

***Preliminary Program***  
(September 18, 2017)

**Advanced Ceramic Matrix Composites:  
Science and Technology of Materials, Design,  
Applications, Performance and Integration**

November 5-9, 2017

LaFonda on the Plaza - Santa Fe, New Mexico, USA

**Conference Chair**

**Prof. Yutaka Kagawa**  
Tokyo University of Technology

**Conference Co-Chairs**

**Dr. Dongming Zhu**  
NASA Glenn Research  
Center

**Dr. Ram Darolia**  
GE Aviation (retired)

**Prof. Rishi Raj**  
University of Colorado,  
Boulder



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**Sunday, November 5, 2017**

16:30 - 18:30                      Conference check-in

18:30 - 20:30                      Reception followed by Dinner

**Monday, November 6, 2017**

07:00 - 08:45 Breakfast

08:45 - 09:00 Opening Remarks  
Conference Chair: Yutaka Kagawa  
ECI Conference Technical Liaison: Ram Darolia

**Session I. Plenary Session**

09:00 - 09:45 **Keynote: Development and Commercialization of GE's Ceramic Matrix Composites (CMCs) for Aircraft Engines**  
Krishan Luthra \*, GE Global Research, USA

09:45 - 10:15 **HIGH TEMPERATURE COMPOSITE OVERVIEW IN FRANCE**  
Marc Montaudon\*, Eric Bouillon, Safran Ceramics

10:15 - 10:45 **Application of CMC Materials into Aero-Engines**  
Kuniyuki Imanari \*, IHI Corporation, Japan

10:45 - 11:15 Coffee break

11:15 - 11:45 **ONR and NAVY Research in CERAMIC MATRIX COMPOSITES Systems for Advanced Naval Engines**  
Presenter: David Shifler \*, Office of Naval Research, USA

11:45 - 12:15 **Overview of NASA Transformational Tools and Technologies Project's 2700°F CMC/EBC Technology Challenge**  
Janet B. Hurst \*, NASA Glenn Research Center, USA

**Session I – Plenary Session Continued**

12:15 - 12:40 **Discussion Panel: Plenary Session**

12:40 - 14:00 Lunch break

**Monday, November 6, 2017 (continued)**

**Session: Integrated Design and Applications – 1**

- 14:00 - 14:25      **FIBER CREEP AND RUPTURE MODELS FOR DESIGN OF ADVANCED HIGH-TEMPERATURE SiC-BASED CERAMIC MATRIX COMPOSITES**  
James DiCarlo \*, NASA Glenn Research Center, USA
- 14:25 - 14:50      **PROGRESS OF SILICON CARBIDE FIBERS AND THEIR APPLICATION TO CERAMIC MATRIX COMPOSITES**  
Michio Takeda \*, NGS Advanced Fibers Co., Ltd, Japan
- 14:50 - 15:15      **CERAMIC COMPOSITES FOR HIGH TEMPERATURE AEROSPACE STRUCTURES AND PROPULSION SYSTEMS**  
David Marshall \*, University of Colorado, USA  
Olivier Sudre, Teledyne Scientific Company, Thousand Oaks, CA; Brian Cox, Arachne Consulting, Sherman Oaks, CA
- 15:15 - 15:40      **Twenty Years of Experience with Carbon/Ceramic Brakes: Status and Perspectives**  
Walter Krenkel \*, University of Bayreuth, Germany

**15:40 - 16:00**      Coffee break

**Session: Integrated Design and Applications – 2**

- 16:00 - 16:25      **Honeywell Perspective on Ceramic Matrix Composites and Enabling Technologies for Gas Turbine Aeroengines**  
Natalie A. Kruk<sup>1</sup> \*, Edwin Martinez<sup>2</sup>, Terence. E. Whalen<sup>1</sup>  
<sup>1</sup> Honeywell, Morristown, NJ 07962, USA  
<sup>2</sup> Honeywell Aerospace, Phoenix, AZ 80534, USA
- 16:25 - 16:50      **Overview of Ceramic Matrix Composite Research at NASA Glenn Research Center**  
James D. Kiser \* et al, NASA Glenn Research Center, USA
- 16:50 - 17:15      **Informatics Based Structure-Property Linkages for Transverse Strength of Ceramic Matrix Composites**  
Dipen Patel, Triplicane Parthasarathy, Daniel Rapking, Michael Braginsky, Craig Przybyla \*, Air Force Research Laboratory, USA
- 17:15 - 17:40      **ENGINEERING FRAMEWORK FOR SAFRAN INTERLOCKED CERAMICS COMPONENTS**  
David Marsal \*, Eric Bouillon, Nicolas Laval, Safran Ceramics
- 17:40 - 18:05      **SiC-Based Ceramic Matrix Composite Behavior Enhancement for Gas Turbines Hot Sections**  
Eric Bouillon \*, Nicolas Laval, David Marsal, Safran Ceramics, France

