frontiers | Frontiers in Materials

TYPE Editorial
PUBLISHED 18 November 2022
DOI 10.3389/fmats.2022.1079681

Check for updates

OPEN ACCESS

EDITED AND REVIEWED BY
Valeria Cannillo,
University of Modena and Reggio Emilia, Italy

*CORRESPONDENCE
Stefan Karlsson,
stefan.karlsson@ri.se
Shinji Kohara,
kohara.shinji@nims.go.jp

SPECIALTY SECTION
This article was submitted to Ceramics and Glass, a section of the journal Frontiers in Materials

RECEIVED 25 October 2022
ACCEPTED 02 November 2022
PUBLISHED 18 November 2022

CITATION
Karlsson S and Kohara S (2022), Editorial: Innovators in ceramics and glass.
Front. Mater. 9:1079681.
doi: 10.3389/fmats.2022.1079681

Editorial: Innovators in ceramics and glass

Stefan Karlsson[1]* and Shinji Kohara[2]*

[1]Glass Unit, Division of Built Environment, Department of Building and Real Estate, RISE Research Institutes of Sweden AB, Växjö, Sweden, [2]Research Center for Advanced Measurement and Characterization, National Institute for Materials Science, Tsukuba, Japan

KEYWORDS

innovators, ceramics, glass, editorial, sustainable develoment

Editorial on the Research Topic
Innovators in ceramics and glass

In the year of 2022, which falls during an age of transition towards sustainability, the United Nations' seventeen global goals define the direction of development. Materials development is an important component of sustainable development and innovation. The latter is conventionally defined as the implementation of creative ideas that are introduced into society in the form of services or goods. However, in order for innovations to arise, innovators are required. An innovator is a person or a group who introduces something novel, e.g., a method, an idea, or a product, or does something for the first time. The term *pioneer* is frequently used to describe an innovator who creates a paradigm shift, but innovators are also those who contribute incremental ideas that eventually combine to produce innovations. This model of incremental and disruptive innovation draws a simple distinction, but we stress that both types of innovators are needed to drive sustainable development.

Ceramics and glasses are not the most widely studied materials, yet they see versatile use in a wide range of applications due to their properties (e.g., mechanical, chemical, optical, and electrical) and the multiple processes by which they are manufacturable. Over the years there have been many innovators within ceramics and glass; we mention some of them below (n.b., the list could be made much longer).

- Mikhail Lomonosov, a Russian scientist who experimented with colored glasses (Leicester, 1969; Karlsson, 2012).
- Josiah Wedgwood, an English potter who systematically experimented in pottery (Chaldecott, 1975).
- Erik Laxman, a Finnish glass technologist who replaced potash with soda (Karlsson, 2012).
- Otto Schott, a German chemist and the inventor of borosilicate glass, who also systematically investigated composition–property relationships (Fotheringham et al., 2022).
- William J. Woods and David E. Gray, inventors of the ribbon machine for manufacturing light bulbs (Cable, 1999).

- S. Donald Stookey, American inventor and originator of glass-ceramics (Beall, 2016).
- W. David Kingery, American material scientist and the father of modern ceramic science (Brook, 2000).

Due to the importance and widespread use of glass, 2022 has been designated *International Year of Glass* (IYOG 2022, www.iyog2022.org) by the United Nations (Duran and Parker, 2021). Since 1959, the United Nations has dedicated international years to a variety of topics to attract attention to pressing issues and to provide a platform for international action on sustainable development. Interest in this practice has increased over the years, so 2022 is also designated International Year of Basic Sciences for Sustainable Development (www.iybssd2022.org) and Sustainable Mountain Development (https://www.fao.org/mountain-partnership/internationalyear2022/en/). The designation of IYOG 2022 has led to the organization of several celebrations and informational activities, e.g., publication of papers, editorials, and special issues, and other scientific activities (Duran and Parker, 2021; Ballato, 2022; Ballato et al., 2022; Castro and Jitianu, 2022; Choudhary et al., 2022; Fotheringham and Müller, 2022; N/A, 2022; Nielsen et al., 2022; Parker and Durán, 2022). The current Research Topic, "*Innovators in ceramics and glass*," is also partly dedicated to celebration of the IYOG 2022. Time will tell whether we will also have an international year of ceramics in the future.

