

Office of Naval Research International Field Office

Conference Report: Low Cost Ceramics Workshop

Osaka, Japan

March 17 - 22, 2002

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Key Words:

Low cost ceramics, ceramics fabrication, oxide ceramics, silicon carbide fibers, zirconia powder, silicon nitride, low thermal expansion ceramics, structural ceramics, spark plasma sintering, functionally graded materials, porous silicon, liquid filtration, hydrophilic titanium oxide, photo-catalytic titanium oxide powder, ceramics matrix composites, solid lubricants, ceramic bearings, ceramics machining, ceramics processing, wear resistant ceramics, fiber reinforced composites, high performance ceramics, squeeze casting, ceramic materials and joints, ceramic nanocomposites, high temperature ceramics, armor ceramic materials, gas turbine engines, heat engines, non-oxide ceramics.

1. Summary

A Low Cost Ceramics Workshop, organized by Osaka University, Japan and Penn State University, USA and sponsored by the Tri-Service Research Offices located in Tokyo, was held in Osaka, Japan from 17 to 22 March, 2002. Participants attended the meeting from seven countries, including Japan, US, Korea, China, Norway, Germany, and India.

Topics discussed in the workshop included powder and related raw materials, forming and consolidation for monolithic ceramics, forming and consolidation for monolithic CMCs, forming and consolidation for monolithic ceramics MMCs, machining and surface finishing and joining, new materials and processing, low cost production, low cost processing for ceramic fibers, Porous ceramics, and Structural ceramics.

Since the primary cost associated with ceramics depends primarily on material preparation and the volume produced, it is necessary to develop technologies in these areas to enable economic production. The goal of this conference was to discuss recent research and advances that will lead to further breakthroughs and further the economic utilization of ceramics.

2. Background

In the past 20 years, intensive research has been carried out on in the areas of ceramics and related materials. Various high performance materials have been developed which are playing important roles related to the future of the ceramics industry. Their applications, however, are still limited, mainly by cost performance issues.

The Low Cost Ceramics workshop was organized to address the low cost processing and production methods that represent the future of ceramics research and production. World leading ceramist from the US and Japan, as well as China, Norway, Germany, and India discussed recent research and advances that will lead to further breakthroughs in this field.

3. Conference Abstracts

Below is the listing of conference abstracts. The actual abstract may be obtained by clicking on the abstract title:

Powder and Related Raw Materials	
	<p><u>SiC Powder and Premix - Prospects for Cost Reduction</u> Lars Petter Maltby (Norton-Lillesand, Norway)</p>
	<p><u>Progress in Powder Technology of Silicon Nitride</u> Tetsuo Yamada (Ube Research Laboratory, UBE Industries, Ltd., Japan)</p>

Large Scale Production of ZrO₂ Powders in Tosoh

Kuniyoshi Ueda (Zirconia Synthetic Chemicals Production, Tosoh Corp., Japan)

Recent Advances in Production and Development of Continuous SiC Fibers (Nicalon and Hi-Nicalon

Hiroshi Ichikawa (Nippon Carbon Co. Ltd., Japan)

**Production and Properties of
UBE's SiC Long Fibers**

Toshihiro Ishikawa (Ube Research
Laboratory, UBE Industries, Ltd.,
Japan)

Forming and Consolidation for Monolithic Ceramics

**Processing of Large-Sized and
Low Cost Oxide Ceramics**

Hiroshi Suzuki (SINTO V-CERAX
Ltd., Japan)

Fabrication of Large Ceramic Components by Newly Developed Processes⁷

Hae-Weon Lee, Hyung-Woo Jun,
Joosun Kim, Huesup Song,
Jowoong Ha*
(Korea Institute of Science and
Technology, *Inocera Inc., Korea)

Low Cost Processing for Large Scale Production of Ceramics in China⁸

Lian Gao (Shanghai Institute of
Ceramics, Shanghai, China)

	<p><u>Glimpses of Advanced Ceramics - ARC-I's Perspective-9</u> N.Thiyagarajan, Roy Johnson, Y.S.Rao, B.P.Saha, I.Ganesh, S.Kumar, Y.R.Mahajan (International Advanced Research Center for Powder Metallurgy & New Materials, Hyderabad, India)</p>
	<p><u>Development of High Performance Si₃N₄ Ceramics and Their Applications</u> Kazunori Koga (Kyocera Corp., Japan)</p>

**Prospects for the Low Cost
Production of Advanced Armor
Ceramic Materials1**

Richard J. Palicka (CerCom Inc.,
USA)

Forming and Consolidation of CMCs	
	<p><u>Melt Growth Composites for Super High Temperature Applications</u> Yoshiharu Waku (Ube Research Laboratory, UBE Industries Ltd., Japan)</p>
	<p><u>Low Cost Processing of Al₂O₃-ZrO₂ Nano-composite Ceramics with High Performance</u> H. Miyamoto, H. Kume, Y. Nishikawa, F. Tsumori and S. D. De la Torre (Technology Research Institute of Osaka Prefecture, Japan)</p>