- 18:05 - 18:30      **Updated Composite Materials Handbook-17 (CMH-17) Volume 5 - Ceramic Matrix Composites**  
James Doug Kiser\*, NASA Glenn Research Center, USA
- 18:30 - 20:00      Dinner
- 20:00 - 21:30      **Poster Session/Social hour**

**Tuesday, November 7, 2017**

- 07:30 - 09:00      Breakfast

**Session: Advanced Materials and Architectures, Interfaces and Composite System Performance**

- 09:00 – 09:25      **CONSTITUENT DEVELOPMENT FOR HIGHER-TEMPERATURE CAPABLE CERAMIC MATRIX COMPOSITES**  
Michael K. Cinibulk \*, Air Force Research Laboratory, USA
- 09:25 – 09:50      **Interface Engineering in Oxide/Oxide Composites**  
K.K. Chawla \*, University of Alabama at Birmingham, USA
- 09:50 - 10:15      **Creep Durability of 3D Woven SiC/SiC Composites with (CVI+PIP) Hybrid Matrix**  
R.T. Bhatt \*, OAI/NASA Glenn Research Center, USA
- 10:15 - 11:40      **SiC Fibers and SiC/SiC Ceramic Matrix Minicomposites Damage Behavior**  
Amjad Almansour, NASA Glenn Research Center, USA
- 11:40 - 12:05      **Image analysis, synthesis and image-based modeling of ceramic-matrix composites**  
Gerard L. VIGNOLES \*, University of Bordeaux, France
- 11:05 - 12:30      **EFFECT OF FIBER DISTRIBUTIONS ON THE MECHANICAL PERFORMANCE OF CMC MATERIALS: VIRTUAL MANUFACTURING AND TESTING APPROACH**  
Wooseok Ji \*, Hye-gyu Kim, Ulsan National Institute of Science and Technology, Korea
- 12:30 - 12:55      **EFFECT OF MECHANICAL MACHINING ON SURFACE ROUGHNESS OF CMCs**  
Ralf Goller \*, Achim Rösiger, Augsburg University of Applied Sciences
- 12:55                **Pick up boxed lunch and depart for excursion**
- After excursion: Dinner on your own in Santa Fe**

**Wednesday, November 8 2017**

07:00 - 09:00 Breakfast

**Session: Processing and Mechanical Behavior, NDE, Modeling and Life Prediction**

08:35 - 09:00 **In-situ 3D Visualization of Composite Microstructure During Polymer-to-Ceramic Conversion**

Frank Zok, University of California Santa Barbara, USA

09:00 - 09:25 **A Methodology Based on in Situ Crack Propagation and Modeling for Designing Ceramic Composites for Use at High Temperature**

Raj N. Singh \*, Oklahoma State University, USA

09:25 - 09:50 **VIRTUAL SIMULATION AND DESIGN OF BARRIER COATINGS FOR CERAMIC COMPOSITES**

Matthew R. Begley \*, University of California, Santa Barbara, USA

09:50 - 10:15 **Multi-Scale Modeling of Damage and Delaminations Failure in Ceramic Matrix Composites**

Rajesh S. Kumar \*, UTRC/Pratt & Whitney, USA

10:15 - 10:40 **Monitoring damage accumulation using acoustic emission and electrical resistance at room and elevated temperatures of SiC-based composites**

Greg Morscher \*, University of Akron, USA

10:40 - 11:00 Coffee break

**Session: Polymer Derived Ceramics and Processing**

11:00 - 11:25 **Dual function polymer-derived non-oxide/oxide matrix prepared by additive manufacturing**