In the current collection of papers, six innovative contributions have been published; these are introduced below. In summary, they all represent innovative approaches towards sustainable future applications by offering new advances in understanding on novel methods, processes, and simulations, and on the structure–property relationships of ceramic and glass materials.

A review paper describes the electrostatic levitation furnace (ELF) facility installed at the International Space Station (ISS) and the measurement methods employed, and reports on the thermophysical properties determined for Al_2O_3, HfO_2, ZrO_2, and lanthanoid sesquioxides (Ishikawa et al.). The ISS-ELF facility provides opportunities to study high -temperature melts that would be extremely difficult to study using conventional methods and enables the determination of a set of basic physical properties: density, surface tension, viscosity, and in the future probably also heat capacity.

Reverse Monte Carlo (RMC) modelling combined with extended X-ray absorption fine structure (EXAFS) and X-ray diffraction (XRD) data on disordered Fe-Ni alloys enables visualization of the atomic arrangement of the structure, which is classified as an intermediate structure between the glassy and crystalline states (Kubo et al.). The study reveals a non-randomly distributed atomic arrangement but an elongation of the Fe-Fe pairs in the ferromagnetic phase at low pressures, which exhibits a strong correlation with magnetic and elastic anomalies.

The structure of layered perovskite lanthanum nickelate doped with Ca^{2+} was studied using molecular dynamic simulations and Monte Carlo simulations supported by complementary data from neutron diffraction and X-ray absorption near edge structure (XANES) measurements (Kitamura et al.). Lanthanum nickelate is an interesting material for application in air electrodes in solid oxide fuel cells (SOFCs). The study revealed that the conductive oxide ions surround La^{3+} but not Ca^{2+} and that Ca^{2+} doping results in a volume decrease around the O^{2-} ions, which consequently leads to a decrease in conductivity.

The piezoelectric materials $Ca_3TaGa_3Si_2O_{14}$ (CTGS) and $Ca_3TaGa_{1.5}Al_{1.5}Si_2O_{14}$ (CTGAS) were studied through use of X-ray fluorescence holography (XFH) (Kitaura et al.), which is a relatively novel method for studying the short-to-medium-range order of materials. Piezoelectric ceramics are essential as stress sensors for simultaneous control of pieces of equipment located in different environments. The XFH results reveal that the relative positional shift of the Ca atom is responsible for the piezoelectricity and that a larger relative positional shift occurs as Ga is substituted for Al.

Filament-based 3D printing of silica glass using CO_2-laser heating, with a focus on the bonding width of first-layer printing onto fused quartz substrates, was studied by Liu et al. Their investigation of parameters including printing speed, filament feed rate, and incident laser power generated detailed information on the bonding between printed line and substrate, including the shape dynamics (height and width) of the printed line. This enabled the highly reproducible demonstration of a 3D printed object with >100 printed layers. This significant advancement in the field of glass additive manufacturing provides a new platform for advanced glass fabrication in applications within life science, chemistry, optics, and electronics.

The mechanical, thermal, and structural properties of chemically strengthened soda lime aluminosilicate glasses were studied (Karlsson et al.). Chemical strengthening of glass is complex, and the process and its implications are still not completely understood. SiO_2-for-Al_2O_3 substitution revealed a reduction in the degree of K^+-for-Na^+ ion exchange. Application of ^{23}Na NMR revealed a resonance displacement that could be attributed to an overall reduction in the mean Na coordination number. Differential thermal analysis revealed a blurred glass transition temperature (T_g) range and a sub-T_g exothermic step for these chemically strengthened types of glass. Nanoindentation in combination with scattered light polariscope stress data revealed that the increased hardness from chemical strengthening can be directly correlated with compressive surface stress. Crack resistance is favored by an increase in polymerization and decrease in compactness, which is indicated to be linked to the buildup of residual compressive stress.

