The American Ceramic Society

48th International Conference & Exposition on Advanced Ceramics and Composites

ABSTRACT BOOK

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The American Ceramic Society
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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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large HEC grains with sizes from 1.0 μm to 1.5 μm. The wear characteristics were studied using ball-on-flat technique/dry sliding in air with SiC ball as tribological partner at applied loads 5 N, 25 N and 50 N with total sliding distance and sliding velocity 500 m and 0.1m/s. The friction coefficient values during the test were very similar, 0.57 in case of 5 N and 0.6 for applied load 25 N and 50 N. The dominant wear mechanisms were tribochemical reaction and tribo-layer formation.

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(ICACC-S18-003-2024) Synthesis and Properties of (Hf,Mo,Ti,W,Zr)B_2-(Hf,Mo,Ti,W,Z)C Dual Phase Ceramics

S. Filipovic*[1]; G. Hilmas[1]; W. Fahrenholtz[1]; N. Obradovic[2]; S. Curtarolo[3]

1. Missouri University of Science and Technology, Materials Science and Engineering, USA
2. Institute of technical sciences of SASA, Materials, Serbia
3. Duke University, Materials Science, Electrical Engineering and Physics, USA

Dual phase high entropy ceramics are attractive due to potential synergetic effects of the constituents on mechanical properties and thermal stability. In this research, dense, dual phase (Hf,Mo,Ti,W,Z)B_2-(Hf.Mo.Ti.W,Zr)C powder was synthesized by varying the contents of the transition metals in the final product. The co-synthesis method was used to obtain boride and carbide constituents by boro/carbothermal reduction of mixtures of oxides and appropriate amounts of carbon black and B_4C. Solid solution formation and densification of the reacted powders were done utilizing two step spark plasma sintering or hot pressing processes. Phase compositions of the produced ceramics were identified by x-ray diffraction while chemical compositions were measured using energy dispersive spectroscopy. The final microstructures showed submicron grains due to pining effect of the two phases. Investigation of the mechanical properties showed increasing in Vickers hardness values s up to 48.6 ± 2.2 GPa for applied load of 0.49N for compositions with optimized elemental contents. Room temperature strength was also measured.

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(ICACC-S18-004-2024) Densification kinetics of high entropy ceramics during spark plasma sintering

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1. Missouri University of Science & Technology, Materials Science and Engineering, USA
2. Duke University, Materials Science, Electrical Engineering and Physics, USA

High entropy ceramics have been densified by hot pressing and spark plasma sintering, but little information is available for their densification kinetics. In this study, a (Hf,Nb,Ta,Ti,Zr)B_2 high entropy boride, a (Hf,Nb,Ta,Ti,Zr)C high entropy carbide, and a dual phase ceramic containing both high entropy phases were densified by spark plasma sintering. The ram travel was used to determine the densification rates as a function of temperature. The activation energy for intermediate stage densification was determined from Arrhenius plots of densification rate data. X-ray diffraction was used for phase identification and scanning electron microscopy was used to examine the microstructure. Grain size measurements were used to determine the densification mechanism for each ceramic. This presentation will focus on the densification behavior and identification of the densification mechanisms.

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(ICACC-S18-005-2024) Extreme applications of high-entropy carbides (Invited)

S. Curtarolo*[1]

1. Duke University, Materials Science, Electrical Engineering and Physics, USA

Disordered multicomponent systems - occupying the mostly uncharted centers of phase diagrams - have been studied for the last two decades for their potential revolutionary properties. Very resilient compositions can be stabilized by maximizing entropy (configurational and/or vibrational) of (near) equimolar mixtures. The search for new systems is mostly performed with trial-and-error techniques, as effective computational discovery is challenged by the immense number of configurations: the synthesizability of high-entropy ceramics is typically assessed using ideal entropy along with the formation enthalpies from density functional theory, with simplified descriptors or machine learning methods. With respect to vibrations — even if they may have significant impact on phase stability — their contributions are drastically approximated to reduce the high computational cost, or often avoided with the hope of them being negligible, due to the technical difficulties posed in calculating them for disordered systems. In this presentation I will address many of the problems in the discovery of disordered systems, offer some data-based effective solutions, and discuss the avenues opened by the latter, especially for plasmonic applications.

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(ICACC-S18-006-2024) Synthesis and Characterization of High Entropy Carbonitrides (Invited)

L. Backman*[2]; J. Tsai[2]; H. Ryou[1]; E. Patterson[1]; S. Mills[1]; J. Wollmershauser[1]; E. Gorzkowski[1]; J. Maxwell[2]

1. U.S. Naval Research Laboratory, Materials Science & Technology Division, USA
2. U.S. Naval Research Laboratory, Spacecraft Engineering Division, USA

The high temperature (T>1700°C), highly chemically reactive environments encountered during hypersonic flight present unique design challenges for materials scientists. Requirements for these materials include melting temperatures greater than 3000°C, high thermal and dimensional stability, good thermal shock resistance, low reactivity and low coefficients of thermal expansion. Before 2015, less than 15 elements or compounds were considered to have the thermochemical stability to be viable material system candidates for this application and development of materials with coincident mechanical stability (e.g. ductility, toughness) has lagged. The recent advent of the high entropy design paradigm has expanded the composition space for UHTCs significantly and provided unprecedented tunability of mechanical and chemical properties. This is of particular interest for hypersonic vehicle designs requiring both high temperature oxidation resistance as well as maintaining structural and dimensional integrity to maximize aerodynamic performance. This presentation will review design strategies for performance in high temperature environments and discuss material system candidates, with a special focus on carbonitride high entropy ceramics. Experimental work on the synthesis and characterization of high entropy carbonitrides will also be presented.

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(ICACC-S18-007-2024) Thermal and Electrical Properties of Single Phase High Entropy Carbides with Varying Compositions

P. Brune*[1]; G. Hilmas[1]; W. Fahrenholtz[1]; J. Watts[1]

1. Missouri University of Science & Technology, Dept. of Materials Science and Engineering, USA

High entropy carbide (HEC) research is expanding rapidly due to their exceptionally high hardness over the baseline of their constituents and the proposed ability to tailor the thermal properties with compositional changes. While most of the current body of

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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 Mougin, 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; Byounwoo 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, German; 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, Technischee Universitat 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