OVERVIEW

Organized by the Ceramic Society of Japan, the 3rd International Congress on Ceramics (ICC3) was held in Osaka, Japan, Nov. 14th to 18th, 2010. The program was designed to advance ceramic and glass technologies to the next generation through discussion of the most recent advances and future perspectives, and to engage the worldwide ceramics community in a collective effort to expand the use of these materials in both conventional as well as new and exciting applications. ICC3 consisted of 22 voluntarily organized symposia in the most topical and essential themes of ceramic and glass materials as listed in pages 10-19, as well as the Special Symposium "Emerging Technologies and Future Aspects for Ceramics," which discussed the issues and challenges of various ceramic technologies for sustainable development of tomorrow's human society. The congress, consisted of plenary/invited lectures and both oral and poster presentations which all led to intensive and stimulating discussion. In addition to the scientific program, the congress also included a Welcome reception on the 14th, Opening Ceremony and Plenary Lectures on the 15th, Exhibition on the 15-16th, and Banquet on the 17th. The Exhibition displayed the latest technologies, products, etc., for ceramics and glass materials from industries, universities and public institutions. More than 1850 research papers including invited talks, oral presentations, and posters were presented from 56 countries (according to the Program), with 1979 registered participants plus 177 exhibitors, 97 staff and 80 accompanying persons.

Opening Ceremony and Plenary Lectures

The opening ceremony was held from 9:00 AM, Monday, November 15th in the Main Hall, Osaka International Convention Center. Opening and welcome speeches were given by Koichi Niihara, ICC3 President, Akio Makishima, ICF President, Masanari Iketani, President of Iketani Science and Technology Foundation, Gary Messing, ICF Incoming President, and Katherine Faber, ICC4 President. ICF and ICC Medals were presented from the Incoming Presidents to the Current Presidents.

Following the opening ceremony, the three plenary lectures were delivered, whose titles, lecturers and abstracts are shown below:

Opening Ceremony, Monday, November 15th at Main Hall

Koichi Niihara, ICC3 President gave welcome speech at Opening Ceremony

Akio Makishima, ICF President gave a welcome address

Masanari Iketani, President of Iketani Science and Technology Foundation, gave a welcome address

Gary Messing, ICF Incoming President addressed participants

Katherine Faber, ICC4 President addressed participants

"My Life Developing Fine Ceramic Technology - Message to Researchers and Engineers for Future-" by Kazuo Inamori, Founder and Chairman Emeritus, Kyocera Corporation, Japan

Abstract: The Japanese electronics industry achieved postwar recovery and started to rapidly grow in the mid-1950s. At that time, I was engaged in the research and development of fine ceramics materials, which was an entirely new field of research in Japan. I succeeded in developing forsterite, whose insulation properties were superior to other materials at high frequencies. We began mass-producing insulators for the electron guns of TV cathode-ray tubes. In 1959, Kyocera was established with the help of supporters. Since then, we have developed new products one after another by believing in the endless potential of fine ceramics and utilizing their excellent characteristics. In addition to the fine ceramics used in electronic components, semiconductor components, and components for industrial machines, Kyocera has aggressively diversified its businesses to

Koichi Niihara presented a certificate of appreciation to Kazuo Inamori for his plenary lecture.

include photovoltaic cells, telecommunications equipment, copy machines, and other products to become a comprehensive electronics manufacturer.

From the vast array of products that Kyocera has developed since its inception, I would like to introduce some of our flagship products, such as the ceramic semiconductor packages we succeeded in developing by satisfying the exacting demands of our customers in Silicon Valley since the earliest days of the semiconductor industry. Furthermore, I would like to introduce our successful research activities in the environmental energy field — where Kyocera has become a cutting-edge developer — and national projects in space research. Lastly, I would like to offer my opinion on the attitudes and ideas that young researchers and engineers need to successfully lead R&D, based on my experiences over the last half-century.

(Full content of this lecture is available in page 31-53.)

