

The American Ceramic Society
**48th International Conference & Exposition
on Advanced Ceramics and Composites**

ABSTRACT BOOK

**January 28–February 2, 2024
Daytona Beach, Florida**

Introduction

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How to Use the Abstract Book

Refer to the Table of Contents to determine page numbers on which specific session abstracts begin. At the beginning of each session are headings that list session title, location and session chair. Starting times for presentations and paper numbers precede each paper title. The Author Index lists each author and the page number on which their abstract can be found.

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11:50 AM

(ICACC-S17-030-2024) Water-based 2D material inks: From printed electronics to biomedical applications (Invited)

C. Casiraghi^{*1}

1. University of Manchester, United Kingdom

Solution processing of 2D materials allows simple and low-cost techniques, such as ink-jet printing, to be used for fabrication of heterostructure-based devices of arbitrary complexity. Our group has developed a supramolecular approach able to provide highly concentrated, defect-free, printable and water-based 2D crystal inks, suitable for fabrication of large area arrays of photosensors on plastic [1], programmable logic memory devices [1], capacitors [2], transistors on paper [3-5] and printed memristors on rigid and flexible substrates [6]. Furthermore, our supramolecular approach allows to easily tune the charge of graphene, enabling production of amphoteric, cationic and anionic graphene dispersions [7]. Cytotoxicity tests confirm biocompatibility of the graphene ink, making it very attractive for applications in drug delivery and imaging [8].

S18 Ultra-High Temperature Ceramics

SYMPOSIUM 18: Advanced Characterizations and Simulations

Room: Coquina A

Session Chairs: Scott McCormack, University of California, Davis; Theresa Davey, Bangor University

8:30 AM

(ICACC-S18-024-2024) High-fidelity 3D microstructural characterization of ZrB₂ during hot-pressing (Invited)

R. Swanson⁴; D. A. Kosanovic³; M. Chapman⁵; M. D. Uchic²; W. Fahrenholtz³; S. J. McCormack^{*1}

1. University of California, Davis, Materials Science and Engineering, USA
2. Air Force Research Lab, USA
3. Missouri University of Science and Technology, Department of Materials Science and Engineering, USA
4. University of California, Davis, Chemical Engineering, USA
5. UES, Inc., USA

Standard ultra-high temperature ceramic (UHTC) manufacturing results in components with large differences in properties due to variability in microstructural “critical flaw” distributions. Critical flaws can be any irregularity in a component, such as a secondary phase, cracks, pores, etc. This is problematic when designing reproducible UHTC components. The goal of this project is to understand how these critical flaws evolve during hot pressing of ZrB₂ (a UHTC) by examining them in 3D. This study incorporates 3D imaging such as (i) preliminary in-situ high-temperature pressureless sintering X-ray μ -CT, (ii) ex-situ X-ray μ -CT, and (iii) 3D electron imaging and backscattered diffraction data collected at different stages of densification. 3D microstructure statistics along with unique observations of individual pore and secondary phase evolution will be presented. This data is brought together to give a holistic view of the densification of ZrB₂ during hot pressing at multiple length scales. This data will be incorporated into a process-structure-property (PSP) database for statistical modeling to reduce uncertainty during ZrB₂ processing.

9:00 AM

(ICACC-S18-025-2024) Retained flexural strength of Cf-ZrB₂ UHTCMCs after arc-jet tests at 2200°C

D. Sciti^{*1}; P. Galizia¹; S. Mungiguerra²; R. Savino²; A. Airoidi³; A. Caporale³; A. Vinci⁴; L. Zoli¹; M. De Stefano Fumo⁵

1. National Research Council of Italy, ISSMC (former ISTE), Italy
2. University of Naples Federico II, Department of Industrial Engineering, Italy
3. Politecnico di Milano, Department of Aerospace Science and Technology, Italy
4. CNR - ISSMC, Italy
5. CIRA - Italian Aerospace Research Centre, Italy

