

Program

THERMAL AND ENVIRONMENTAL BARRIER COATINGS VI

June 19 - 24, 2022

**Irsee, Germany
Kloster Irsee**

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Pratt & Whitney, USA

Uwe Schulz
German Aerospace Center, Germany

Mike Maloney (retired)
Pratt & Whitney, USA

Robert Vaßen
Research Center, Jülich, Germany

Ram Darolia (retired)
GE Aviation, USA



Engineering Conferences International
32 Broadway, Suite 314 - New York, NY 10004, USA
www.engconfintl.org – info@engconfintl.org

Kloster Irsee
Tagungs-, Bildungs- und Kulturzentrum
Klosterring 4
D-87660 Irsee, Germany
Tel.: +49 (0)8341 906-00
hotel@kloster-irsee.de

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Previous conferences in this series:

Thermal and Environmental Barrier Coatings

Aug 17-22, 2003

Irsee, Germany

Conference Chairs:

David R. Clarke, University of California Santa Barbara, USA

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Manfred Ruehle, MPI, Germany

Thermal Barrier Coatings II

August 12-17, 2007

Irsee, Germany

Conference Chairs:

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Thermal Barrier Coatings III

Aug. 7-12, 2011

Irsee, Germany

Conference Chairs:

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Ram Darolia, GE Aviation, USA

Odile Lavigne, ONERA DMSM/MAT, France

Hideyuki Murakami, National Institute of Materials Science, Japan

Hongbo Guo, Beihang University, China

Thermal Barrier Coatings IV

June 22-27, 2014

Irsee, Germany

Conference Chairs:

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Thermal Barrier Coatings V

June 24 – 29, 2018

Irsee, Germany

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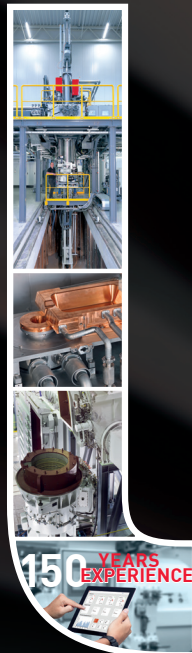
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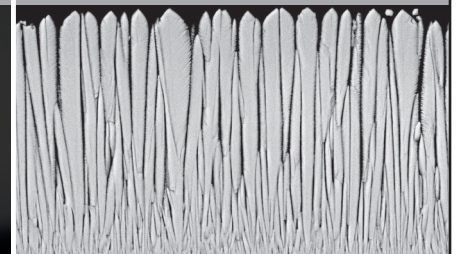
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Coatings Conference VI.

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Sunday, June 19, 2022

16:00 – 18:00	Conference Check-In
18:00 – 22:00	Garden Gathering including reception, BBQ dinner and music by BauernStreichwurst

Locations and Notes

- *Poster Sessions will be in the corridor near the meeting room.*
- *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.*
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Monday, June 20, 2022

- 07:00 – 08:15 Breakfast
- 08:15 – 08:30 **Conference Overview**
Brian Hazel, Pratt & Whitney, USA
- ECI welcome: Ram Darolia (GE Aviation, retired)
- Session: Overview of TBC/EBC Application**
Chairs: Gyn Brewster, Rolls-Royce plc., United Kingdom
- 08:30 – 09:00 **Requirements and Design Constraints for TBC's in Land Based Gas Turbines**
Grégoire Witz, Siemens Energy, Switzerland
- 09:00 – 09:30 **Successes, Challenges and Opportunities for Environmental Barrier Coatings**
Julie Kuhn, GE Aviation, USA
- 09:30 – 10:00 Coffee Break
- Session: EBCs for Novel Alloy Systems**
Chairs: Uwe Schulz, DLR - German Aerospace Center, Germany
- 10:00 – 10:30 **New Environmental-Thermal Barrier Coatings for Ultrahigh Temperature Alloys**
Ji-Cheng Zhao, University of Maryland, USA
- 10:30 – 11:00 **High Temperature Refractory Metal Alloys-advances and Challenges**
John Perepezko, University of Wisconsin-Madison, USA
- 11:00 – 11:30 **High Entropy Rare Earth Oxide (HERO) Environmental Barrier Coatings for Refractory Metal Alloys**
Elizabeth Opila, University of Virginia, USA
- 11:30 – 12:00 **Selective Thermal Emission Coatings for Improved Turbine Efficiency**
Pete McGrail, Pacific Northwest National Lab, USA
- 12:00 – 13:30 **Lunch**
- Session: EBCs for Novel Alloy Systems (continued)**
Chairs: Uwe Schulz, DLR - German Aerospace Center, Germany
- 13:30 – 14:00 **Assessing the High Temperature Performance of Refractory Metal Alloys**
Bruce Pint, Oak Ridge National Laboratory, USA
- Session: EBC**
Chairs: Sanjay Sampath, Stony Brook University, USA
- 14:00 – 14:30 **EBC Development and Behaviour Analysis for High Temperature CMC Components**
Lisa Pin, Safran Ceramics, France
- 14:30 – 15:00 **Concepts for Enhancing the Life of Environmental Coatings Systems**
Jeroen Deijkers, University of Virginia, USA

