

Program

ULTRA-HIGH TEMPERATURE CERAMICS: MATERIALS FOR EXTREME ENVIRONMENT APPLICATIONS V

June 5-8, 2022

**The Cliff Lodge at Snowbird
Snowbird, Utah**

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Previous conferences in this series

***Ultra-High Temperature Ceramics:
Materials for Extreme Environment Applications***

August 3-8, 2008

Lake Tahoe, California

Conference Chairs:

Eric Wuchina, Naval Surface Warfare Center, USA

Alida Bellosi, Institute of Science & Technology for Ceramics, Italy

***Ultra-High Temperature Ceramics:
Materials for Extreme Environment Applications II***

May 13-18, 2012

Hernstein, Austria

Conference Chairs:

Bill Fahrenholtz, Missouri University of Science & Technology, USA

Bill Lee, Imperial College, London, UK

Eric Wuchina, Naval Surface Warfare Center, USA

Yanchun Zhou, Aerospace Research Inst. Of Materials & Processing Technology, China

***Ultra-High Temperature Ceramics:
Materials for Extreme Environment Applications III***

April 12-16, 2015

Gold Coast, Australia

Conference Chairs:

George Franks, The University of Melbourne, Australia

Carolina Tallon, The University of Melbourne, Australia

***Ultra-High Temperature Ceramics:
Materials for Extreme Environment Applications IV***

September 17 – 20, 2017

Windsor, UK

Conference Chairs:

Jon Binner, University of Birmingham, UK

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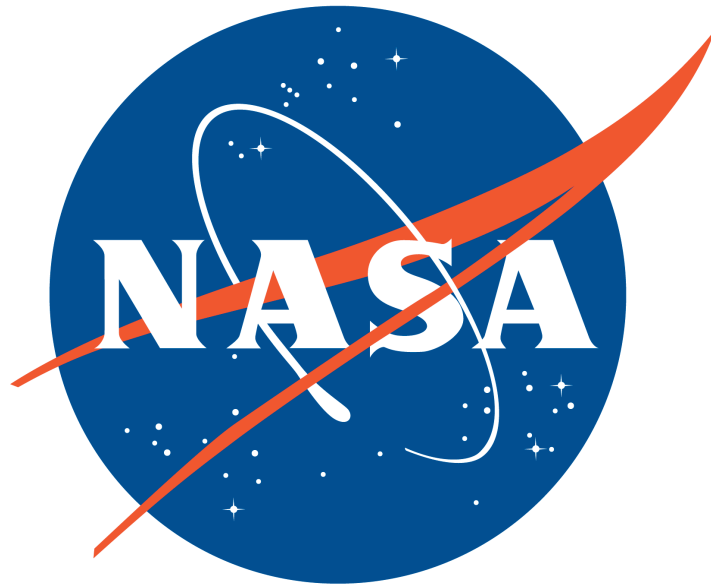
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The conference organizers gratefully acknowledge support from
the U.S. Office of Naval Research.







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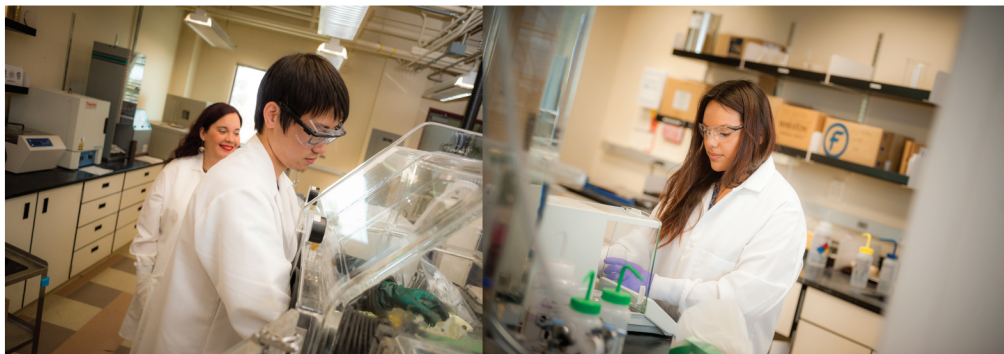
TALENT
DEVELOPMENT