Ultra High-Temperature Ceramic Matrix Composites (UHTCMCs) represent an innovative class of materials that potentially combine the high oxidation resistance of UHTCs with the damage tolerance and lightweight properties of CMCs. Few studies have been conducted so far to understand the impact of re-entry conditions on the mechanical properties. In this study, fully dense UHTCMCs based on ZrB₂-SiC and Cf, were produced using a slurry impregnation and sintering process to create bars for flexural strength tests. Additionally, sample holders suitable for fitting into an arc jet chamber and holding the bars were fabricated from the same material. Five bars, each with dimensions 60 x 10 x 2.5 mm³ (length-width-thickness), were exposed to a plasma of dissociated air at a temperature of 2200°C for two minutes. Subsequently, they were weighed and subjected to 3-point bending tests to evaluate the impact of oxidation damage on their properties. Unexposed bars were also tested to assess their pristine strength. The oxidized layer was analysed using optical microscopy and SEM-EDS. The materials retained more than 80% of the initial strength despite the high temperature reached. Furthermore, prolonged tests lasting up to 4 minutes at 2200°C were conducted on additional samples, demonstrating the material's durability. The reusability of the sample holder for up to four cycles was also confirmed.

9:20 AM

(ICACC-S18-026-2024) Novel contactless measurement technique to determine the ultra-high temperature (>2000 °C) thermal conductivity and spectral emissivity of UHTCs

H. B. Schonfeld^{*1}; M. Milich¹; D. Robba²; L. Vlahovic²; K. Boboridis²; R. Konings²; E. Opila³; P. E. Hopkins¹

1. University of Virginia, Mechanical and Aerospace Engineering, USA
2. European Union Joint Research Centre, Germany
3. University of Virginia, Material Science and Engineering, USA

New ultra-high temperature ceramics (UHTCs) are being developed as candidate hot structures for use as thermal protection systems with space and hypersonic vehicle applications. UHTCs experience extreme heat fluxes in flight, resulting in peak surface temperatures well above 2500 °C. Currently there is limited understanding of the thermal and radiative properties at relevant temperatures (>2000 °C). In this work we present a newly developed contactless measurement technique based on modulated laser heating and hyperspectral radiative pyrometry to measure the thermal conductivity and spectral emissivity of UHTC materials above 2000 °C. We validate this technique on standard metals tungsten and molybdenum by measuring their thermal and radiative properties from 2000 °C through their melting points. We then further evaluate our technique by measuring the thermal conductivities of TaC, HfC, ZrC and TiC from room temperature to 2000 °C, and compare our values with literature. Lastly, we measure the thermal conductivity and spectral emissivity of these materials above 2000 °C for the first time. Thermal conductivity and spectral emissivity measurements at relevant temperatures are crucial for evaluating and influencing the design of the next generation of extreme temperature thermal protection systems.

SYMPOSIA ORGANIZERS

2024 PROGRAM CHAIR: **Jie Zhang**, Institute of Metal Research, China

S1: MECHANICAL BEHAVIOR AND PERFORMANCE OF ADVANCED CERAMICS & COMPOSITES

Amjad Almansour, NASA Glenn Research Center, USA; Dong (Lilly) Liu, University of Bristol, UK; Jonathan Salem, NASA Glenn Research Center, USA; Monica Ferraris, Politecnico di Torino, Italy; Gerard Vignoles, University of Bordeaux, France; Dileep Singh, Argonne National Laboratory, USA; Craig Przybyla, Air Force Research Laboratory, USA; Dietmar Koch, University of Augsburg, Germany; Emmanuel Maillet, GE Research, USA; Kamala Raghavan, US Department of Energy, USA; Kevin Strong, Sandia National Laboratory, USA

S2: ADVANCED CERAMIC COATINGS FOR STRUCTURAL, ENVIRONMENTAL, AND FUNCTIONAL APPLICATIONS

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S3: 21TH INTERNATIONAL SYMPOSIUM ON SOLID OXIDE CELLS (SOC): MATERIALS, SCIENCE AND TECHNOLOGY

