kgf/mm^2, and ~1000 kgf/mm^2 after ion-exchange strengthening. The 4-point bending strength could be ~1000 MPa. The ball-drop height could be over 100 cm. The transmittance in visible range could be ~91%, for 0.7 mm glass plate. The thermal bending parameters were discussed, for 3D display protection. In addition, ultra-thin glass ceramics (UTGC) for foldable devices will be discussed.

Potential applications

Glass ceramics with excellent mechanical and optical transmittance properties for mobile, wearable, and smart devices display protection.

Biography

Jihong Zhang is an associate professor in the State Key Laboratory of Silicate Materials for Architectures, Wuhan University of Technology (WUT). He is the author of over 40 international peer-refereed papers and 10 granted patents. His current research interests include ultra-thin and ultra-strong glass and glass ceramics, the additive manufacturing (3D print) of GRIN glass, noble metal nanostructure based fiber sensors and infrared glass.

Pressure control of fluctuations in glass

Madoka Ono

AGC Inc.

Abstract

Silica glass is the most indispensable material in optical communication and high-power laser applications due to its superior optical properties. However, the optical loss remains an outstanding challenge in both fields. More than 80% of the optical loss in silica glass is due to Rayleigh scattering, which can be suppressed by reducing the density fluctuations. Previously, reducing fictive temperature had been the only path toward reducing density fluctuations. Pressure-quenching is another recently discovered method for reducing density fluctuations.

In the talk, I will introduce the recent findings about the pressure control of fluctuations in silica glass. We recently applied molecular dynamics simulations to predict the Rayleigh scattering loss of pressure-quenched silica glass at higher pressure. The models predict further suppression of loss is possible.

Potential applications

Highly transparent silica glass is desired for fiber-core material in optical communication and high-power laser applications. It is also said to be indispensable for quantum key distribution (QKD).

Biography

Madoka Ono has completed her PhD in the year 2004 from Tokyo University. Her PhD research was the study of linear and nonlinear optical responses of low-dimensional Mott insulators. After joining AGC, her researches since then were; 1. Electron-emission properties of Calcium Aluminate Electride 2. Improvement of the transmittance and laser-durability of silica glass 3. Studies of glass composition and structure for optimization of strength in glass. She is working as not only a principle researcher in AGC, but also as an associate professor in Hokkaido University. She received is a prize from Japanese Laser Community in 2019. She is a board member of Japanese division of International Year of Glass 2022.

You can find her at https://researchmap.jp/MO-Hokudai

VO_2 based thermochromic glass

Shouqin Tian

Wuhan University of Technology

Abstract

At present, VO_2-based thermochromic glass is an important way to rationally adjust and utilize sunlight to realize the building energy saving because its phase transition at near room temperature can lead to a large change in the NIR transmittance. However, it is not widely applied due to its main drawbacks including low visible light transmittance, poor solar modulation efficiency, higher phase transition temperature and weak environmental durability. In order to solve these problems, the mesoporous VO_2 granular dispersion films with controllable pore size and particle size were designed. The local surface plasma resonance effect of isolated VO_2 nanocrystals in the films at high temperature was employed to enhance the solar modulation efficiency and dispersion structure was used to improve the visible transmittance. W dopant was introduced into the dispersion structure to reduce the phase transition temperature. These three effects lead to a remarkable energy saving efficiency. The VO_2/ZnO bilayer structure was designed to delay the oxidation of VO_2 layer by the charge transfer effect in the heterogeneous interface, improving the environmental durability of the intelligent energy-saving glass.

Potential applications

The VO2 based thermochromic glass will be applied in smart windows to realize the rational untilization of solar energy in response to the ambient temperature change. It will be also applied as intelligent thermal protection shield of some devices.