Rishi Raj \*, University of Colorado, USA

11:25 - 11:50 **Fundamentals of Polymer Precursor Method for Synthesizing Silicon Carbide Based Ceramic Fibers**

Masaki Narisawa \*, Osaka Prefecture University; Yuka Ikemoto, Japan Synchrotron Radiation Research Institute; Kenji Suzuki, Advanced Institute of Materials Science, Japan

11:50 - 12:15 **Implications of Coupled Crystallization and Decomposition Reactions for CMC Processing Using Polymer Derived Ceramics**

David Poerschke \*, University of Minnesota, USA

12:15 - 12:40 **SiC-SiC CMC's USING BN POWDER COATED SILICON CARBIDE FIBERS**

Eric Ness \*, Koichi Machida, Shinichiro Aonuma, Charles Lewinsohn, CoorsTek Inc., USA

12:40 - 14:00 Lunch break

**Session: Environmental Effects and CMAS Degradation**

14:00 - 14:25 **Non-oxide ceramic matrix composites for application in hot gas atmospheres – requirements and potential**

Hagen Klemm \*, Willy Kunz, Bernd Grönde, Katrin Schönfeld, Fraunhofer IKTS  
Dresden, Germany

14:25 - 14:50 **Borosilicate Wetting on Ceramic Matrix Composites and Si-based Substrates**

Megan Wilson \*, Elizabeth Opila, University of Virginia, USA; Tim Keenan, Alfred  
University

14:50 - 15:15 **Ceramic Matrix Composite Environmental Barrier Coating Durability Model**

Mike Dion and Brian Sullivan \*, MR&D, USA

15:15 - 15:40 **Evaluation of ceramic matrix composite leading edge samples under simulated hypersonic flight conditions**

Triplicane Parthasarathy \*, Carmen Carney, Mike Cinibulk, Tarun Mathur, Mark  
Gruber, Air Force Research Laboratory, USA

**15:40 - 16:00** Coffee break

16:00 - 16:25 **CMAS Challenges to CMC-T/EBC Systems**

Carlos Levi \*, D.L. Poerschke, W. Summers, J.H. Shaw, R.W. Jackson,  
D. Park, K.M. Grant, N. Verma, F.W. Zok, University of California Santa Barbara,  
USA

16:25 - 16:50 **Boria Effects on the Oxidation Mechanisms of SiC/BN/SiC CMCs**

Elizabeth Opila \*, Valentina Avincola, Bohuslava McFarland, Megan Wilson,  
Madeline Morales, University of Virginia, USA

16:50 - 17:15 **ISSUES OF ADVANCED CERAMIC MATRIX COMPOSITES IN AEROENGINE APPLICATIONS**

Sung R. Choi \*, Naval Air Systems Command, Patuxent River, USA

17:15 - 17:40 **Interfacial Characteristics and Microstructural Evolution of Ceramics Exposed to High Temperature Sand Laden Combustion Environments**

Anindya Ghoshal \* et al, Army Research Laboratory, USA

17:40 - 18:05 **Calcium-Magnesium Alumino-Silicates (CMAS) Reaction Mechanisms and Resistance of Advanced Turbine Environmental Barrier Coatings - SiC/SiC Ceramic Matrix Composites**

Dongming Zhu \*, Gustavo Costa, Bryan Harder, Valerie L. Wiesner, Janet B. Hurst  
NASA Glenn Research Center, USA

18:05 - 18:30

**DEGRADATION OF Si BOND COAT LAYER AFTER UNEXPECTED MELTING CONDITION IN OXIDE/Si/(SiC/SiC) MODEL ENVIRONMENTAL BARRIER COATING SYSTEM**

Rumi Kitazawa \*<sup>1</sup>, Takaho Kuribara <sup>2</sup>, Yutaka Kagawa <sup>1- 1</sup>. Tokyo University of Technology, Japan; 2. University of Tokyo, Japan

**Wednesday, November 8, 2017 (continued)**

19:30 - 21:00 Banquet

**Thursday, November 9, 2017**

07:00 - 09:00

Breakfast

**Session: Environmental Barrier Coatings-1: Processing and Test Development**

09:00 - 09:25

**Current EBC Development and Testing at NASA**

Kang Lee \*, Deborah Waters, Gustavo Costa, Bernadette Puleo, NASA GRC, USA

09:25 - 09:50

**Advanced Design of EBC Based on Mass-transfer Mechanisms in Oxides under Oxygen Potential Gradients at High Temperatures**