We sincerely believe and hope that the paper collection "Innovators in Ceramics and Glass" will influence future innovators in their research on ceramics and glassy materials towards an improved understanding of this domain and towards sustainable development. In summary, we encourage both pioneering and incremental contributions to ceramics and glass science and engineering in the future.

Author contributions

StK prepared a draft of the editorial and ShK revised the draft.

Acknowledgments

StK acknowledges funding from FORMAS, the Swedish Research Council for Sustainable Development (Grant No. 2018-00707). ShK acknowledges funding from JSPS Grant-in-Aid for Transformative Research Areas (A) "Hyper-Ordered Structures Science" (Grant Nos 20H05881 and 20H05878).

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

All claims expressed in this article are solely those of the authors and do not necessarily represent those of their affiliated organizations, or those of the publisher, the editors and the reviewers. Any product that may be evaluated in this article, or claim that may be made by its manufacturer, is not guaranteed or endorsed by the publisher.

References

Affatigato, M., and Durán, A. (2022). Special issue: Celebrating the international year of glass. *Int. J. Appl. Glass Sci.* 13 (4), 139. doi:10.1111/ijag.12344

Ballato, J. (2022). Optical fiber: Through the looking glass. *Opt. Photonics News* 33 (3), 30–40. doi:10.1364/opn.33.3.000030

Ballato, J., Seddon, A., Clare, A., Petit, L., Hu, J., and Richardson, K. (2022). Future of optical glass education. *Opt. Mat. Express* 12 (7), 2626–2634. doi:10.1364/OME.457792

Beall, G. H. (2016). Dr. S. Donald (don) Stookey (1915–2014): Pioneering researcher and adventurer. *Front. Mat.* 3 (37). doi:10.3389/fmats.2016.00037

Brook, R. J. (2000). W. David Kingery (1926–2000). *Nature* 406 (6796), 582. doi:10.1038/35020685

Cable, M. (1999). Mechanization of glass manufacture. *J. Am. Ceram. Soc.* 82 (5), 1093–1112. doi:10.1111/j.1151-2916.1999.tb01883.x

Castro, Y., and Jitianu, A. (2022). Preface for the SI international year of glass IYOG 2022. *J. Solgel. Sci. Technol.* 102 (3), 465. doi:10.1007/s10971-022-05858-1

Chaldecott, J. A. (1975). Josiah Wedgwood (1730–95)—scientist. *Brit. J. Hist. Sci.* 8 (1), 1–16. doi:10.1017/s0007087400013674

Choudhary, M. K., Pye, L. D., and Duran, A. "The united Nations international year of glass-2022," in Proceedings of the 82nd Conference on Glass Problems, Ohio, USA, November 2022 (John Wiley & Sons).270

Duran, A., and Parker, J. (2021). How the united Nations international year of glass 2022 arrived and what happens now. *Glass Technology-European J. Glass Sci. Technol. Part A* 62 (2), 45–46.

Fotheringham, U., and Müller, M. (2022). Optical glass: An interplay of challenges and success. *Photoniques* 113, 20–25. doi:10.1051/photon/202111320

Fotheringham, U., Petzold, U., Ritter, S., and James, W. (2022). Optical glass and optical design: Otto Schott's role in the entangled development. *Opt. Mat. Express* 12 (8), 3171–3186. doi:10.1364/OME.460691

Karlsson, K. H. (2012). Mikhail Lomonosov, Erik laxman and the dawn of glass technology - European journal of glass science and technology Part A. *Glass Technol. - Eur. J. Glass Sci. Technol. Part A* 53 (5), 189–191.

Leicester, H. M. (1969). Mikhail Lomonosov and the manufacture of glass and mosaics. *J. Chem. Educ.* 46 (5), 295. doi:10.1021/ed046p295

Nielsen, J. H., Belis, J., Louter, C., Overend, M., and Schneider, J. (2022). Celebrating the international year of glass. *Glass Struct. Eng.* 7 (1), 1. doi:10.1007/s40940-022-00173-1

Parker, J. M., and Durán, A. (2022). Glass, optics and IYOG: Opinion. *Opt. Mat. Express* 12 (8), 2938–2941. doi:10.1364/OME.463038