Biography

Shouqin Tian received the B.S. degree in Materials Science and Engineering from Wuhan University of Technology (WUT), Wuhan, China, in 2007, and the M. S. and Ph. D degrees in Materials Science from Huazhong University of Science and Technology, Wuhan, China, in 2009 and 2013, respectively. He was a visiting research scholar in the department of Chemistry at University College London, London, UK. He is currently an associate professor in the Stat Key Laboratory of Silicate Materials for Architectures at WUT. He has over 50 publications in SCI journals and five authorized national invention patents. His research interests include coating glass and functional films. He also serves as a director of Thin Film and Coating Branch of Chinese Silicate Society, a director of the Silicate Society of Hubei Province, a member of Youth Working Committee of Chinese Ceramic Society and a topic editor of Materials.

Anisotropic structure and properties of alkali metaphosphate glass

Seiji Inaba

AGC Inc.

Abstract

Entropic elasticity, a property typical of rubbers and well known in organic polymers with appropriate network structures, is not known to occur in oxide glasses. Here, we report the occurrence of entropic elasticity in alkali metaphosphate-glass fibers with highly anisotropic structures, drawn by mechanical elongation from supercooled liquids. We observed a large lengthwise shrinkage of ~35% for phosphate glasses with an enhanced one-dimensional structure, as well as a distinct endotherm on reheating them up to temperatures between that of the glass transition temperature Tg and the softening temperature. The novel aspect of our experimental results is that the shrinkage was induced by entropic elasticity, typical of rubbers. This is the first observation of entropic deformation of an oxide glass. We consider that non-crystalline materials, regardless of whether they are organic or inorganic, show more or less entropic elasticity in the rubbery region above Tg. Rubber is a typical example of extensive entropic elasticity, whereas most oxide glasses, which have polymerized three-dimensional structures, rarely exhibit entropic elasticity. Special glasses with a highly designed chain structure are an exception.

Potential applications

Considering that the anisotropic glass shows huge shrinkage and an excellent resistance of oxidization at high temperatures, a potential application area for our discovery is as a smart material within various sensors and actuators in electric appliances and anti-vibration materials that could work at high temperatures.

Biography

He received Ph. D degree in Materials Science and Engineering from Kyushu university in 2002. His Ph. D research was the study on compositional dependence of elastic and thermal properties of oxide glass. He involved in the development of glass substrate for magnetic disk and novel noncontact method for measuring the viscosity of high temperature melts in his former jobs. He has been employed by AGC Inc. since 2014 and engaged in the research, development and analysis of new functional glass for the electronics fields.

Formation, structure and properties of melt-quenched metal-organic framework (MOF) glasses

Ang Qiao

Wuhan University of Technology

Abstract

Melt-quenched metal-organic framework (MOF) glasses are a newly emerged glass family, distinct from existing organic, inorganic and metallic glass families. MOF glasses are characterized by organic-inorganic hybrid composition and fully polymerized glass network, where metal nodes are linked by organic ligands through coordination bonds. This class of glass exhibits numerous unique properties and potential applications. I will present our recent works on investigating the formation mechanism, microstructure and properties of MOF glasses. Specially, I will highlight the discovery of MOF glass former with ultrahigh glass-forming ability, the breakthrough in revealing short-range disorder in MOF glasses and investigations of their optical, mechanical properties and porosity, as well as the approaches for tuning the glass structure and properties. Researches on MOF glass give a new perspective for understanding the fundamental mechanism of glass formation, and find MOF glasses to be good candidates for functional glasses with tunable properties.

Potential applications

Potential applications in gas separation and storage, luminescence, batteries and so on.

Biography

Dr. Ang Qiao is Professor of Materials Science at State Key Laboratory of Silicate Materials for Architectures at Wuhan University of Technology. He received his Ph.D. degree in Materials Science and Engineering from Wuhan University of Technology in 2017, followed by two years postdoctoral research in Professor Yuanzheng Yue's group at Aalborg University, Denmark. His research interests are focused on preparation, glass formation mechanism, microstructure and properties of metal-organic framework glasses. He has published over 20 papers in international peer-refereed journals, including two research papers in Science and Science Advances as co-first and first author respectively.

Thank You