Program

Thermal Barrier Coatings III

August 7-12, 2011

Kloster Irsee
Irsee, Germany

Conference Chair:
Dr. Michael J. Maloney
Pratt & Whitney, USA

Conference Co-Chairs:
Dr. Uwe Schulz, German Aerospace Center, Germany
Dr. David Rickerby, Rolls-Royce UK
Dr. Ram Darolia, GE Aviation (Retired), USA
Dr. Odile Lavigne, ONERA DMSM/MAT, France
Dr. Hideyuki Murakami, National Institute for Materials Science, Japan
Prof. Hongbo Guo, School of Materials Science and Engineering, Beihang University, China
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European Office of Aerospace Research and Development, Air Force Office of Scientific Research, United States Air Force Research Laboratory (www.london.af.mil)

The Office of Naval Research

Pratt & Whitney
Sunday, August 7, 2011

16:00 - 18:00  Registration (Hospitality Desk in Kloster Irsee Lobby)

18:15 - 19:30  Organ Concert:
Roland Götz, Organist, will play on the historic organ of the monastery Church

19:30 - 20:30  Reception (Kloster Irsee Restaurant)

20:30 - 22:00  Dinner (Kloster Irsee Restaurant)

22:00 – 23:00  Social Hour (Bierstube/Stiftskeller)

Notes

• Technical sessions will be in “Vortragsaal” (Room 128)
• Lunches and dinners will typically be in the Kloster Irsee Restaurant.
• The conference banquet will be in the Festsaal.
• Audiotaping, videotaping and photography of presentations are prohibited.
• 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 cellular telephones to vibrate or off during technical sessions.
• Be sure to make any corrections to your name/contact information on the Master Participant List or confirm (by your initials) that the listing is correct. A corrected copy will be sent to all participants after the conference.
• Participants staying at the Klosterbräu Hotel Irsee should have breakfast at the hotel. Those staying at Kloster Irsee will have breakfast at Kloster Irsee.
Monday, August 8, 2011

07:00 - 08:00 Breakfast

08:00 - 08:15 Welcome and Conference Overview
    Michael Maloney, Pratt & Whitney
    Ram Darolia, ECI Technical Liaison

SESSION 1: OVERVIEWS
Chair: David Shifler, Office of Naval Research, USA

08:15 - 09:00 H.-P. Bossmann
    Alstom, Switzerland
    RELIABLE THERMAL BARRIER COATINGS FOR HIGH-LOADED TURBINE AND COMBUSTOR PARTS

09:00 - 09:45 Huibin Xu
    Beihang University, China
    RESEARCH PROGRESS ON TBCS MATERIALS FOR ULTRA-HIGH TEMPERATURE APPLICATIONS

09:45 - 10:15 Coffee Break

10:15 - 11:00 David Rickerby
    Rolls Royce, UK
    LIFING AND DEGRADATION OF EB-PVD THERMAL BARRIER COATINGS

SESSION 2: BONDCOAT DEVELOPMENT AND BEHAVIOR
Chair: Brian Gleeson, University of Pittsburgh, USA

11:00 - 11:40 Teresa Pollock
    University of California, Santa Barbara, USA
    COMBINATORIAL STUDIES OF NIAL-BASED OVERLAY BOND COATINGS

11:40 - 12:20 Shengkai Gong,
    Beihang University, China
    NEW BOND COAT MATERIALS IN TBC SYSTEM FOR ADVANCED SINGLE CRYSTAL SUPERALLOY

12:20 - 13:30 Lunch

13:30 - 14:10 Akihiro Sato
    Research Laboratory, IHI Corporation, Japan
    DEVELOPMENT OF NEW PT-γ+γ' TYPE BOND COATINGS FOR ADVANCED NI-BASE SINGLE CRYSTAL SUPERALLOYS

14:10 - 14:40 Discussion
SESSION 3: FUNDAMENTALS OF OXIDATION
Chair: Gerald Meier, University of Pittsburgh, USA