Mihails Kusnezoff, Fraunhofer IKTS, Germany; Federico Smeacetto, Politecnico di Torino, Italy; John Hardy, Pacific Northwest National Laboratory, USA; Narottam P. Bansal, NASA Glenn Research Center, USA; Prabhakar Singh, University of Connecticut, USA; Scott A. Barnett, Northwestern University, USA; Henrik Lund Frandsen, DTU Energy Conversion and Storage, Denmark; Vincenzo Esposito, DTU Energy Conversion and Storage, Denmark; Tae Ho Shin, Korea Institute of Ceramic Engineering & Technology, South Korea; Ruey-Yi Lee, Institute of Nuclear Energy Research, Taiwan; Tatsumi Ishihara, Kyushu University, Japan; Julie Mouglin, CEA, France; Sebastian Molin, Gdansk University of Technology, Poland

S4: PROTECTIVE CERAMICS – CHALLENGES AND NEW DEVELOPMENTS

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S5: NEXT GENERATION BIOCERAMICS AND BIOCOMPOSITES

Katalin Balazsi, Center for Energy Research, Hungary; Hui-Suk Yun, Korea Institute of Materials Science, Korea; Cristina Balagna, Politecnico di Torino, Italy; Roger Narayan, University of North Carolina, USA; Eva Hemmer, University of Ottawa, Canada; Akiyoshi Osaka, Okayama University, Japan; Antonia Ressler, University of Zagreb, Croatia; Aldo Boccaccini, University of Erlangen-Nuremberg, Germany; Monika Tatarková, Slovak Academy of Sciences, Slovakia

S6: ADVANCED MATERIALS AND TECHNOLOGIES FOR RECHARGEABLE ENERGY STORAGE

Palani Balaya, National University of Singapore, Singapore; Olivier Guillon, Forschungszentrum Jülich, Germany; Naoaki Yabuuchi, Yokohama National University, Japan; Valerie Pralong, CNRS CRISMAT, France; Mali Balasubramanian, Oak Ridge National Laboratory, USA; Prabeer Barpanda, Indian Institute of Science, India; Byunwoo Kang, Pohang University of Science and Technology, Republic of Korea; Richard M Laine, University of Michigan, USA; Yu Yau Wai Denis, City University of Hong Kong, Hong Kong; Shih-Kang Lin, National Cheng Kung University, Taiwan

S7: 18TH INTERNATIONAL SYMPOSIUM ON FUNCTIONAL NANOMATERIALS AND THIN FILMS FOR SUSTAINABLE ENERGY HARVESTING, ENVIRONMENTAL AND HEALTH APPLICATIONS

Muhammet S. Toprak, KTH Royal Institute of Technology, Sweden; Sanjay Mathur, University of Cologne, Germany; Shashank Mishra, University of Lyon, France; Sedat Ballikaya, Istanbul University, Turkey; Andreu Cabot, Catalonia Institute for Energy Research, Spain

S8: 18TH INTERNATIONAL SYMPOSIUM ON ADVANCED PROCESSING AND MANUFACTURING TECHNOLOGIES FOR STRUCTURAL AND MULTIFUNCTIONAL MATERIALS AND SYSTEMS (APMT18)

Hisayuki Suematsu, Nagaoka University of Technology, Japan; Young-Wook Kim, University of Seoul, Republic of Korea; Tatsuki Ohji, National Institute of Advanced Industrial Science and Technology (AIST), Japan; Weimin Wang, Wuhan University of Technology, China; Enrico Bernardo, University of Padova, Italy; Surojit Gupta, University of North Dakota, USA; Eugene Medvedovski, Endurance Technologies Inc., Canada; Tohru S. Suzuki, National Institute for Materials Science (NIMS), Japan; Yiquan Wu, Alfred University, USA; Chang-Jun Bae, Korea Institute of Materials Science, Republic of Korea; Satoshi Tanaka, Nagaoka University of Technology, Japan; Manuel Belmonte, Institute of Ceramics and Glass (ICV-CSIC), Spain; Kyu Hyoung Lee, Yonsei University, Republic of Korea; Csaba Balazsi, Centre for Energy Research ELKH, Hungary; Heping Li, Huazhong University of Science and Technology, China; Zhixiao Zhang, Hebei University of Engineering, China