MANUFACTURING
AND INTEGRATION

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AND DIAGNOSIS

ECONOMIC
EVALUATION

We collaborate and innovate across disciplines and industries to design materials and systems for extreme environments found in a variety of engineering applications, including ultra-high temperatures, extreme pressures and deformations, radiation, and acidic conditions, to name a few. We develop and innovate advanced



technologies for **aerospace, energy, nuclear, biomedical, environmental and defense applications** that are dependent on the design and performance of new materials and devices.

UC San Diego

Sunday, June 5, 2022

15:00 – 16:45	Conference Check-in (Ballroom 3 Lobby)
16:45 – 17:00	Opening remarks – Conference Chairs ECI welcome: Ram Darolia (GE Aviation, retired)
17:00 – 18:00	<u>Plenary – Parker Solar Probe</u> Elizabeth Congdon, Johns Hopkins University Applied Physics Laboratory (JHU/APL), USA
18:00 – 20:30	Welcome reception followed by Dinner

Locations and Notes

- *Technical sessions are in Ballroom 3.*
- *Poster sessions are in Atrium Overlook and Ballroom Mezzanine.*
- *Breakfasts are in Golden Cliff / Eagles Nest.*
- *Lunches on Monday and Wednesday are in Golden Cliff / Eagles Nest.*
- *Boxed lunches will be available Tuesday in Ballroom 3 Lobby.*
- *The reception and dinner on Sunday are in the Golden Cliff Terrace / Golden Cliff Room.*
- *The conference banquet on Tuesday is in Golden Cliff / Eagles Nest.*
- *The ECI on site office is in Coat Room A.*
- *Please wear your mask except when giving a presentation or actively eating or drinking. Please maintain physical distancing as much as possible.*
- *Audio, still photo and video recording by any device (e.g., cameras, cell phones, laptops, PDAs, watches) is strictly prohibited during the technical sessions, unless the author and ECI have granted prior permission.*
- *Speakers – Please have your presentation loaded onto the conference computer prior to the session start (preferably the day before).*
- *Speakers – Please leave at least 3-5 minutes for questions and discussion.*
- *Please do not smoke at any conference functions.*
- *Turn your mobile telephones to vibrate or off during technical sessions.*
- *After the conference, ECI will send an updated participant list to all participants. Please check your listing now and if it needs updating, you may correct it at any time by logging into your ECI account.*
- *Emergency Contact Information: Because of privacy concerns, ECI does not collect or maintain emergency contact information for conference participants. If you would like to have this information available in case of emergency, please use the reverse side of your name badge.*

Monday, June 6, 2022

07:00 – 08:00

Breakfast

Session: Processing & Properties

Chairs: Bill Fahrenholtz, Jon Binner

08:00 – 08:10

Conference Welcome and Expectations

Carmen Carney, Air Force Research Laboratory, USA
Ram Darolia

8:10 – 8:15

Session Introduction

Bill Fahrenholtz, Jon Binner

08:15 – 08:35

Investigation of the oxidation resistance of ZrB₂-based monoliths using polymer-derived Si(Zr,B)CN as sintering aid

Nils-Christian Petry, DECHEMA-Forschungsinstitut, Germany

08:35 – 08:55

The zeta phase in the transition metal carbides and nitrides: Structure, microstructure and properties

Christopher Weinberger, Colorado State University, USA

08:55 – 09:15

Textured UHTC borides using extremely low magnetic fields: influence of colloidal processing parameters and material selection

Juan Diego Shiraishi, Virginia Tech, USA

09:15 – 09:35

Plasticity of ZrB₂ grains during micropillar compression: The effect of anisotropy, temperature and dislocations