Monday, June 20, 2022 (continued)

15:00 – 15:30	Coffee Break
15:30 – 16:00	Processing and Characterization of Ytterbium Silicate Environmental Barrier Coatings Ping Xiao, University of Manchester, United Kingdom
16:00 – 16:30	Damage Mechanism of an Environmental Barrier Coated Ceramic Matrix Composite Under Thermal and Mechanical Loadings Thibaut Archer, ONERA, France
16:30 – 17:00	The Synthesis of EBC Layer Stacks by the Combination of PVD and CVD in a Continuous Vacuum Process Jurgen Ramm, Oerlikon Surface Solutions AG ZN Balzers, Liechtenstein
17:00 – 18:00	Discussion Leader: Matthew Begley, University of California, Santa Barbara, USA
18:30 – 21:30	Dinner & Social Hour

Tuesday, June 21, 2022 (Summer Solstice)

- 07:00 – 08:30 Breakfast
- Session: EBC (continued)**
Chairs: Sanjay Sampath, Stony Brook University, USA
- 08:30 – 09:00 **Stabilization Mechanism and CMAS Corrosion Behavior of Rare Earth Oxides Based Environmental Barrier Coatings Prepared by Thermal Spray**
Naoki Yamazaki, IHI, Japan
- 09:00 – 09:30 **Cyclic oxidation of yttrium/ytterbium disilicate environmental barrier coatings**
Bruce Pint, Oak Ridge National Laboratory, USA
- Session: TBC**
Chairs: Grégoire Witz, Seimens Energy, Switzerland
- 09:30 – 10:00 **Factors influencing the performance of zirconia based thermal barrier coatings**
Robert Vaßen, Forschungszentrum Julich GmbH, Germany
- 10:00 – 10:30 Coffee Break
- 10:30 – 11:00 **A Coupled Thermal and Mechanical Analysis of Sintering in Thermal Barrier Coatings Under Gradient Exposure**
John Saputo, Stony Brook University, USA
- 11:00 – 11:30 **A mechanism-based approach for assessing the structural integrity of plasma-sprayed multilayer thermal barrier coatings**
Matthias Oechsner, University of Darmstadt, Germany
- 11:30 – 12:00 **Thermo-mechanical Analysis of Blister Damage in Eb-pvd Tbc System: Experiments and Modeling**
Vincent Maurel, Mines Paris PSL University – Centre des Materiaux UMR CNRS 7633, France
- 12:00 – 13:30 Lunch
- Session: TBC (continued)**
Chairs: Grégoire Witz, Seimens Energy, Switzerland
- 13:30 – 14:00 **Degradation of aluminide type bondcoats due to oxidation and interdiffusion: effect of base alloy composition**
Dmitry Naumenko, Forschungszentrum Juelich GmbH, Germany
- 14:00 – 14:30 **Novel multicomponent equiatomic pyrochlores for future thermal barrier coatings**
Maren Lepple, JLU Gießen, Germany
- Session: TBC/EBC Processing**
Chairs: Robert Vaßen, Research Center, Julich, Germany
- 14:30 – 15:00 **Microstructure, phase formation and cyclic behavior of PVD-based Y-silicate Environmental Barrier Coatings for SiC-SiC CMC**
Uwe Schulz, DLR – German Aerospace Center, Germany

Tuesday, June 21, 2022 (continued)

15:00 – 15:30	Coffee Break
15:30 – 16:00	Multilayer TBCs and EBCs: Integrating Design and Manufacturing Innovations for Multifunctional Performance Sanjay Sampath, Stony Brook University, USA
16:00 – 16:30	Microstructure and Phase Composition Evolution of Thermal Sprayed Yb-Silicate Coatings during Post Heat Treatment and Burner Rig Test Emine Bakan, Forschungszentrum Jülich GmbH, Germany
16:30 – 17:00	Comparative Study of Thermal Barrier Coatings by S-hvof and Eb-pvd Process Yoshifumi Okajima, Mitsubishi Heavy Industries, Ltd., Japan
17:00 – 18:00	Discussion Leader: Brian Stephens, GE Aviation, USA
18:00 – 19:30	Dinner
19:30 – 21:30	Poster Session & Social Hour