S9: POROUS CERAMICS: NOVEL DEVELOPMENTS AND APPLICATIONS

Manabu Fukushima, National Institute of Advanced Industrial Science and Technology (AIST), Japan; Tobias Fey, University of Erlangen-Nuremberg, Germany; Paolo Colombo, University of Padova, Italy; Farid Akhtar, Lulea University of Technology, Sweden; Ulfe Betke, Otto-von-Guericke-University, Germany; Ulla Simon, Technische Universität Berlin, Germany; Samuel Bernard, Institut de Recherche sur les Céramiques de Limoges, France; Doug Wing, Corning Incorporated, USA; Elie Kamseu, Laboratory of Materials, Cameroon; C.D. Madhusoodana, Ceramic Technological Institute Bharat Heavy Electricals Ltd., India; Yuki Nakashima, National Institute of Advanced Industrial Science and Technology (AIST), Japan; Jian-feng Yang, Xi'an Jiaotong University, China

S10: MODELING AND DESIGN OF CERAMICS AND COMPOSITES

Jingyang Wang, Institute of Metal Research, Chinese Academy of Sciences, China; Valentino Cooper, Oak Ridge National Laboratory, USA; Bin Liu, Shanghai University, China; Jian Luo, University of California, San Diego, USA; Yixiu Luo, Institute of Metal Research, Chinese Academy of Sciences, China; Katsuyuki Matsunaga, Nagoya University, Japan; Sergei Manzhos, Tokyo Institute of Technology, Japan; Paul Rulis, University of Missouri-Kansas City, USA; Gerard L. Vignoles, University of Bordeaux, France; William J. Weber, University of Tennessee, USA

S11: ADVANCED MATERIALS AND INNOVATIVE PROCESSING IDEAS FOR PRODUCTION ROOT TECHNOLOGIES

Chisung Ahn, Korea Institute of Industrial Technology, Korea; Sungwook Mhin, Kyonggi University, Korea; Tadachika Nakayama, Nagaoka University of Technology, Japan; Kyoung Il Moon, Korea Institute of Industrial Technology, Korea; Byungkoog Jang, Kyushu University, Japan; Kouichi Yasuda, Tokyo Institute of Technology, Japan; Hyuksu Han, Konkuk University, Korea; Hosung Kang, Cornell University, USA

S12: ON THE DESIGN OF NANOLAMINATED TERNARY TRANSITION METAL CARBIDES/NITRIDES (MAX PHASES) AND BORIDES (MAB PHASES), SOLID SOLUTIONS THEREOF, AND 2D COUNTERPARTS (MXENES, MBENES)

Surojit Gupta, University of North Dakota, USA; Miladin Radovic, Texas A&M University, USA; Konstantina Lambrinou, University of Huddersfield, UK; Jochen M. Schneider, RWTH Aachen University, Germany; Thierry Cabioch, Université de Poitiers, France; Sylvain Dubois, Université de Poitiers, France; Per Eklund, Linköping University, Sweden; Johanna Rosen, Linköping University, Sweden; Jesus Gonzalez, RWTH Aachen University, Germany; Chenxu Wang, Peking University, China

S13: DEVELOPMENT AND APPLICATIONS OF ADVANCED CERAMICS AND COMPOSITES FOR NUCLEAR FISSION AND FUSION ENERGY SYSTEMS

Takaaki Koyanagi, Oak Ridge National Laboratory, USA; Kyle Brinkman, Clemson University, USA; Monica Ferraris, Politecnico di Torino, Italy; Tatsuya Hinoki, Kyoto University, Japan; Dong Liu, University of Bristol, UK; Gyanender Singh, Idaho National Laboratory, USA; Konstantina Lambrinou, University of Huddersfield, UK; Krista Carlson, University of Nevada, USA; David Sprouster, Stony Brook University, USA; Samuel Humphry-Baker, Imperial College London, UK

