Program

Beyond Nickel-Based Superalloys II

July 17 – 21, 2016

Clare College
Cambridge, United Kingdom

Conference Chair
Howard J. Stone (University of Cambridge, United Kingdom)

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Engineering Conferences International (ECI) is a not-for-profit global engineering conferences program, originally established in 1962, that provides opportunities for the exploration of problems and issues of concern to engineers and scientists from many disciplines.

Beyond Nickel-Based Superalloys Conferences History

An ECI Conference Series

Beyond Nickel-Based Superalloys I (2013)
Uwe Glatzel
Bad Berneck (Bavaria), Germany

Conference Sponsors

NETZSCH

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UNIVERSITY OF CAMBRIDGE

International Organising Committee

Howard J. Stone
(University of Cambridge, United Kingdom)

Bernard P. Bewlay
(General Electric Global Research, USA)

Lesley A. Cornish
(University of the Witwatersrand, South Africa)

Uwe Glatzel
(University Bayreuth, Germany)

Martin Heilmaier
(KIT Karlsruche, Germany)

Haruyuki Inui
(Kyoto University, Japan)

John Lewandowski
(Case Western Reserve University, USA)

David A. Shifler
(Office of Naval Research, USA)

Kyosuke Yoshimi
(Tohoku University, Japan)

Local Organising Team

Alison Vann
(University of Cambridge, United Kingdom)

Katerina Christofidou
(University of Cambridge, United Kingdom)

Nicholas Jones
(University of Cambridge, United Kingdom)

Lewis Owen
(University of Cambridge, United Kingdom)

Welcome to the Beyond Nickel Based Superalloys Conference 2016

On behalf of the International Organising Committee, Local Organising Team and ECI, I am delighted to welcome you to the 2nd International Conference on Beyond Nickel Based Superalloys.

As a community, we are striving to identify and develop new high temperature materials for more efficient aviation and energy generation. The potential benefits that can be derived from these new materials are considerable but we know that this is a challenging undertaking. Therefore, it is tremendous that we have this opportunity to come together as a community to discuss recent developments and future prospects in this field. Through this conference we hope that both the scientific and social programmes create a relaxed and open forum in which everyone can present and discuss their research, build on existing links and establish new ones.

The preparations for this conference have required considerable efforts from many people and I would especially like to thank the International Organising Committee for their help in establishing an excellent programme of speakers and poster presentations. I would also like to extend thanks to the Local Organising Team and ECI for all their work with the logistics of preparing and running this conference.

In addition, I am very grateful to the Office of Naval Research Global, Rolls-Royce plc and the Netzsch Group, for their support in providing travel grants, prizes and student bursaries for this conference.

I am certain that you will find the technical presentations interesting and rewarding. However, I also hope that you take the opportunity to enjoy the small, historic and beautiful city of Cambridge. In this regard, please feel free to contact any member of the Local Organising Team if there is anything you need during your stay.

Howard Stone

Cambridge, July 2016

Sunday, July 17, 2016

16:30 – 18:00	Registration (Garden Room, Gillespie Centre)
18:00 – 19:00	Welcome Drinks (Scholar's Garden)
19:00 – 20:30	Dinner (Great Hall)
20:30	College Bar opens

NOTES

- Technical and Poster Sessions as well as lunches and breaks will be held in The Gillespie Centre.
- Dinners and breakfasts will be in the Great Hall.
- Audiotaping, videotaping and photography of presentations are prohibited.
- Speakers – Please leave at least 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.
- 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.
- Please do not smoke at any conference functions.
- Please write your name in the front of this program booklet so it can be returned if misplaced.