Wednesday, June 22, 2022

- 07:00 – 08:30 Breakfast
- Session: TBC/EBC Processing (continued)**
Chairs: Molly O'Connor, Praxair Surface Technologies, USA
- 08:30 – 09:00 **Columnar Thermal Barrier Coatings Manufactured by Novel Laser Cladding Process**
Daniel Mack, Forschungszentrum Jülich, Germany
- 09:00 – 09:30 **Thermal Barrier Coatings on Additive Manufactured Superalloy Parts**
Nicolaie Markocsan, University West, Sweden
- 09:30 – 10:00 **Plasma-activated EB-PVD of protective coatings: tools and processes**
Burkhard Zimmerman, Fraunhofer FEP, Germany
- 10:00 – 10:30 Coffee Break
- 10:30 – 11:00 **Investigating the microstructure of as-sprayed high-crystalline Yb₂Si₂O₇ environmental barrier coating (EBC) deposited by atmospheric plasma spray (APS)**
Christian Moreau, Concordia University, Canada
- 11:00 – 11:30 **New Enhanced Technical Capabilities of the ALD SMARTcoater**
Ole Hinrichs, ALD Vacuum Technologies GmbH, Germany
- 11:30 – 12:00 **Cathodic Arc Evaporation of MCrALY Coatings**
Sebastien Guimond, Oerlikon Surface Solutions AG, Liechtenstein
- 12:00 – 13:30 Lunch
- Session: Properties and Testing**
Chairs: Bruce Pint, Oak Ridge National Laboratory, USA
- 13:30 – 14:00 **Simulations of Oxide Growth and Stress Evolution in Silicon-based Coatings and Composites**
Matt Begley, University of California, USA
- 14:00 – 14:30 **Micromechanical Testing of Thermal Barrier Coatings**
Ying Chen, The University of Manchester, United Kingdom
- 14:30 – 15:00 **Assessment of Mechanical TBC Failure in Complex Geometries**
Mario Rudolphi, DECHEMA-Forschungsinstitut, Germany
- 15:00 – 15:30 **Synthesis and characterization of compositionally complex zirconate and phosphates**
Daniel Mumm, University of California, Irvine, USA
- 15:30 – 16:00 Coffee Break
- 16:00 – 17:00 **Discussion**
Leader: David Poerschke, University of Minnesota, USA
- 17:00 – 17:30 **Future engine challenges for TBCs/EBCs**
Frank Preli, Pratt & Whitney, USA

Wednesday, June 22, 2022 (continued)

19:30 – 20:00 Reception

20:00 Conference Dinner with music by VolXmucke

Thursday, June 23, 2022

07:00 – 08:30 Breakfast

Session: CMAS

Chairs: Elizabeth Opila, University of Virginia, USA

08:30 – 09:00 **E Understanding the Stability of Mixed-Anion Deposits and Effects on Reactions with Advanced Coating Materials**
David Poerschke, University of Minnesota, USA

09:00 – 09:30 **Reactions in Thermal Barrier Coatings and Multi-Mineral Dusts in a Gas Turbine Engine Dust Ingestion Test**
Gyn Brewster, Rolls Royce, USA

09:30 – 10:00 **A Geoscientific Perspective on Silicate Melt Interactions with TBCs**
Dirk Müller, LMU Munich, Germany

10:00 – 10:30 Coffee Break

Student Presentations

Chair: Brian Hazel, Pratt & Whitney, USA

10:30 – 10:45 Student Presentation 1

10:45 – 11:00 Student Presentation 2

11:00 – 11:15 Student Presentation 3

11:15 – 11:30 Student Presentation 4

11:30 – 12:00 **Discussion**
Leader: Ravisankar Naraparaju, DLR – German Aerospace Center, Germany

12:00 – 13:30 Lunch

13:30 – 18:30 **Kaufbeuren Excursion**

18:30 – 21:30 Dinner & Social Hour

Friday, June 24, 2022

07:00 – 08:30	Breakfast
	<u>Session: CMAS (continued)</u> Chairs: Vincent Maurel, Mines Paris PSL University – Centre des Materiaux UMR CNRS 7633, France
08:30 – 09:00	Understanding Silicate Deposit Variability and its Implications for Evaluating TBCs and EBCs Andrew Ericks, University of California, Santa Barbara, USA
09:00 – 09:30	CMAS Reactive Coatings for TBCs Margeaux Wallace, General Electric Global Research, USA
09:30 – 10:00	Development of CMAS Resistant Thermal Barrier Coatings: Challenges and Implications Ravisankar Naraparaju, DLR, Germany
10:00 – 10:30	Coffee Break
10:30 – 11:00	Corrosion of E/TBCs: Chemical Interactions of Ceramic Materials with CMAS Pierre-Jean Panteix, University of Lorraine, France
11:00 – 12:00	Discussion Leader: Mike Maloney, Pratt & Whitney, USA
12:00 – 13:30	Lunch
13:30	Departures