"Discoveries, Inventions and Innovations in Ceramic Science and Technology" by Ludwig J. Gauckler, Professor and Chairman of Department of Materials, Swiss Federal Institute of Technology Zurich (ETH Zurich), Switzerland

Abstract: Different concepts illustrate how to transform discoveries into inventions and sometimes, finally into innovations. The first example reports about processing μ-meter tiny tin oxide gas sensors synthesized and shaped via colloid chemistry technologies combined with silicon nitride micro hot plates on silicon [1]. These sensor arrays are integrated in microelectronics and operate as electronic noses. The second example illustrates processes for ultra-thin ceramic films and foils enabling micro solid oxide fuel cells for battery replacements with hitherto unrivaled energy densities for portable electronics [2]. The third example reports about tailoring Janus type nano particle surfaces in colloids leading to ceramic foams, emulsions and colloidosomes. They have a wide variety of complex microstructures that allow many new applications to be developed [3]. By using principles found in natural composites, layered polymer/ceramic hybrid composites combining high tensile strength and high ductility are possible [4]. These novel polymer-ceramic composites allow scratch resistant paints and laminates opening up markets that were new for ceramics. Finally, rapid prototyping of ceramic components from presintered blanks enabled in recent years all ceramic teeth, crowns and bridges revolutionizing dental restoration practice [5]. In this example, we demonstrate how the rigorous combination of well-known ceramic technologies opened up new applications. Some criteria are essential for the successful mutation of inventions into innovations in ceramic technology.

Ludwig J. Gauckler delivered his plenary lecture.

[1] M. Heule, S. Vuillemin and L. J. Gauckler, *Advanced Materials,* 15 (2003) 1237–1245

[2] U. P. Muecke, D. Beckel, A. Bernard, A. Bieberle-Hutter, S. Graf, A. Infortuna, P. Muller, J. L. M. Rupp, J. Schneider, and L. J. Gauckler, *Advanced Functional Materials* 18 (2008) 3158–3168

[3] A. R. Studart, U. T. Gonzenbach, E. Tervoort, and L. J. Gauckler, *J. Am. Ceram. Soc.,* 89 (2006) 1771–1789

[4] L. J. Bonderer, A. R. Studart, and L. J. Gauckler, *Science,* 319 (2008) 1069–1073.

[5] I. Sailer, A. Feher, F. Filser, L. J. Gauckler, H. Luthy, and C. H. F. Hammerle, *Int. J. of Prosthodontics*, 20 (2007)

"Ceramic Nanotechnology for Sustainable Energy Science in Micro/Nano-Systems" by Zhong Lin Wang, Regents' Professor and Director of Center for Nanostructure, Characterization, Georgia Institute of Technology USA

Zhong Lin Wang delivered his plenary lecture.

Abstract: Ever since the wide range applications of laptop computers and cell phones, seeking of power sources for driving portable electronics is becoming increasingly important. The current technology mainly relies on rechargeable batteries. But for the near future, micro/nano-systems will be widely used in health monitoring, infrastructure and environmental monitoring, internet of things and defense technologies; the traditional batteries may not meet or may not be the choice as power sources for the following reasons. First, with the increasingly shrinkage in size, the size of the total micro/nano-systems could be largely dominated by the size of the battery rather than the devices. Second, the number and density of micro/nano-systems to be used for sensor network could be large, thus, replacing batteries for these mobile devices becoming challenging and even impractical. Lastly, the power needed to drive a micro/nano-system is rather small, in the range of micro- to milli-Watt range. To meet these technological challenges, the author proposed the self-powering nanotechnology in 2005, aiming at harvesting energy from the environment to power the micro/nano-systems based sensor network. This talk will introduce the nanogenerator as a sustainable self-sufficient power source for micro/nano-systems.

[1] Z.L. Wang and J.H. Song, *Science*, 312 (2006) 242–246.
[2] X.D. Wang, J.H. Song J. Liu, and Z.L. Wang, *Science*, 316 (2007) 102–105.
[3] Z. L. Wang, *Advanced Materials*, 19 (2007) 889–992.
[4] Y. Qin, X.D. Wang and Z.L. Wang, *Nature*, 451 (2008) 809–813.
[5] Z.L. Wang, *Advanced Functional Materials,* 18 (2008) 3553–3567.
[6] R.S. Yang, Y. Qin, L.M. Dai and Z.L. Wang, *Nature Nanotechnology*, 4 (2009) 34–39.
[7] S. Xu, Y. Qin, C. Xu, Y.G. Wei, R.S. Yang, Z.L. Wang, *Nature Nanotechnology*, 5 (2010) 366–373
[8] Y.F. Hu, Y.L. Chang, P. Fei, R.L. Snyder and Z.L. Wang, *ACS Nano*, *4* (2010) 1234–1240.