[Low Cost Fabrication of Mutual
Ce-ZrO₂-Al₂O₃ Nanocomposites
with Complex Shape and Its
Applications](#)

Masahiro Nawa, Tohru Sekino*,
Koichi Niihara* (Matsushita
Electric Work Co. Ltd.,
*ISIR, Osaka University, Japan)

Forming and Consolidation of MMCs

[Squeeze Casting for Low Cost
Fabrication of Advanced
Composite Materials and Joints](#)

Katsuaki Suganuma, Masahiro
Inoue and Kimiaki Tanihata (ISIR,
Osaka University, Japan)

	<p><u>Production of Long Fiber Reinforced Composites1</u> Y.Hirata, S.Sameshima, H.Sueyoshi, S.Uchida*, S.Hamauzu**, S.Kurita⁺, (Kagoshima University, *Nippon Steel Corp., **Mishima Kosan Co., Ltd., ⁺Koransha Co., Ltd., Japan)</p>
	<p><u>Low Cost Production of Near-net Shaped Ceramic/Metal Composites by Novel Processing</u> Rolf Janssen (Technical University of Humburg, Germany)</p>

<p>Machining, Surface Finishing and Joining</p>
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**Study on Wear Mechanism of
Advanced Structural Ceramics
for Low Cost Processing**¹⁸

Soo W. Lee, Seung Ho Kim, Yoon-
Ho Kim, Yo Yamamoto*, Takafumi
Kusunose* (SunMoon University,
Korea, *ISIR, Osaka University,
Japan)

**Precise and High Speed
Machining of Ceramics Materials**

Kozo Ishizaki (Nagaoka Gijutsu-
Kagaku Daigaku, Japan)

	<p><u>Performance and Application of Ceramic Bearing</u> Hirokazu Takii, Kazuhisa Kitamura, Yasuhiro Kobayashi (Research & Development Center , Koyo Seiko Co., Ltd., Japan)</p>
	<p><u>Cost Effective Ceramic Manufacturing - A Machining Perspective</u> Vimal K. Pujari (Saint Gobain Ceramics and Plastics, Northboro R&D Center, USA)</p>

	<p><u>Mass-production of WS₂ Solid Lubricant and Its Industrial Applications</u> Dong-Woo Shin, In-Hyuk Choi, Dae-Hyun Yoon*, Kyeong-Do Kim * (Kyongsang National University, *FAG Hanwha Bearings Corp., Korea)</p>
	<p><u>Joining and Attachment Technologies for Ceramic Matrix Composites: Current Status and Future Prospects</u> M. Singh (QSS Group, Inc., NASA Glenn Research Center, USA)</p>
<p>New Materials and Processing (I)</p>	

Mass Production of High Efficiency Hydrophilic TiO₂ Sol and Photocatalytic TiO₂ Powder

D. W. Shin, Kwang Wook Kim*,
Bub Jin Kim**, Yong Tae Kim**,
Min Ju Lee**,
Dae-Hyun Yoon, Hong-Dae Kim
(Gyongsang National University,
*Korea Atomic
Energy Research Institute, ** Nano
Co. Ltd., Korea)

New Aspects of Porous Ceramics with Synergistic Properties

Tatsuki Ohji (Synergy Materials
Research Center, AIST, Japan)

**Development of a Porous Silicon
Nitride Filter for Liquid
Filtration**

Jin-Joo Park, Akira Yamakawa
(Sumitomo Electric Industries, Ltd.,
Japan)

Development of FGMs by SPS

Masao Tokita (Sumitomo Coal
Mining Co., Ltd., Japan)

	<p><u>New Aspects of Structural Ceramics with Synergistic Properties</u> Kiyoshi Hero (Synergy Materials Research Center, AIST, Japan)</p>
	<p><u>Development of Ultra Low Thermal Expansion Ceramics: NEXCERA</u> Tetsuro Nose (Nippon Steel Corp., Advanced Technology Research Lab., Japan)</p>
<p>General Discussions on Low Cost Production of Ceramic Materials</p>	

Necessary, Cost-effective
Chemical Technology to Produce
Ceramics on the Large-Scale

Peter E. D. Morgan (Rockwell
Science Center, USA)

Emergent Presentation on “Low
Cost Processing for Ceramic
Fibers”

Toshihiro Ishikawa (Ube Research
Laboratory, UBE Industries, Ltd.,
Japan)

4. Assessment

The Low Cost Ceramics workshop was very well attended and met its original goals; both the areas of cost reduction as well as materials development were extensively discussed in the workshop. New processing technologies, applications, and large-scale production of ceramics are necessary for cost reduction and high performance of materials in future. While the US and Japan are the ideal partners in the challenge, other global partners are necessary to effectively and collectively address the problems. Through this conference, an awareness of the problems and difficulties of ceramics industry has been created, and active international interaction, collaboration, and cooperation have been initiated. As far as it is known, this is the first international workshop on Low Cost Ceramics to date, and it is a good start. It is expected that the next workshops on low cost ceramics will be able to address and focus on more particular issues in terms of definite problems and solutions.

5. Points of Contact

For further information, please contact:

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