14:40 - 15:20 Brian Gleeson
University of Pittsburgh, USA
COMPOSITIONAL FACTORS AFFECTING THE OXIDATION BEHAVIOR OF CURRENT AND DEVELOPMENTAL BOND COATING SYSTEMS

15:20 - 15:50 Afternoon Coffee Break

15:50 - 16:30 Dimitry Naumenko
Juelich, Germany
OXIDATION OF MCRALEY-BONDCOATS AND ITS INFLUENCE ON THE THERMAL CYCLIC LIFETIME OF YSZ TBC SYSTEMS

16:30 – 16:50 Roger Reed (presented by Rudder Wu)
University of Birmingham, UK
FACTORS CONTROLLING ADHESION OF TBC SYSTEMS TO NICKEL-BASED SUPERALLOYS

16:50 – 17:10 Rudder Wu
ICYS, National Institute for Materials Science, Japan
TOWARDS A DETAILED UNDERSTANDING OF THE FUNDAMENTAL MECHANISMS UNDERLYING THE BENEFICIAL EFFECTS OF PLATINUM MODIFICATION

17:10 – 17:50 Vladimir Tolpygo
Honeywell, USA
ON THE ORIGIN OF STRESSES IN ALUMINIDE BOND COATS DURING SERVICE AT HIGH TEMPERATURES

17:50 - 18:10 Discussion

19:00 - 20:30 Dinner

20:30 - 22:00 Social Hour
**Tuesday, August 9, 2011**

07:00 - 08:00  Breakfast

**SESSION 4-1: TOP COAT DEVELOPMENT AND CHARACTERISTICS**

Chairs: Uwe Schulz, DLR, German Aerospace Center, Germany
Richard Wellman, Cranfield University, UK

08:00 - 08:40  Konstyantyn Yakovchuk
ICEBT, Ukraine
ELECTRON BEAM TECHNOLOGY AND EQUIPMENT FOR DEPOSITION OF GRADED TBC

08:40 - 09:20  Frederic Rousseau
LGPPTS Ecole Nationale Supérieure de Chimie de Paris, France
DEVELOPMENT OF A LOW PRESSURE PLASMA DEPOSITION TECHNIQUE TO IMPROVE THE PROPERTIES AND THE RESISTANCE OF THERMAL BARRIER COATINGS

09:20 - 10:00  Robert Vassen
Juelich, Germany
SUSPENSION PLASMA SPRAYING FOR THE MANUFACTURE OF ADVANCED THERMAL BARRIER COATINGS

10:00 - 10:30  Coffee Break

10:30 - 11:10  Derek Hass
DVTI, USA
PROCESSING OF ADVANCED THERMAL BARRIER COATINGS VIA DIRECTED VAPOR DEPOSITION

11:10 - 11:40  Roman Kubrin
Hamburg University of Technology, Germany
MULTILAYER 3D PHOTONIC CRYSTALS FOR APPLICATION AS HIGHLY REFLECTIVE THERMAL BARRIER COATINGS

11:40 - 12:10  Lucy Y. Liu
Chromalloy Gas Turbine LLC, USA
A NEW APS MULTILAYER TBC WITH LOW K AND HIGH DURABILITY

12:10 - 12:30  Discussion

12:30 -  Boxed Lunch
Optional Excursion

18:00 - 19:00  Dinner
Tuesday, August 9, 2011 (continued)

**SESSION 4-2: TOP COAT DEVELOPMENT AND CHARACTERISTICS**
Chair: Robert Vassen, Forschungszentrum Jülich GmbH, Germany

19:00 - 19:40  Sanjay Sampath  
State University of New York, USA  
CONTROLLED INTRODUCTION ON ANELASTICITY IN PLASMA SPRAYED TBCS: IMPLICATIONS FOR PERFORMANCE AND RELIABILITY

19:40 - 20:20  Konstantin Von Niessen  
Sulzer, Switzerland  
VAPOR PHASE DEPOSITION USING A PLASMA SPRAY PROCESS

20:20 - 21:00  Ping Xiao  
University of Manchester, UK  
MICROSTRUCTURE, RESIDUAL STRESSES AND MECHANICAL PROPERTIES OF TBCS