Tamás Csanádi, Institute of Materials Research, Slovakia

09:35 – 10:15

Coffee Break

10:15 – 10:35

Highly Stable Nanolamellar MXene-derived Carbides by Phase Transformation of Ti₃C₂T_x and Mo₂TiC₂T_x MXenes

Babak Anasori, Indiana University-Purdue University Indianapolis, USA

10:35 – 10:55

Oxidation of high entropy ultra-high temperature ceramics

Elizabeth Opila, University of Virginia, USA

10:55 – 11:15

Tungsten diboride for high energy nuclear applications

James Davidson, Imperial College London, United Kingdom

11:15 – 11:35

Carbon influence on the fracture toughness of transition metal carbides

Xingyuan Zhao, Colorado School of Mines, USA

11:35 – 11:55

Discussion

11:55 – 13:30

Lunch

Session: Fundamental Properties

Chairs: Chris Weinberger, Kris Behler

13:30 – 13:35

Session Introduction

Chris Weinberger, Kris Behler

13:35 – 13:55

Experimental techniques to study structure and thermodynamics at ultra-high temperatures

Sergey V. Ushakov, Arizona State University, USA

Monday, June 6, 2022 (continued)

- 13:55 – 14:15 ***In-situ* high temperature spatially resolved X-ray diffraction of TiB₂ up to ~3250 °C**
Scott McCormack, University of California, Davis, USA
- 14:15 – 14:35 **Design of Ultra-High Temperature Ceramics for Oxidation Resistance**
Niquana Smith, University of Virginia, USA
- 14:35 – 14:55 **Short-range chemical environment versus long-range chemical homogeneity analyses in high-entropy transition metal AlB₂-type diboride solid solutions**
Frederic Monteverde, CNR-ISTEC, Italy
- 14:55 – 15:25 **Coffee Break**
- 15:25 – 15:45 **First-principles prediction of thermal conductivity of zirconium carbide and hafnium carbide at ultra-high temperatures**
Tianli Feng, University of Utah, USA
- 15:45 – 16:05 **From the atomic scale to the bulk: Ultra high temperature evaluation of metal diborides MB₂ (M = Ta, Ti, Hf, Zr, Nb)**
Elizabeth Sobalvarro Converse, Lawrence Livermore National Laboratory, USA
- 16:05 – 16:25 **Modeling environmental effects in MeB₂/SiC UHTCs: Oxidation by oxygen and water vapor**
Pavel Mogilevsky, UES Inc., USA
- 16:25 – 16:45 **Stress distribution analysis in zirconium diboride and silica carbide (ZrB₂-SiC) based thermal protection system under hypersonic flight conditions using a machine learning driven approach**
Carmine Zuccarini, Kingston University London, United Kingdom
- 16:45 – 17:00 **Break**
- 17:00 – 20:00 Poster Session with heavy hors d'oeuvres and wine/beer/soft drinks

Tuesday, June 7, 2022

07:00 – 08:00

Breakfast

Session: UHTC-CMCs & Coatings

Chairs: Mike Cinibulk, Lisa Rueschhoff

08:00 – 08:05

Session Introduction

Mike Cinibulk, Lisa Rueschhoff

08:05 – 08:25

Advances and challenges in the development of UHTCMCs - A review of the C3harme project

Diletta Sciti, ISTEC-CNR, Italy

08:25 – 08:45

The AM3aC2A Project: Multiscale approach for modeling CMC and UHTCMC materials for reusable components for aerospace

Mario De Stefano Fumo, Italian Aerospace Research Centre, Italy

08:45 – 09:05

Influence of Nb coating on the oxidation behavior of ZrB₂

Jan Erik Förster, German Aerospace Center, Germany

09:05 – 09:25

Novel polymer-derived carbide and boride refractory ceramics

Brad Pindzola, Triton Systems Inc, USA

09:25 – 09:45

Laser additive manufacturing of ultra high temperature ceramics

Steven Storck, Johns Hopkins University-Applied Physics Laboratory, USA

09:45 – 10:15

Coffee Break

10:15 – 10:35

Thermal ablation behaviour of ultra-high temperature ceramic matrix composites made by RF enhanced chemical vapour infiltration