Symposia

22 voluntarily organized symposia (see page 10-19 for the organizers) were held in the most topical and essential themes of ceramic and glass materials, as shown below.: The symposia comprised invited papers and oral presentations made in 18 Conference Rooms from Monday, Nov 15 to, Thursday, 18, and poster presentation sessions were held in the Event Hall, on Monday, Nov 15, and Tuesday, 16, along with intensive discussion.

Characterization, design and processing technologies

- Symposium 1: Advanced Structure Analysis and Characterization of Ceramic Materials
- Symposium 2A: Novel Chemical Processing; Sol-Gel and Solution-Based Processing
- Symposium 2B: Novel Chemical Processing; Molecular Routes to Ceramics and Ceramics-based Materials
- Symposium 2C: Novel Chemical Processing; Chemical Tectonics for Materials Design
- Symposium 3: Nano-Crystals and Advanced Powder Technology
- Symposium 4: Green and Smart Processing
- Symposium 5: Hybrid and Nano-Structured Materials

Electro, magnetic and optical ceramics and devices
• Symposium 6: Advances in Electro Ceramics
• Symposium 7: Optical Ceramics
• Symposium 8: Glasses - Science & Technology, and Photonic Applications-

Energy and environment related ceramics and systems
• Symposium 9A: Ceramics for Electricity; Energy Conversion and Storage Systems for Green World
• Symposium 9B: Ceramics for Electricity; SOFC and Related Technologies
• Symposium 9C: Ceramics for Electricity; Direct Conversion Technology between Heat and Electricity
• Symposium 9D: Ceramics for Electricity; Advanced Superconducting Materials
• Symposium 10: Ceramics and Composites for Advanced Nuclear Energy and Hazardous Waste Treatment Applications
• Symposium 11: Advanced Ceramic Surface for Environmental Purification: Photocatalysis and Wettability Control
• Symposium 12: Porous Ceramics for Environmental Protection and Advanced Industries

Oral presentations. Special Symposium at Conference Hall (top) & Symposium 2A at Conference Room 801 (bottom)

Bio-ceramics and bio-technologies
• Symposium 13: Ceramics for Medicine, Biotechnology and Biomimetics

Ceramics for advanced industry and safety society
• Symposium 14: Advanced Engineering Ceramics and Composites
• Symposium 15: Advanced Ceramic Sensor Technologies
• Symposium 17: Health and Safety Aspects of Ceramic Nanoparticles

Innovation in traditional ceramics
• Symposium 16: Innovation in Refractories and Traditional Ceramics

Special Symposium

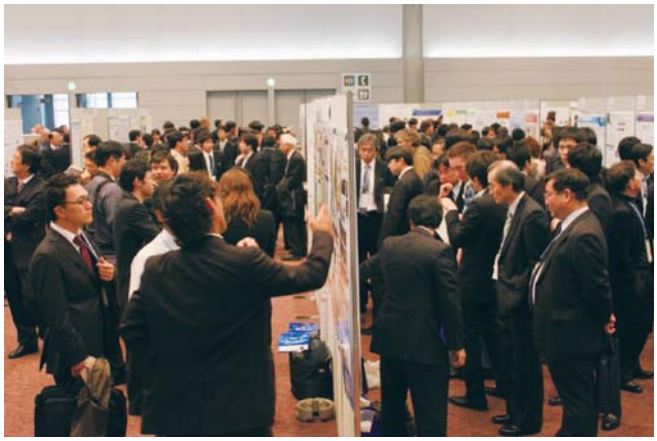
One of the primary purposes of ICC is to discuss the issues and challenges of various ceramic technologies for the sustainable development of tomorrow's society. For this purpose, the Special Symposium "Emerging Technologies and Future Aspects for Ceramics," was held in the Conference Hall from, Monday, Nov 15 to Wednesday, 17, and invited lectures from thirty renowned scientists were delivered on various aspects of novel ceramic technologies contributing to a sustainable society. As part of this Special Symposium, a Special Session, "Key Functional Ceramics for Sustainable Development," was held on Tuesday, Nov 16, organized by the ICF Technical Committee on Ceramics and Environment (Chair: Hideo Hosono, Tokyo Institute of Technology). The lecturers and titles are listed as follows.

