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Glass - the challenge for the 21st century

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The International Commission on Glass (ICG) invited international experts to take a look into the future of glass. The ICG organized a Top-level expert meeting on the "Future of Advanced Materials and Glass-Melting Technologies for the year 2020" in Brig (Switzerland), In March 2008, financed by the European Union within the framework of the EFONGA project. Two expert workshops were held in parallel and covered the topics "Advances in materials: glasses, glass-ceramics, ceramics" as well as "Innovation in glass melting technology: revolution or evolution". Three months later, the 9th ESG Conference along with the Annual Meeting of the ICG, hosted by the Slovak Glass Society, was held in June 2008 in Trenčín, Slovakia. The conference was intended to deal not only with the state-of-the art in the areas (glass science and technology today) concerned, but also to address the questions of future developments, applications and challenges in glass science and technology. Special attention was paid to the future role of the ICG (International Commission on Glass).

Keywords: value chain, manufacturer-distributor relationships, relational marketing.

Vidrio: el desafío para el siglo XXI

La Comisión Internacional del Vidrio (ICG) organizó un encuentro de expertos en Brig, Suiza, en marzo de 2008 para discutir acerca del futuro del vidrio. El Workshop "Materiales futuros y avanzados y tecnologías para el año 2020", fue financiado por la UE a través del proyecto EFONGA. Se celebraron dos sesiones paralelas que cubrieron una serie importante de temas, bajo los títulos de "Avances en materiales: vidrios, vitrocerámicos, cerámicos" e "Innovaciones en tecnologías de fusión de vidrio: revolución o evolución". Tres meses más tarde, en Trencin, Eslovaquia, se celebró la 9ª conferencia de la Sociedad Europea del Vidrio (ESG) junto con la reunión anual de la ICG. La conferencia no solo trató el estado del arte en ciencia y tecnología del vidrio sino que abordó las cuestiones clave de futuros desarrollos, aplicaciones y desafíos del sector, prestando especial atención al papel de la ICG.

Palabras clave: cadena de valor, relaciones fabricante-distribuidor, sector cerámico español, martketing relacional.

1. TECHNOLOGY ROADMAP ON INNOVATIVE GLASS MELTING AND ADVANCED MATERIALS

The objective of the two workshops held in Switzerland was to bring together international experts in the field of glass and material science to discuss future developments in the field of glass melting and new glasses, glass-ceramics, and ceramic materials. About 30 experts presented papers addressing either the current status of glass/ glass ceramic/ ceramic materials and new functionalities, or developments in and future concepts for new melting technologies. The outcome was an extensive evaluation of the requirements that new technologies must meet and the research needed to develop new materials and processes.

1.1 The workshop "Advanced Materials"

This workshop was hosted by Prof. Wolfram Höland (Ivoclar Vivadent AG). The presentations focused on glasses for technical applications and environmental protection, glass-ceramics with new properties, trends in functional ceramics, biomaterials for dental restoration, and medical applications.

The first session focused particularly on innovative applications using glass or glass-ceramics. After populating a roadmap with content, the workshop participants ranked the different items according to their level of impact and concern. Several topics were identified as being highly relevant:

a) Education: The participants demanded that stronger efforts be made to attract young people not only to the field of glass and glass-ceramics, but also to materials science.

b) Tough/Strong: the participants agreed that achieving both toughness and strength simultaneously is difficult. They also addressed the question of the high m-modulus after aging. There identified a need to utilise different approaches and develop models for characterization of glass failure in terms of quality aspects. Also discussed were aspects of "Fracture Theory" and measurement of toughness and strength.

c) Other relevant topics will be addressed in future discussions: Solar glass, Photonics/OE, Add-on functionality, Modelling and Solar Photocatalysis / Chemical Reactions.

In the second session the topics "Functional Ceramics and Biomaterials" were combined to "Materials for Biomedical Applications". Several topics were identified as highly relevant:

• 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 interrelations with living cells.

• Dental materials: Problems regarding 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 standard cell-type, cell-seeding, concentration, flow-rate, etc. A standardised test for aging of mechanical properties would be helpful.

• Further topics from the ranking not be discussed in detail were: Role of surface properties, Modelling, and Self Healing Medicine.

Both sessions focused primarily on glass and glass-ceramics for "solar systems" and "biomedical applications". The specific challenges for the future were summarized as:

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 apply these innovative materials to the year 2020 and beyond.

1.2 The workshop "Glass Melting Technology"

This workshop was organised by Prof. Ruud Berkens (TNO Glass Group/NL) and Prof. Helmut Schaeffer, including the following topics: analysis of today's glass melting processes, new glass melting concepts, intensive-heating technologies for glass melts, process intensification, rapid glass melting, batch technology, tailored raw material batches, process control and sensors for glass melting processes, energy savings by reduction of heat losses and waste heat recovery, energy efficient glass melting, and glass melting with extremely low emissions.