Jon Binner, University of Birmingham, United Kingdom

10:35 – 10:55

Thermodynamic and experimental SiC-ZrC CVD process development

Benjamin Lam, Oak Ridge National Laboratory, USA

10:55 – 11:15

Oxidation behavior of Cf / MC – SiC (with M = Hf, Zr) composites in an oxyacetylene torch environment under over oxygen concentration

Thomas Bourdeau, Laboratory for thermo-structural composites LCTS, France

11:15 – 11:35

Zirconium Carbide Oxidation and Passivation for Nuclear Fuel Applications

Allison Rzepka, UIUC Department of Mechanical Science and Engineering, USA

11:35 – 11:55

UHTC coatings obtained by plasma spraying: Characterization and oxidation behavior

Arthur Charrue, CEA-DAM Le Ripault, France

11:55 – 15:30

Lunch / Free time

Session: Near Net Shape Processing

Chairs: Greg Hilmas, Carolina Tallon

15:30 – 15:35

Session Introduction

Greg Hilmas, Carolina Tallon

15:35 – 15:55

Additive manufacturing of chopped fiber ultra-high ceramic composites

Lisa Rueschhoff, Air Force Research Laboratory, USA

Tuesday, June 7, 2022 (continued)

- | | |
|---------------|--|
| 15:55 – 16:15 | Low-toxity gelcasting to 3D shaping of UHTCs
Carolina Tallon, Virginia Tech, USA |
| 16:15 – 16:35 | Direct ink writing of ultra-high temperature ceramics
Swetha Chandrasekaran, Lawrence Livermore National Laboratory, USA |
| 16:35 – 16:55 | Additive manufacturing enabling W-SiC and W-ZrB₂-SiC heterogeneous materials
David Mitchell, Oak Ridge National Laboratory, USA |
| 16:55 – 17:15 | Discussion |
| 17:15 – 18:00 | Break |
| 18:00 – 20:00 | Conference Dinner |

Wednesday, June 8, 2022

07:00 – 08:00

Breakfast

Session: Engineered Structures

Chairs: Diletta Sciti, Daniel Butts

08:00 – 08:05

Session Introduction

Diletta Sciti, Daniel Butts

08:05 – 08:25

Ultra-high temperature ceramics for transpiration cooling applications in hypersonic vehicles

Matthew McGilvray, University of Oxford, United Kingdom

08:25 – 08:45

Porous UHTCs for transpiration cooling of hypersonic flight

Rowan Hedgecock, Imperial College London, United Kingdom

08:45 – 09:05

Ultra-high temperature ceramics with exceptional strength at elevated temperature

Laura Silvestroni, CNR-ISTEC, Italy

09:05 – 09:25

Characterization of ultra-high temperature materials produced by rapid-laser chemical vapor deposition (R-LCVD)

Jeff Vervlied, Free Form Fibers, USA

09:25 – 09:45

Integrated self-healing thermal protection for high-speed vehicles

Steven Storck, Johns Hopkins University, Applied Physics Laboratory, USA

09:45 – 10:15

Coffee Break

Session: Extreme Environment Testing

Chairs: Frederick Monteverde, Scott McCormack

10:15 – 10:20

Session Introduction

Frederick Monteverde, Scott McCormack

10:20 – 10:40

Diagnostics for improved understanding of test environment and material interactions to advance oxidation-degradation models of UHTCs

Michael K. Cinibulk, Air Force Research Laboratory, USA

10:40 – 11:00

Plasma wind tunnel testing of UHTC coated components for hypersonic applications

Mario De Stefano Fumo, Italian Aerospace Research Centre, Italy

11:00 – 11:20

Characterization & testing in extreme, applicable environments

Bhaves V. Patel, Southern Research Institute, USA

Session: High Entropy Materials I

Chairs: Greg Thompson, Lavina Backman

11:20 – 10:25

Session Introduction

Greg Thompson, Lavina Backman

11:25 – 11:45

Synthesis, densification, and properties of high entropy ultra-high temperature ceramics