Poster Presentations

1. **Influence of alumina addition on steam corrosion behaviour of Ytterbium disilicates for EBC applications**
Ahmet Hilmi Paksoy, The University of Manchester, United Kingdom
2. **Reactions of rare earth hafnates and zirconates with silicate melts of different basicity**
Andrew R. Ericks, University of California, Santa Barbara, USA
3. **Debye-Larmor high enthalpy cascade plasma gun technology to apply ceramic coatings for the turbine industry**
Armando Salito, Gulhfi Consulting AG, Switzerland
4. **TUBA Nova - A novel industrial EB-PVD coater platform for state-of-the-art TBCs and multi-layer coatings**
Carsten Deus, VON ARDENNE GmbH, Germany
5. **Investigating the microstructure of as-sprayed high-crystalline Yb₂Si₂O₇ environmental barrier coating (EBC) deposited by atmospheric plasma spray (APS)**
Christian Moreau, Concordia University, Canada
6. **Microstructure modification of EB-pvd gadolinium zirconate thermal barrier coatings and the effect on their resistance against siliceous CMAS melts**
Christoph Mikulla, German Aerospace Center (DLR), Germany
7. **Thermal Environmental Barrier Coatings (TEBCs), and their deposits-induced degradation and its mitigation**
Christopher Louzon, Brown University, USA
8. **Synthesis of multi component rare-earth silicate systems for T/EBC application: Study of their high temperature interactions with CMAS**
Cynthia Yanel Guijosa Garcia, German Aerospace Center (DLR), Germany
9. **Environmental barrier coatings deposited by suspension plasma spraying**
Dapeng Zhou, Forschungszentrum Jülich GmbH, Germany
10. **Understanding garnet phase stability in Gd/Y/Yb-CMAS systems and influences on multiphase T/EBC-CMAS interactions**
Eeshani Paresh Godbole, University of Minnesota, USA
11. **Mechanical properties of Yb₂Si₂O₇ coatings prepared using electrophoretic deposition**
Esma Yilmaz, University of Manchester, United Kingdom
12. **Ytterbium silicate environmental barrier coatings prepared by a novel slurry spraying-reactive sintering technique**
Gauri Waghmare, Indian Institute of Technology Bombay, India
13. **Concepts for enhancing the life of environmental coatings systems**
Jeroen Deijkers, University of Virginia, USA
14. **Coatings for increased efficiency in compression ignition engines**
John Saputo, Stony Brook University, Center for Thermal Spray Research, USA

15. **A coupled thermal and mechanical analysis of sintering in thermal barrier coatings under gradient exposure**
John Saputo, Stony Brook University, Center for Thermal Spray Research, USA
16. **Effects of EB-PVD microstructural features on CMAS infiltration of Yttria-rich zirconia coatings**
Juan Gomez, Pratt & Whitney, USA
17. **Thermochemical stability of high entropy rare earth oxide (HERO) coatings for refractory alloys**
Kristyn Ardrey, University of Virginia, USA
18. **Spatially resolved characterization of thermally grown oxides using time-domain thermorefectance**
Milena Milich, University of Virginia, USA
19. **Emerging coating materials for H₂ powered turbines**
Molly O'Connor, Praxair Surface Technologies, USA
20. **A study of the of ytterbium disilicates undergoing water vapour corrosion for environmental barrier coating applications**
Simon McCormack, University of Manchester, United Kingdom
21. **Simultaneous residual stress mapping of topcoat and TGO in APS TBC using combined micro-Raman-PL spectroscopy**
Srikanth Batna, Indian Institute of Technology Bombay, India
22. **Lessons learned in design and characterization of EBC spray powders**
Ursa Pirnat, Treibacher Ind. AG, Austria
23. **A comparative study of phase evolution in YSZ powders, pellets and free-standing air plasma sprayed thermal barrier coatings**
Vikram Hastak, Indian Institute of Technology Bombay, India
24. **SiC-based/EBC Coating systems investigated by LASAT (Laser Shock Adhesion Test)**
Vincent Guipont, MINES Paris - PSL / Centre des Matériaux (CNRS 7633), France
25. **Non-destructively capturing CMAS degradation of EB-PVD thermal barrier coatings through 3D confocal Raman renderings**
Zachary Stein, University of Central Florida, USA
26. **The utilization of laser thermal testing with thermographic measurement for TBC lifetime performance evaluation**
Zdeněk Veselý, University of West Bohemia, Czech Republic