Monday, July 18, 2016

07:00 – 08:45	Breakfast
08:45 – 09:00	**Introduction** Conference Chair: Howard Stone, University of Cambridge, United Kingdom ECI Liaison: Ram Darolia
	General (Chair: Bernard Bewlay)
09:00 – 09:20	**Search for materials beyond the capabilities of Ni-based Superalloys: A partial journey** Ramgopal Darolia, GE Aviation (Retired), USA
09:20 – 09:40	**Navy research for materials beyond Ni- Superalloys** David A. Shifler, Office of Naval Research, USA
09:40 – 10:00	**Potential for material systems beyond Superalloys** Neil Jones, Rolls-Royce plc., USA
10:00 – 10:20	**Plasticity of hard and brittle materials at micron-meter size scales** Haruyuki Inui, Kyoto University, Japan
10:20 – 10:50	Coffee / tea break
	Molybdenum – I (Chair: John Lewandowski)
10:50 – 11:10	**High-temperature creep strength and room-temperature fracture toughness of MoSiBTiC alloy** Kyosuke Yoshimi, Tohoku University, Japan
11:10 – 11:30	**Microstructure and creep resistance of Ti-rich Mo + Mo_5Si_3 + Mo_5SiB_2 alloys** Daniel Schliephake, Karlsruhe Institute of Technology, Germany
11:30 – 11:50	**Mo-9Si-8B alloys with additons of Zr – microstructure and creep properties** Uwe Glatzel, University Bayreuth, Germany
11:50 – 12:10	**Effect of W substitutions on the phase stability and oxidation behaviour of Mo-Si-B alloys** Mufit Akinc, Iowa State University, USA
12:10 – 12:30	**Effects of compositional and microstructural variations on the mechanical and oxidation behavior of Mo-Si-B at elevated temperatures** Peter Marshall, Imaging Systems Technology, USA
12:30 – 14:00	Lunch

Monday, July 18, 2016 (continued)

Cobalt – I (Chair: Steffen Neumeier)

14:00 – 14:20 **Design of gamma-prime-strengthened Co-based Superalloys: Where we are and where we need to go**
Eric Lass, National Institute of Standards and Technology, USA

14:20 – 14:40 **Evaluation of Co-based thermodynamic databases with respect to own and literature experimental data**
Suzana G. Fries, ICAMS, SKTS, Ruhr University Bochum, Germany

14:40 – 15:00 **The influence of stacking fault energies and solute segregation on high temperature creep strength in L12-containing Co-based Superalloys**
Michael Titus, Max-Planck-Institute für Eisenforchung, Germany

15:00 – 15:30 Coffee / tea break

Modelling (Chair: Suzana Fries)

15:30 – 15:50 **Systematic coarse graining of the electronic structure for atomistic modelling of high-temperature materials**
Ralf Drautz, ICAMS, Ruhr-Universität Bochum, Germany

15:50 – 16:10 **Creep behaviors and microstructural stabilities of Co-Al-W-Ta-Ti-based Superalloys**
Qiang Feng, University of Science and Technology Beijing, China

16:10 – 16:30 **Planar fault energies in superalloys from first principles**
Alessandro Mottura, University of Birmingham, United Kingdom

17:00 – 19:00 Punting (45 minutes boat tour)

19:00 – 20:30 Dinner

20:00 – 22:30 Live Entertainment (Guitarist)

20:30 College Bar opens

Tuesday, July 19, 2016

07:30 – 09:00 Breakfast

Cobalt – II (Chair: Eric Lass)

09:00 – 09:20 **γ/γ' Co-base superalloys – new high temperature materials beyond Ni-base Superalloys?**
Steffen Neumeier, Friedrich-Alexander-Universität Erlangen-Nürnberg (FAU), Germany

09:20 – 09:40 **The effects of alloying additions in polycrystalline Co-Ni Superalloys**
Paul Mulvey, Imperial College London, United Kingdom

09:40 – 10:00 **Alloying effects on the oxidation behaviour of shot-peened Co-Ni base Superalloys**
Farah Ismail, Imperial College London, United Kingdom

10:00 – 10:30 Coffee / tea break

Molybdenum – II (Chair: Kyosuke Yoshimi)

10:30 – 10:50 **Microstructural analysis and high temperature creep of Mo-9Si-8B alloys with Al and Ge additions**
Peter Kellner, University Bayreuth, Germany

10:50 – 11:10 **Oxidation behavior and mechanical properties of Ti-enriched MoSiBTiC alloy**
Mi Zhao, Tohoku University, Japan

11:10 – 11:30 **Enhanced oxidation resistance of Ti-rich Mo-Si-B alloys by pack-cementation process**
Camelia Gombola, Karlsruhe Institute of Technology, Germany

11:30 – 11:50 **Oxidation protection of Mo-Si-B alloys by magnetron-sputtered coatings**
Reinhold Braun, DLR – German Aerospace, Germany

12:00 – 14:00 Lunch

Alternatives – I (Chair: Haruyuki Inui)