Satoshi Kitaoka \*, Tsuneaki Matsudaira, Masashi Wada, Taishi Yokoi, Masasuke Takata, Japan Fine Ceramics Center, Japan

09:50 - 10:15

**APS Y<sub>2</sub>O<sub>3</sub> Environmental Barrier Coatings for Oxide Ceramic Matrix Composites**

Peter Mechnich \*, DLR, Germany

10:15 - 10:40

**Development of NASA's Advanced Environmental Barrier Coatings for SiC/SiC Composites: Prime-Reliant Design and Durability Perspectives**

Dongming Zhu \*, NASA GRC, USA

10:40 - 11:00

Coffee break

**Session: Environmental Barrier Coatings-2: Mechanics and Failure mechanisms**

11:00 - 11:25

**Delamination resistance of oxide environmental barrier coatings from SiC/SiC substrate**

Yutaka Kagawa \*, Tokyo University of Technology, Japan

11:25 - 11:50

**Failure Resistant Thermal and Environmental Barrier Coating Concepts**

Haydn Wadley \*, University of Virginia, USA

11:50 - 12:15

**An Evaluation Method for Interface Toughness of Environmental Barrier Coatings (EBCs) on Ceramic Matrix Composites (CMCs)**



Hideki Kakisawa \*, National Institute for Materials Science, Japan

12:15 - 12:40

**Development of Thermally Sprayed Environmental Barrier Coatings**  
Emine Bakan, Caren Sophia Gatzert, Daniel Emil Mack \*, Robert Vaßen,  
Forschungszentrum Jülich GmbH, Germany

12:40 - 14:00

Lunch and Departures

## Poster Presentations

List posters:

**1. Residual stress measurement of Yb silicates by Raman spectroscopy: First-principles and experimental studies**

Takafumi Ogawa \*<sup>1</sup>, Yoshihisa Tanaka <sup>2</sup>, Taishi Yokoi <sup>1</sup>, Hideki Kakisawa <sup>2</sup>, Satoshi Kitaoka <sup>1</sup> – <sup>1</sup>. Japan Fine Ceramics Center, Japan; <sup>2</sup>. National Institute of Materials Science, Japan

**2. Oxidation Mechanisms of ZrB<sub>2</sub>-Based Ultra High Temperature Ceramic Matrix Composites**

Ryo Inoue \*, Yasuo Kogo, Tokyo University of Science; Yuki Kubota, Ken Goto, Japan Aerospace Exploration Agency (JAXA)

**3. Microstructure Control of Multi Layered EBC Prepared by Dual Electron Beam PVD**

Taishi Yokoi \*, Norio Yamaguchi, Satoshi Kitaoka, Masasuke Takata, Japan Fine Ceramics Center, Japan

**4. Numerical simulation of energy release rate for interface crack initiation due to thermal stress in environmental barrier coatings for Silicon carbide (SiC) fiber reinforced SiC matrix composite**

Emi KAWAI, Yoshitaka UMENO, The University of Tokyo, Japan

**5. The potential of plasma activation for EB-PVD of EBC systems on CMC components**

Burkhard Zimmermann \*, Gösta Mattausch, Frank-Holm Rögner, Bert Scheffel, Jens-Peter Heinß, Christoph Metzner, Fraunhofer Institute for Organic Electronics, Germany

**6. SiC/SiC composite truster for a non-toxic liquid propellant rocket engine**

Ken Goto \*, Shinichiro Tokudome, Tsuyoshi Yagishita, Japan Aerospace Exploration Agency, Japan

**7. Some Topics Related to Measurement of Delamination Toughness of EBC Layer from 2D/3D SiC/SiC Substrate**

Yuto Aoki \*, Rumi Kitazawa, Junya Inoue, Yutaka Kagawa, Tokyo University of Technology, Japan

**8. How NOT to measure the tensile strength of high-modulus fibers**

Joseph Pegna, Shay L. Harrison, Free Form Fibers, USA

**9. Cost-Performance Analysis of Silicon Carbide fibers**  
Shay Harrison, Joseph Pegna, Free Form Fibers, USA