Besides the presentations the workshops included discussions on potential improvements for glass melting with respect to energy efficiency, environmental impact, glass quality and production cost reduction, and prioritising the most important directions for future research, as well as defining paths for future activities (projects, workshops, training).

Nine clusters of important technologies have been identified as being very important and needing further development. The four top themes were elaborated in more detail:

• New melting technologies: development of a glass melting process with tailored process steps in series where each process step can be optimised and controlled separately. For each process step, new technologies can be applied in order to improve glass quality, flexibility, and energy and cost efficiency.

• Tailored batch technology: with the goal of improving melting kinetics and batch homogeneity or reducting batch costs by replacing an expensive raw material such as soda ash by other raw materials.

• Energy efficiency (waste heat recovery): recover the heat of waste energy streams, especially flue gases and re-use this energy directly in glass melting processes.

• Sensors and advanced control: improve the operation of or modify existing sensors for glass melt properties and combustion processes in order to control glass melt quality with respect to fining and glass colour, and to control the combustion process with respect to energy efficiency and low NO_x emissions.

A team has been appointed for each theme to prepare by mid June a plan for further activities (nutshell proposals). Other subjects for future activities in the field of glass melting, should be:

• Measuring methods and definition of 'glass quality'; application of chemical engineering and thermodynamic principles in developing new glass melting processes; primary measures within glass production to reduce emissions to the environment; and advanced refractory material development for glass furnaces enabling more insulation without decreasing furnace lifetime or glass quality.

The participants of both workshops agreed that a "road-mapping project" should be initiated, and worked on in the future. The aim of such a project would be to foster effective, focused communication leading to closer multi-disciplinary interaction and collaboration.

2. THE ROAD-MAP OF GLASS: AN APPROACH FORM GLASS SCIENCE AND TECHNOLOGY

Increasing energy price levels, limited availability of several raw materials in the future, REACH obligations, needs for alternative raw materials and new glass compositions, as well as strict(er) legislations on emissions during the glass production, are seen as the main threats for glass and glass producers in the future.

On the other hand, a variety of new opportunities is seen for glass: new energy saving applications, glass in sustainable energy supply, glass as a construction materials or light-weighting glass products, but also improving the image and awareness of "Glass" and its indispensable contributions in the society, adding value to base glass products as well as more efficient and focused R & D in the glass industry for breakthrough developments on energy savings and sustainable energy generation.

The main threats and opportunities for glass and the glass industry especially in Europe were discussed in the ICG's plenary session in Trencin, Slovakia with a panel of invited experts, who first presented a short introduction (papers can be obtained by www.icglass.org) on the topics:

• Availability of non-energy materials for the Glass industry within the EU (Dr. Thomas Hünlich, Schott AG, Mainz, Germany).

• Glass and Environment: informing the future (John Stockdale, British Glass, Sheffield, UK).

• Energy and Climate Change (Dr. Guy Tackels, Saint Gobain).

• Glass technologists and researchers: who is inspiring whom? (Prof. Lubomír Němec, Laboratory of Inorganic Materiále, VŠChT, Prag, Czech Republic).

According to the experts' recommendations the main efforts for the glass industry in the 21st century should be:

• Improve communication with the policy makers and society in general and demonstrate the positive role that glass products have always played and will continue to play in meeting future needs.

• Be alert on changes in the world that may jeopardize the future supply of raw materials and fossil fuels necessary to make all types of indispensable glass products.

• Improve the efficiency of research, not only by new innovative ideas, but also by communication between R&D centra and industry and by the formation of consortia including academia, the glass industry and suppliers.

• Find new methods to reduce energy consumption in glass production and minimize CO_2 emissions: e.g. increased recycling, more energy efficient glass furnaces, stronger glass (light-weighting) and higher production yields.

The second part of the plenary session was a discussion based on questions from the audience. The following issues were raised during the discussions and questions on these topics have been treated by the four experts:

2.1 The use of Life Cycle Assessment (LCA) for glass products

The reliability of LCA information seems to be questionable: different institutes or industries have produced LCA's for flat glass or container glass products (comparing it with other packaging materials), including energy consumption and CO_2 analysis. However a realistic comparison of the results often fails. The CO_2 emissions during the production of glass would be relatively easy to determine, but the CO_2 emission reduction realized during the application of a glass product in a country would be more difficult to assess and would require further consideration in LCA's.

2.2 Show the potential of energy savings

Unfortunately the EU only considers caps on energy consumption and CO_2 emissions for production facilities and does not take into account savings made during the use of the product. The glass industry should bring a clear message to society and politicians that most glass products will give, during their lifetime, a strong net contribution to CO_2 emission reductions and energy savings outweighing by far the energy used for this glass production. Reliable data would be absolutely important to show the very important role that the glass industry plays to enable the CO_2 emission reduction targets set by the EU.