S14: CRYSTALLINE MATERIALS FOR ELECTRICAL, OPTICAL AND MEDICAL APPLICATIONS

Kiyoshi Shimamura, National Institute for Materials Science, Japan; Noboru Ichinose, Waseda University; Luisa E. Bausá, Autonomous University of Madrid; Victoria Blair, U.S. Army Research Laboratory; Nerine J. Cherepy, Lawrence Livermore National Laboratory; Yoshihiko Imanaka, S-Nanotech Co-Creation; Kenji Toda, Niigata University; Yiquan Wu, Alfred University, USA; Takayuki Yanagida, Nara Institute of Science and Technology; Romaine Gaume, University of Central Florida, USA; Mariya Zhuravleva, University of Tennessee

S15: 8TH INTERNATIONAL SYMPOSIUM ON ADDITIVE MANUFACTURING AND 3D PRINTING TECHNOLOGIES

Michael Halbig, NASA Glenn Research Center, USA; Soshu Kirihara, Osaka University, Japan; Mrityunjay Singh, Ohio Aerospace Institute, USA; Arnaldo Moreno Berto, ITC, Spain; Zhangwei Chen, Shenzhen University, China; Corson L. Cramer, Oak Ridge National Laboratory, USA; Giorgia Franchin, Università di Padova, Italy; Yan Li, Dartmouth College, USA; Russell Maier, NIST, USA; Majid Minary, University of Texas at Dallas, USA; Alberto Ortona, SUPSI, Switzerland; Tobias A. Schaedler, HRL Laboratories LLC, USA; Martin Schwentenwein, Lithoz GmbH, Austria; Hui-Suk Yun, KIMS, Korea

S16: GEOPOLYMERS, INORGANIC POLYMERS AND SUSTAINABLE CONSTRUCTION MATERIALS

Waltraud M. Kriven, University of Illinois at Urbana-Champaign, USA; Joseph Davidovits, Geopolymer Institute, St. Quentin, France; Henry A. Colorado, Universidad de Antioquia, Medellin, Colombia; Enrico Bernardo, University of Padova, Italy

S17: ADVANCED CERAMIC MATERIALS AND PROCESSING FOR PHOTONICS AND ENERGY

Alberto Vomiero, Luleå University of Technology, Sweden; Federico Rosei, INRS, Canada; Yasuhiro Tachibana, RMIT University, Australia; David Kisailus, University of California at Riverside, U.S.; Tohru Sekino, Osaka University, Japan; Isabella Concina, Luleå University of Technology, Sweden; Haiguang Zhao, Qingdao University, China; Francesco Enrichi, National Research Council (CNR), Italy; Kassa Belay Ibrahim, Ca' Foscari University of Venice, Italy

S18: ULTRA-HIGH TEMPERATURE CERAMICS

Bai Cui, University of Nebraska-Lincoln, USA; William G. Fahrenholtz, Missouri University of Science and Technology, USA; Sea-Hoon Lee, Korea Institute of Materials Science, Korea; Frederic Monteverde, National Research Council-Institute of Science and Technology for Ceramics, Italy; Guo-Jun Zhang, Donghua University, Shanghai, China; Carolina Tallon, Virginia Tech, USA; Ji Zou, Wuhan University of Technology, China; Lisa Rueschhoff, Air Force Research Laboratory, USA; Emanuel Ionescu, Technical University Darmstadt, Germany; Lavina Backman, Naval Research Laboratory, USA; Simon Middleburgh, Bangor University, UK

S19: MOLECULAR-LEVEL PROCESSING AND CHEMICAL ENGINEERING OF FUNCTIONAL MATERIALS

Sanjay Mathur, University of Cologne, Germany; Emanuel Ionescu, Technische Universität Darmstadt, Germany; Samuel Bernard, University of Limoges, France; Gurpreet Singh, Kansas University, USA; Ravi Kumar, IIT Madras, India; Peter Kroll, University of Texas at Arlington, USA; Shashank Mishra, University of Lyon, France; Maarit Karppinen, Aalto University, Finland; Gunnar Westin, Uppsala University, Sweden; Ausrine Bartasyte, University of Franche-Comté, France; Hiromitsu Kozuka, Kansai University, Japan; Hirokazu Katsui, Tohoku University, Japan; Yoshiyuki Sugahara, Waseda University, Japan; Dong-Pyo Kim, Pohang University of Science and Technology, South Korea; Ulrich Wiesner, Cornell University, USA