14:00 – 14:20 **High temperature oxidation behaviour of Mo-Si-B-based and Co-Re-Cr-based alloys**
Bronislava Gorr, Universtity of Siegen, Germany

14:20 – 14:40 **Microstructural stability of Co-Re-Cr-Ta-C alloy strengthened by TaC precipitates**
Debashis Mukherji, Technische Universität Braunschweig, Germany

Tuesday, July 19, 2016 (continued)

14:40 – 15:00	**Nitridation during oxidation as a challenge for Cr-based alloys and its mitigation by alloying** Mathias C. Galetz, Dechema Forschungsinstitut, Germany
15:00 – 15:30	Coffee / tea break
	Aluminides (Chair: David Dye)
15:30 – 15:50	**Addition of PGMS to improve high temperature oxidation resistance of titanium-aluminium alloys** Lesley A. Cornish, University of the Witwatersrand, South Africa
15:50 – 16:10	**A crystal plasticity study of the micromechanics of interfaces in TiAl** Fabio Di Gioacchino, University of Cambridge, United Kingdom
16:10 – 16:30	**Measuring crack initiation and the plastic deformation behaviour of titanium aluminides under compressive and tensile uniaxial loading** Thomas E. J. Edwards, University of Cambridge, United Kingdom
17:00 – 18:00	Guided walking tours of the historic city centre of Cambridge
18:00 – 20:30	Dinner on own
20:00 – 22:30	Live Entertainment (Band)
20:30	College Bar opens

Wednesday, July 20, 2016

07:30 – 09:00 Breakfast

Niobium – I (Chair: Panos Tsakiropoulos)

09:00 – 09:20 **Alloy design concept for bcc-T2 silicide-B2 aluminide multicomponent alloys**
Seiji Miura, Hokkaido University, Japan

09:20 – 09:40 **Effects of Hf, B, Cr and Zr alloying on mechanical properties and oxidation resistance of Nb-Si based ultrahigh temperature alloy**
Xiping Guo, Northwestern Polytechnical University, China

09:40 – 10:00 **The role of Sn in the oxidation of Nb silicide based alloys**
Zhen Xu, The University of Sheffield, United Kingdom

10:00 – 10:30 Coffee / tea break

High Entropy Alloys (Chair: Uwe Glatzel)

10:30 – 10:50 **A critical review of high entropy alloys (HEAs) and related concepts**
Daniel Miracle, Air Force Research Laboratory, USA

10:50 – 11:10 **Development of high temperature refractory-based multi-principle-component alloys by thermodynamic calculations and rapid alloy prototyping**
Michael Titus, Max-Planck-Institute für Eisenforschung, Germany

11:10 – 11:30 **Microstructure, mechanical property and oxidation behavior of $HfZrTiTaB_x$ HEAs**
Yunjia Guo, National University of Defense Technology, China

11:30 – 11:50 **Tuning ductility for refractory high-entropy alloys**
Saad Sheikh, Chalmers University, Sweden

11:50 – 12:10 **Mechanical properties of P/M refractory high entropy alloys**
Ho Jin Ryu, Korea Advanced Insitute of Science and Technology, South Korea

12:15 – 14:00 Lunch

Alternatives – II (Chair: Nicholas Jones)

14:00 – 14:20 **Challenges and opportunities with ultra-high temperature ceramics**
Luc Jean Marie Vandeperre, Imperial College London, United Kingdom

Wednesday, July 20, 2016 (continued)

14:20 – 14:40	**Towards nanoindentation at application-relevant temperatures – A study on CMSX-4 alloy and amdry-386 bond coat** James S.K-L. Gibson, RWTH Aachen University, Germany
14:40 – 15:00	**On the mechanism of oxidation resistance of W-Cr-Pd alloys at high temperatures** Roni Shneck, Ben Gurion University of the Negev, Israel
15:00 – 16:00	Coffee / tea break
16:00 – 18:00	***Poster Session and Beer Tasting***
19:00 – 20:30	Gala dinner and bar

Thursday, July 21, 2016

07:30 – 09:00 Breakfast

Alternatives – III (Chair: Lesley Cornish)

09:00 – 09:20 **V-Si-B alloys for ultra-high temperature applications**
Manja Krüger, Otto-von-Guericke University Magdeburg, Germany

09:20 – 09:40 **On the design and feasibility of refractory metal-base Superalloys**
Ed J. Pickering, University of Manchester, United Kingdom