William Fahrenholtz, Missouri University of Science and Technology, USA

Wednesday, June 8, 2022 (continued)

- 11:45 – 12:05 **Synthesis and crystallography of high entropy metal carbides: A new class of ultrahigh temperature and irradiation resistant ceramics**
Olivia A. Graeve, University of California, San Diego, USA
- 12:05 – 12:25 **Processing of high entropy carbide based ceramics**
Lavina Backman, US Naval Research Laboratory, USA
- 12:25 – 13:30 **Lunch**
- 13:30 – 13:50 **Towards complex component manufacture via 3D printing and joining of parts**
Luc J. Vandeperre, Imperial College London, United Kingdom
- 13:50 – 14:10 **High Entropy Rare Earth $A_2B_2O_7$ Type Zirconates**
Daniel R. Lowry, Sandia National Laboratories, USA
- 14:10 – 14:30 **Protective complex oxide film formation in multi-component ultra-high temperature carbides during plasma jet exposure**
Ambreen Nisar, Florida International University, USA
- 14:30 **Announcement of the 2024 Conference and presentation of awards**

Poster Presentations

1. **Multiscale porous high-temperature heat exchanger using ceramic co-extrusion**
Xiangyu Li, MIT, USA
2. **Strategies for printing fibers and post-processing for ceramic matrix composites (CMCs)**
Corson Cramer, Oak Ridge National Laboratory, USA
3. **Mechanical and thermal properties of Zeta phase tantalum carbide at elevated temperatures**
Evan Schwind, Missouri University of Science and Technology, USA
4. **Design of ultra-high temperature ceramics for oxidation resistance**
Niquana Smith, University of Virginia, USA
5. **Environmental conical nozzle levitator equipped with dual lasers**
Fox Thorpe, University of California, Davis, USA
6. **Investigation of anomalous hardness in sub-stoichiometric transition metal carbides using ab-initio simulations**
Brennan Watkins, Colorado State University, USA
7. **Oxidation behavior of Cf / MC – MB₂ – SiC (with M = Hf, Zr) composites in an oxyacetylene torch environment**
Thomas Bourdeau, Laboratory for thermo-structural composites LCTS (CNRS-CEA-Safran-UB), France
8. **Finite difference simulation of phase transformation kinetics in transition metal carbide composites**
John Carter Stotts, Colorado State University, USA
9. **Mixing the transition metals in transition metal carbides**
Christopher Weinberger, Colorado State University, USA
10. **Oxidation kinetics of sub-stoichiometric ZrC_x via furnace testing to 2500°C / 1 atm air**
Mark Opeka, Southern Research Institute, USA
11. **Oxidation of TaC-HfC blends densified by spark plasma sintering**
Maritza Sanchez, University of California, San Diego, USA
12. **Computational study of temperature in a millimeter wave heat exchanger with an AlN:Mo Susceptor on an isothermal metal plate**
Vadim Yakovlev, Worcester Polytechnic Institute, USA
13. **Cold spray deposition of metallic-UHTC composites**
Michael Large, University of Alabama, USA
14. **Phase evolution in thermally annealed metallic-UHTC composites**
Michael Large, University of Alabama, USA
15. **Materials processing and property-structure characterization capabilities at The University of Alabama**
Gregory Thompson, The University of Alabama, USA

16. **Novel polymer-derived carbide and boride refractory ceramics**
Brad Pindzola, Triton Systems Inc., USA
17. **The development of polymer-derived Si(Al)CN CMC for high temperature applications**
Muhammed Younas, University of Birmingham, United Kingdom
18. **Diffusional and microstructural profiles in metallic-to-UHTC conversion by carbonization**
Haas Blacksher, The University of Alabama, USA
19. **CuAAC for inorganic preceramic polymer synthesis**
Matthew B. Dickerson, US Air Force (AFRL), USA