21:00 – 21:30  Discussion

21:30 - 23:00  Social Hour
Wednesday, August 10, 2011

07:00 - 08:00 Breakfast

SESSION 4-3: TOP COAT DEVELOPMENT AND CHARACTERISTICS
Chairs: Odile Lavigne, ONERA, DMSM/MAT, France
Kevin Hemker, Johns Hopkins University, USA

08:00 - 08:40 Gerry Meier
University of Pittsburgh, USA
THE EFFECT OF PROCESSING VARIABLES ON THE DURABILITY OF HIGH-PURITY YSZ-TBCS PREPARED BY APS

08:40 - 09:20 Dongming Zhu
NASA, USA
ENVIRONMENTAL BARRIER COATINGS FOR SIC/SIC CERAMIC MATRIX COMPOSITE TURBINE ENGINE HOT-SECTION COMPONENTS: ADVANCES, APPLICATIONS AND DIRECTIONS

09:20 - 10:00 Kang Lee
Rolls Royce, USA
RECESSION OF ENVIRONMENTAL BARRIER COATINGS FOR CERAMIC MATRIX COMPOSITES

10:00 - 10:30 Coffee Break

10:30 - 11:00 Maria Ophelia Jarligo
Julich GmbH, Germany
NEW THERMAL BARRIER COATINGS FROM COMPLEX PEROVSKITES

11:00 - 11:30 Ming Fu
GE Aviation, USA
IMPACT AND EROSIN PERFORMANCE OF THERMAL BARRIER COATINGS

11:30 - 12:00 Federico Cernuschi
RSE, Italy
THERMAL DIFFUSIVITY MEASUREMENT BY THERMOGRAPHIC TECHNIQUE FOR THE NON DESTRUCTIVE INTEGRITY ASSESSMENT OF TBCS COUPONS

12:00 - 12:30 Discussion

12:30 - 13:30 Lunch

SESSION 5: CMAS MECHANISMS AND MITIGATION
Chairs: David Litton, Pratt & Whitney, USA
David Clarke, Harvard University, USA

13:30 - 14:10 Carlos Levi
University of California, Santa Barbara, USA
CMAS: LESSONS LEARNED AND PERSPECTIVES
Wednesday, August 10, 2011 (continued)

14:10 - 14:50  Peter Mechnich  
DLR, Germany  
THERMOCHEMICAL ATTACK OF ARTIFICIAL AND NATURAL VOLCANIC Ashes ON 7 YSZ AND PYROCHLORE TBCs

14:50 - 15:20  Wolfgang Braue  
DLR, Germany  
GARNET-TYPE REACTIVE INTERFACES FROM FE-Ti-CMAS HOT CORROSION OF YSZ COATED ENGINE HARDWARE

15:20 - 15:50  Coffee Break

15:50 - 16:20  M.H. Vidal-Setif  
ONERA, France  
CMAS DEGRADATION OF EB-PVD THERMAL BARRIER COATINGS: FROM EX SERVICE EXAMINATIONS TO LABORATORY TESTS

16:20 - 17:00  Nitin Padture  
The Ohio State University, USA  
PLASMA-SPRAYED THERMAL BARRIER COATINGS THAT ARE RESISTANT TO DAMAGE BY MOLTEN DEPOSITS: CMAS SAND, VOLCANIC ASH, AND COAL FLY ASH

17:00 - 17:30  M. Shinozaki  
University of Cambridge, UK  
THE EFFECT OF CMAS- ASSISTED SINTERING ON THE THERMOMECHANICAL STABILITY OF PLASMA- SPRAYED TBCs

17:30 - 18:00  Discussion

18:30 - 19:45  Dinner

20:00 - 22:00  SESSION 6: POSTER SESSION and Social Hour  
Chair: Sanjay Sampath, SUNY Stonybrook, USA
Thursday, August 11, 2011

07:00 - 08:00  Breakfast

**SESSION 7: FAILURE MECHANISMS**

Chairs: David Rickerby, Rolls Royce, UK  
Ram Darolia, General Electric (retired), USA  
Teresa Pollack, University of California Santa Barbara, USA