- Hideo Hosono, Tokyo Institute of Technology, Japan, "Recent Progress in New Superconducting Materials"
- Kazuyuki Hirao, Kyoto University, Japan, "Photonic Materials"
- Morinobu Endo, Shinshu University, Japan, "Mass Production, Applications and Safety Issue of Multi-Walled Carbon Nanotubes"
- Ramamoorthy Ramesh, University of California, Berkeley, USA, "Multifunctional Oxide Heterostructures"
- Nava Setter, Ecole Polytech Fed de Lausanne, Switzerland, "Future Directions in Ferroelectrics Research: An Academic Perspective"
- Hiroshi Takagi, Murata Manufacturing Company, Ltd., Japan, "Current Status and Future Aspects of R&D Activities on Electro-ceramic Components in Japanese Industry"
- Liyuan Han, NIMS- MANA, Japan, "Highly Efficient Dye-Sensitized Solar Cells"
- Claude Delmas, Université de Bordeaux, France, "Sodium Batteries with Intercalation Electrodes: an Old Story or the Future?"
- Kunihito Koumoto, Nagoya University, Japan, "Novel Nanostructured Ceramics for Thermoelectric Conversion"
- Kazuhito Hashimoto, University of Tokyo, Japan, "Novel Visible Light Sensitive TiO_2-based Photocatalysts and Their Virucidal and Bactericidal Effects"
- Kazuyuki Kuroda, Waseda University, Japan, "Recent Developments and Future Prospects of Mesoporous Ceramic Materials"
- Paolo Colombo, University of Padova, Italy, and The Pennsylvania State University, USA, "Cellular Ceramics: Past, Present and Future"
- Hitoshi Sakai, NGK Insulators, Ltd., Japan, "Inorganic Membrane Development in NGK"
- Ralf Riedel, Technische Universitaet Darmstadt, Germany, "Polymer Derived Processing Technologies"
- John E. Marra, Savannah River National Laboratory, USA, "Advanced Ceramic Materials for Next-Generation Nuclear Applications"
- Sylvia Johnson, NASA Ames Research Center, USA, "Ultra High-Temperature Materials"
- Yanchun Zhou, Institute of Metal Research, Chinese Academy of Sciences, P.R. China, "Prospects and Challenges of Damage Tolerant Layered Ternary Carbides and Nitrides (MAX phases)"
- Judd Diefendorf, Clemson University, USA, "Fiber Reinforced Ceramic Matrix Composites"
- Mrityunjay Singh, Ohio Aerospace Institute, NASA Glenn Research Center, USA, "Ceramic Integration Technologies for Advanced Energy Systems"
- Alexander Michaelis, Fraunhofer IKTS, Germany, "Ceramic Materials and Technologies for Energy Systems"
- Wolfgang Rossner, Siemens AG, Corporate Technology, Germany, "Ceramic Technologies for Sustainability: Perspectives from Siemens Corporate Technology"
- Toshihiro Ishikawa, Ube Industries Ltd., Japan, "Ceramic R&D Technology in Ube Industries for Sustainable Society"
- Hongjie Luo, Shanghai Institute of Ceramics, CAS, P.R. China, "The Latest Progress of SIC CAS in Research"
- G. Sundararajan, International Advanced Research Centre for Powder Metallurgy & New Materials, India, "Global Issues and Challenges for Ceramists in 21C"

Session Led by ICF Technical Committee on Ceramics and Environment, "*– Key Functional Ceramics for Sustainable Development –*"

- Yuichi Shimakawa, Kyoto University, Japan, "Material Science Gives Some Solutions for Problems We Face: "New Materials with New Functions"
- Manfred Martin, Aachen University, Germany, "Advanced functional oxide materials"
- Kiyoshi Okada, Tokyo Institute of Technology, Japan, "The Advanced Oxidation Process for

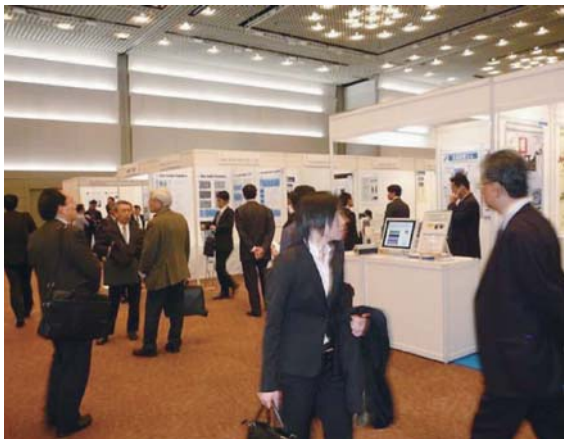
Photodecomposition of Organic Dyes by Naturally Abundant Iron Oxide-Based Materials"
- Peter V. Sushko, University College London, UK, "Predicting Properties of Ca–Al–O Glass Electrides"
- Tetsuya Hasegawa, The University of Tokyo, Japan, and Kanagawa Academy of Science and Technology "Fabrication and Electronic Properties of TiO_2-based Transparent Conducting Thin Films"