09:40 – 10:00 **Microstructure and mechanical behavior of TiC-reinforced Ti-Mo-Al alloys**
Yuanyuan Lu, Tohoku University, Japan

10:00 – 10:20 **High temperature creep of tungsten free cobalt based Superalloys**
Dipankar Banerjee, Indian Institute of Science, India

10:20 – 10:50 Coffee / tea break

Niobium – II (Chair: Howard Stone)

10:50 – 11:10 **Rules for designing Nb silicide based alloys: The case for the solid solution phase**
Panos Tsakiropoulos, The University of Sheffield, United Kingdom

11:10 – 11:30 **Laser additive manufacturing of niobium silicide-based composites**
Andrew Douglas, University of Leicester, United Kingdom

11:30 – 11:50 **Eutectics and peritectics in the solidification processing of Nb silicide based alloys**
Panos Tsakiropoulos, The University of Sheffield, United Kingdom

11:50 – 12:10 Concluding Remarks
Conference Chair: Howard Stone, University of Cambridge, United Kingdom
ECI Liaison: Ram Darolia

12:15 – 13:30 Lunch & Departures

Poster Presentations List

1. **Powder route processing of Nb-silicide based alloys**
   Edward Gallagher, The University of Sheffield, United Kingdom

2. **Poster Withdrawn**

3. **Laser additive manufacturing of niobium silicide-based composites**
   Adam Allen, University of Leicester, United Kingdom

4. **Effect of ZrC phase on high-temperature strength and room-temperature fracture toughness of ZrC-added Mo-Si-B alloys**
   Shunichi Nakayama, Tohoku University, Japan

5. **High temperature properties of several families of TiC-reinforced cast Superalloys**
   Patrice Berthod, Institut Jean Lamour UMR CNRS 7198, France

6. **High temperature properties ZrC-strengthened Co-based and Fe-based cast Superalloys**
   Patrice Berthod, Institut Jean Lamour UMR CNRS 7198, France

7. **Thermal and mechanical properties at high temperature of Co-based Superalloys strengthened by MC carbides with M=Ta or Nb**
   Melissa Ritouet, IJL, France

8. **High temperature behaviour of chromium-nickel alloys with Ni varying from 50 to 0 Wt.%**
   Patrice Berthod, Institut Jean Lamour UMR CNRS 7198, France

9. **Improving the oxidation resistance of refractory metals via aluminum diffusion coatings and halogen effect**
   Anke Silvia Ulrich, DECHEMA-Forschungsinstitut, Germany

10. **Developing Nb-Si based ultra-high temperature materials in BIAM**
    Yongwang Kang, Beijing Institute of Aeronautical Materials, China

11. **Design, characterisation and properties of Mo-Ti-Fe alloys reinforced by ordered intermetallic precipitates**
    Alexander Knowles, Imperial College London / University of Cambridge, United Kingdom

12. **Effect of Al-10Sr on microstructure and fracture toughness at room temperature of Nb-Si-Ti alloys**
    Meiling Wu, Beijing Institute of Aeronautical Materials, China

13. **Controlling plastic flow in brittle structures**
    Robert P. Thompson, University of Cambridge, United Kingdom

14. **Thermophysical properties of a Ni alloy**
    Peter Davies, Netzsch Geraetebau GmbH, Germany

15. **(Nano-)Mechanical properties and deformation mechanisms of the topologically closed packed Fe-55Mo μ-phase at room temperature**
    Sebastian Schröders, RWTH Aachen University, Germany

16. **Increasing the elevated-temperature strength of a beta titanium alloy through thermomechanically-induced phase tranformation**
    Carl Boehlert, Michigan State University, USA

17. **Characterization of microstructure and oxidation resistance of Y and Ge modified silicide coating on Nb-Si based alloy**
    Chungen Zhou, Beihang University, China

18. **Phase equilibria in the Nb-Si-Ge phase diagram**
    Panos Tsakiropoulos, The University of Sheffield, United Kingdom

19. **Failure mode transition of Nb_{SS} phase from cleavage to dimple in Nb-Si based alloys prepared by spark plasma sintering through controlling of Nb_{SS} powder size and morphology and alloying**
    Jiangbo Sha, Beihang University, China

20. **Microstructure, tensile behavior and oxidation resistance of the two step heat treated Nb-Ti-Si based alloy**
    Hu Zhang, Beihang University, China