08:00 - 08:40  Ramesh Subramanian  
Siemens, USA  
ADVANCED MULTI-FUNCTIONAL COATINGS FOR LAND-BASED INDUSTRIAL GAS TURBINES

08:40 - 09:20  David Clarke  
Harvard University, USA  
PROPERTY AND DAMAGE EVOLUTION IN THERMAL BARRIER COATINGS

09:20 - 10:00  Wim G. Sloof  
Technical University of Delft, Netherlands  
DAMAGE GROWTH TRIGGERED BY INTERFACE IRREGULARITIES IN THERMAL BARRIER COATINGS

10:00 - 10:30  Coffee Break

10:30 - 11:10  Yutaka Kagawa  
University of Tokyo, Japan  
EFFECT OF EXTRINSIC FACTORS FOR DEFORMATION OF EB-PVD THERMAL BARRIER COATINGS: SOME RESULTS OF THERMO-MECHANICAL FATIGUE TESTS

11:10 - 11:50  Kevin Hemker  
John Hopkins University, USA  
EXPERIMENTAL INVESTIGATIONS OF DELAMINATION TOUGHNESS IN LAYERED PROTECTION SYSTEMS

11:50 - 12:20  Mario Schweda  
Forschungszentrum Jülich, Germany  
INFLUENCE OF BONDCOAT CREEP AND ROUGHNESS ON TBC-DAMAGE

12:20 - 13:30  Lunch

13:30 - 14:10  Eric Jordan  
University of Connecticut, USA  
UNDERSTANDING APS TBC FAILURE BY SUFFICIENTLY REALISTIC MODELING AND SUPPORTING EXPERIMENTS

14:10 - 14:50  Richard Wellman, University of Cranfield, UK  
ARE EB PVD TBCS MORE EROSION RESISTANT THAN PS TBCS?

14:50 - 15:20  M. Rudolphi  
Karl-Winnacker-Institut der DEHEMA, Germany  
FAILURE PREDICTION OF THERMAL BARRIER COATINGS USING A FRACTURE MECHANICS APPROACH

15:20 - 15:50  Afternoon Coffee
Thursday, August 11, 2011 (continued)

15:50 - 16:30  Matthias Oechsner
University of Darmstadt, Germany
PROPERTY VARIATIONS IN TBC SYSTEMS AND THEIR IMPACT ON TURBINE DESIGN

16:30 - 17:30  Discussion

18:30 -  Conference dinner and social hour
Friday, August 12, 2011

07:00 - 08:00 Breakfast

**SESSION 8: LIFE MODELING AND CHARACTERIZATION TECHNIQUES**

Chairs: Matthias Oechsner, Technische Universität Darmstadt, Germany
Yukata Kagawa, The University of Tokyo, Japan

08:00 - 08:40 Tilmann Beck
FZ Juelich, Germany
TBC'S FOR GAS TURBINES UNDER THERMO-MECHANICAL LOADINGS: FAILURE BEHAVIOUR AND LIFE PREDICTION

08:40 - 09:20 Kyoko Kawagishi (presented by Hiroshi Harada)
National Institute for Materials Science, Japan
THERMAL CYCLIC LIFE OF EB-PVD TBC SYSTEM

09:20 - 10:00 Jeffery Eldridge
NASA, USA
OBSERVING DAMAGE EVOLUTION IN THERMAL BARRIER COATINGS BY LUMINESCENCE IMAGING

10:00 - 10:30 Coffee Break

10:30 - 11:00 Pascale Kanoute,
ONERA, France
LIFE TIME ANALYSIS FOR TBC SPALLATION

11:00 - 11:30 Bauke Heeg
Lumium, The Netherlands
OPTICAL DIAGNOSTICS ON THERMAL BARRIER COATING STRUCTURES

11:30 - 12:00 Hua Wei
Institute of Metals, Academy of Science, China
A NUMERICAL MODEL FOR FAILURE MECHANISMS OF THERMAL BARRIER COATINGS

12:00 – 12:30 Wrap-up discussions

12:30 Lunch and Departures