Poster presentations. Monday, Nov 15th & Tuesday, 16th at Event Hall

Exhibition

An exhibition was held in the Event Hall over two days, on Nov 15 and 16, to display the latest technologies and products for ceramics and glass materials.. In total 54 booths (41 from industry and 13 from universities, public labs, etc.) provided the latest information on their products and technologies to congress participants. During the exhibition period, a separate "Ceramic Archives Exhibition" was held, which demonstrated technological innovations realized by advanced ceramics and glass materials in various fields of industry and daily life. The ceramic/glass products related to these innovations were also exhibited, and were very well received, particularly by oversea participants. The exhibitors are listed as follows (alphabetical order).



Exhibitions. Monday, Nov 15th & Tuesday, 16th at Event Hall

- Advanced Manufacturing Research Institute, AIST, Japan (2 booths)
- Asahi Glass Co. Ltd., Japan
- Avio Sales Co., Ltd., Japan
- BEL JAPAN, Japan
- Bridgestone Corporation, Japan
- Bruker AXS K.K., Japan
- DAIKEN CHEMICAL CO., LTD., Japan
- DENKI KAGAKU KOGYO K.K., Japan
- EXPERT SYSTEM SOLUTIONS S.R.L., Italy
- Fuji Dempa Kogyo Co., Ltd., Japan
- Gunze Limited/Institute of Energy Science and Technology Co., Ltd., Japan
- HAKUSUI TECH CO., LTD., Japan
- Hysitron Inc., USA
- IKETANI SCIENCE AND TECHNOLOGY FOUNDATION, Japan
- INABA RUBBER CO., LTD., Japan
- INAX Corporation, Japan
- International Centre for Diffraction Data, USA
- Institute of Physics Publishing, UK
- ISHIKAWA TRADING CO., LTD., Japan
- ISMANJ Corporation, Japan
- Iwatsu Test Instruments Corporation, Japan

- KIYOKAWA Plating Industry Co., Ltd., Japan
- KOTOBUKI INDUSTRIES CO., LTD., Japan
- Kurosaki Harima Corporation, Japan
- KYOCERA Corporation, Japan (2 booths)
- LAEIS GmbH, Luxembourg
- MARUSHO DENKI CO., LTD., Japan
- Murata Manufacturing Co., Ltd., Japan
- Nagaoka University of Technology, Japan (3 booths)
- Nano/Micro Structure Tectonics, SPRC-JWRI, Osaka University, Japan
- National Institute for Materials Science (NIMS), Japan (2 booths)
- NEOARK Corporation, Japan
- NGK INSULATORS, LTD., Japan (2 booths)
- NGK SPARK PLUG CO., LTD., Japan
- NIKKATO CORPORATION, Japan
- Nippon Electric Glass Co., Ltd., Japan
- Noritake Co., Litd., Japan
- Open Advanced Research Facilities Initiative, Project ADMIRE, Kyoto University, Japan
- Rigaku Corporation, Japan
- SAKAI CHEMICAL INDUSTRY CO., LTD., Japan
- SHIKEN Inc. / Osaka Prefecture University Physical Chemistry Group, Japan
- SPS SYNTEX INC., Japan
- Stereo Fabric Research Association, Japan
- TDK Corporation, Japan
- The Ceramic Society of Japan, Japan
- TOCALO Co., Ltd., Japan
- TOTO LTD., Japan
- TYK CORPORATION, Japan

Welcome reception. Sunday, Nov 14th at Conference Room 1001-03

Banquet. Wednesday, Nov 17th at RIHGA Royal Hotel Osaka. 739 Registered attendees.

Shin-Ichi Hirano, ICC3 Honorary Chair, delivered welcome speech at Banquet.

Marina R. Pascucci, President of the American Ceramic Society addressed attendees at Banquet.

Hasan Mandal, President, the European Ceramic Society addressed attendees at Banquet.