2.3Alternative energy sources, more efficient use of energy in glass melting processes

It was mentioned that electric melting of glass, using electricity that is not generated from gas, oil, brown coal or coal might become of increasing interest. The glass industry should also search for alternative processes supported by mechanical devices or other methods that require less energy than thermal processes only. In addition to this, new routes on batch preparation or use of pre-reactions at lower batch temperatures might be exploited to convert the most batch materials at much lower temperatures, as applied today, into a silicate material. New types of glass melting systems equipped with flue gas waste heat recovery need to be developed. The glass industry should also become aware of energy efficiency improvements made in other industrial sectors, such as the steel industry in order to learn from these other sectors, working with high temperatures and melting processes.

2.4 Organization of research activities in glass industry.

It was pointed out that R&D in the community needs to be better organized and priority should be given to the most essential developments. The International Commission on Glass (ICG) should increase its role in defining and organizing research activities on energy efficient and environmentally sound glass production or development of new glass products. Two ICG-expert meetings in Brig, Switzerland in March 2008 could have been the first steps to define and organize large scale projects in the glass society with the aim of developing breakthrough technologies in glass products and glass production. Since R&D budgets for the glass sector available from governments in countries such as Germany are rather small, it would be important to have more access to financial support from states or the EU. It was proposed that the glass society should improve communication with governments and the EU commission to help develop realistic funding schemes or to look for financial institutions that might support innovation in the glass industry, especially for projects aimed at energy efficiency improvement and major breakthroughs in CO_2 emission reduction.

3. THE ROLE OF ICG

It was stated that the ICG now enters a new era and has a role to play in initiating and stimulating R&D and promotion activities for glass and glass products. It should improve the "image" of glass in society showing its unique role in saving energy, generating energy and contributing strongly to the CO_2 emission reduction targets.

3.1 Co-operation worldwide

Many issues in Europe, such as the future position of the glass industry in society, energy efficiency, alternative energy sources, and CO_2 emission reduction targets are similar to those in the USA. Therefore it would be important to communicate with the USA glass industry (for instance represented by the GMIC) and to organize joint workshops.

The main conclusions of the plenary sessions were, that

• The glass industry and the ICG need to improve their external communication with other parties: governments, politicians, funding organizations, the public, but especially the policy makers. Only communication will enable them to get across the message that glass products have a key role to play in meeting the Kyoto and post-Kyoto targets on greenhouse gas emission reduction.

• The ICG should take a leading role in defining, initialising and organizing consortia for major research activities, addressing innovative glass products and energy efficient glass production.

3.2 Building a Sustainable Global Glass Industry

As a first product of these agreements the GMIC organised a conference on Monday, 3 November 2008, GPC with participation of ICG Technical Committes.

On the idea that glass companies and associations around the world are currently discussing strategies to ensure our industry continues to grow and thrive in the future in the face of uncertainty on many fronts: technical challenges; opportunities for innovation; sources of energy; energy efficiency; emissions and environmental issues; and competitive products, to mention a few. Leaders and experts in these areas will share their views on these and other issues, followed by open discussion regarding possible strategic directions we can take to ensure our industry's long term sustainability.

The topics to be discussed are the following:

a) Technical challenges;
b) Opportunities for innovation;
c) Sources of energy;
d) Energy efficiency;
e) Emissions and environmental issues;
f) New Markets
g) Sustainability

4. THE ACTORS AND TOOLS TO FACE THIS CHALLENGE

4.1 International Commission on Glass (ICG)

ICG is a non-profit international GLASS SOCIETY consisting of 32 national organisations in glass science and technology. The aim of ICG is to promote cooperation between glass experts. ICG organises Technical Committee work (laboratory round robins, publication of scientific and technical papers). ICG organises every three years the International Congress on Glass: www.icglass.org

4.2 The European Forum on New Glass Applications (EFONGA)

EFONGA is a Coordination Action in the field of glass science and technology, which aims at co-ordinating all European groups working in fundamental and applied pre-competitive research. The success of this project could be the basis for the establishment of a Network of Excellence on Glass. The EFONGA project works in the following fields: basic knowledge of glassy materials, relation structure-properties, setting-up of new methods for the characterisation of glassy materials, preparation of reference materials, information exchange on efficient production technology. The three activities of this Coordinated Action are: round robin tests, organisation of workshops, diffusion and dissemination of information and coordination of training and education on a European level. (for more information: www.efonga.group.shef.ac.uk

4.3 The Roadmap method

The overarching goal of the roadmapping activity as a method for carrying out technology foresight is to identify interesting aspects and trends including their dependencies across the different levels. The roadmaps can be used for different purposes. Associations and research organizations orient their R&D activities on roadmaps and companies can use the roadmaps for uncovering future trends and lead markets.

Research organizations can identify technology avenues they want to follow or try something in different directions. Clearly, research funding organizations can use the roadmap to uncover and monitor interesting trends.

The gathered information is supposed to be used to enhance the competitiveness of materials research in Europe and also outside the EU. The future discussion about the roadmap helps to obtain a cleaner picture on future developments and currently neglected opportunities in the landscape of material and material processing science.

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