

Preface

A workshop titled “Advanced Materials and Innovative Glass Melting Technologies” was held in Brig, Switzerland from 26 to 29 March 2008 as part of the European program EFONGA (European Forum on New Glass Applications) to promote the collaboration of scientists in the field of glassy materials. The EFONGA program is a European Coordination Action, headed by Prof. R. Vacher, University Montpellier in France and Dr K. Bange, Schott AG, Mainz in Germany, and aims at co-ordinating scientists working in fundamental and applied pre-competitive research in the fields of glassy materials, characterization of glassy materials as well as glass production and processing technologies. The workshop in Brig was based around specific areas of the EFONGA program and was conducted in two parallel parts: Workshop A focused on advanced materials and Workshop B looked at innovative glass melting technologies. Leading experts were invited to these workshops to give talks and prepare the ground for discussing and preparing a roadmap. While W. Höland, Ivoclar Vivadent AG, Liechtenstein was responsible for the scientific content of Workshop A, R. Beerkens, TNO, Netherlands was in charge of Workshop B.

Before the attendees split into their respective workshop groups, a joint event took place, centred around the keynote lectures of D. Chowdury, Corning Inc., France on the “Future opportunities for the application of glass” and U. Roger, German Glass Society, Germany on “The future of glass”.

At the end of the individual workshops, the attendees of both groups A and B were invited to evaluate the roadmap that was developed in the course of the workshop.

The present special edition of the Journal of European Ceramic Society includes the lecture notes of almost all scientific talks given in Workshop A. (*Note*: Selected contributions of Workshop B will be published in the Journal of the European Glass Society.) The overall topic of Workshop A was “Advanced Materials” and the talks given within this context focused on *glasses, glass–ceramics and biomaterials*. Lectures were presented by the following scientists, who are leaders in their respective fields:

(1) Glasses and glass–ceramics:

- J. Alkemper, Schott AG, Mainz, Germany: Trends in optical and technical glasses.
- R. Brow, University of Missouri-Rolla, Rolla, MO, USA: Energy and environmental application for glasses and glass–ceramics.

- J. Deubener, University Clausthal, Clausthal, Germany: New functional glasses and glass–ceramics for energy application and conservation of natural resources.
 - G.H. Beall, Corning Inc., Corning, NY, USA: Refractory glass–ceramics.
 - C. Rüssel, University of Jena, Jena, Germany: New chemical systems for nano glass–ceramics.
 - J. Mauro, Corning Inc., Corning, USA: Advanced glasses and glass–ceramics through fundamental research.
- (2) Biomaterials:
- H. Hofmann, EPFL, Lausanne, Switzerland: Ceramics for functional application.
 - J. Chevalier, INSA, Lyon, France: New trends for medical application.
 - L.L. Hench, University of Tucson, USA: 21st Century challenges for glasses and ceramics.
 - T. Kokubo, Shubu University, Kasugai, Japan: Development of bioactive materials based on surface chemistry.
 - J. Jones, Imperial College, London, UK: New trends in bioactive scaffolds.
 - R. Hicckel, University of Munich, Munich, Germany: Trends in materials from the point of view of a practicing dentist.
 - W. Höland, Ivoclar Vivadent AG, Schaan, Liechtenstein: Future perspectives of biomaterials for dental restoration.

These talks provided the basis for thoughtful discussions to establish a roadmap. The discussions took place under the guidance of J. Deubener, L.L. Hench and W. Höland and were further facilitated by the methodical work of D.J. Koch, ISI Fraunhofer Institute, Karlsruhe, Germany. In addition to the above speakers and facilitators, the following persons were involved in preparing the roadmap: R. Vacher (France), K. Bange (Germany), J. Parker (UK) and E. Apel (Liechtenstein). Essentially, the roadmap, which was compiled by J. Chevalier, J. Deubener, W. Höland and D.J. Koch, comprises the following points:

(1) Glasses and glass–ceramics:

- In the course of the roadmap-related discussions, the following areas emerged as particularly important to the field of glasses and glass–ceramics:
- strategies for education,
 - relationship between toughness and strength,
 - solar glass,
 - modelling and solar photocatalysis/chemical reactions,

- glasses for photonics,
 - glass with add-on functionalities.
- After the areas had been prioritized, the roadmapping discussions explored the first two priorities. Emphasis was given to the following points in particular:

- The strategies for *education* should in particular aim at increasing the interest of young people in materials science.
- Under the keywords *tough and strong*, the particular material requirements of products that demonstrate both high strength and high toughness were discussed. According to the strategies of the EFONGA program, understanding the relationship between the toughness and strength of a material is a key area of investigation and shall be used to develop tailor-made materials. In this context, the various approaches to glass failure and measuring methods to determine the strength and toughness of materials were discussed.

(2) Biomaterials:

Biomaterials include functional ceramics, glasses and glass–ceramics. The following areas of investigation were defined as being central to the roadmap:

- Nanostructured materials:

Problems regarding upscaling aspects of nano-scaled monolithic ceramic products versus fast processing of nanoscaled ceramic coatings were reviewed. Other topics discussed included safety issues, control of agglomeration, loss of functionality by agglomeration, material handling, and understanding of materials properties from modelling.
- Bioactive materials for tissue regeneration:

Discussion focused on types of tissues, different aspects of materials properties, understanding of biological and materials mechanisms, and understanding of response of living tissue (soft and hard tissue/ bone).
- Dental materials:

Future directions of metal-free restorations (tough and strong with special optical properties) and minimally invasive techniques.
- Tests for bioactive materials:

The discussions related to conclusions about the adoption of experiences from a new ISO test of treating the materials in simulated body fluid. The participants agreed that there is also a need for a cell-based test with stan-

ard cell-type, cell-seeding, concentration, flow-rate, etc. A standardised test for aging of mechanical properties would be helpful.

Role of surface properties, modelling, and self healing medicine are further topics from the ranking of the roadmap strategy, but they were not discussed in detail during the workshop.

Both parts of Workshop A focused primarily on glass and glass–ceramics for solar systems and biomedical applications. The specific challenges for the future were summarized in the following key phrases:

1. sustainable energy supply,
2. access to clean water,
3. affordable health care.

The participants therefore saw a growing demand for new glasses, glass–ceramics, and the technical solutions needed to use these innovative materials up to the year 2020 and beyond.

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