

Final Program (June 10, 2019)

Beyond Nickel-Based Superalloys III

June 11 – 14, 2019
Nara Kasugano International Forum

Conference Chair

Haruyuki Inui (Kyoto University, Japan)

Conference Co-Chairs

Bernard P. Bewlay

(General Electric Global Research, USA)

John Lewandowski

(Case Western Reserve University, USA)

Lesley A. Cornish

(University of the Witwatersrand, South Africa)

David A. Shifler

(Office of Naval Research, USA)

Qiang (Charles) Feng

(University of Science and Technology Beijing, China)

Howard J. Stone

(University of Cambridge, United Kingdom)

Uwe Glatzel

(University Bayreuth, Germany)

Panos Tsakirooulos

(The University of Sheffield, United Kingdom)

Martin Heilmaier

(Karlsruhe Institute of Technology, Germany,)

Kyosuke Yoshimi

(Tohoku University, Japan)



Program Overview

Monday, June 10, 2019

17:00 ~ 19:00 Registration & Welcome Reception (Cafe Halftime, Nara National Museum B1)

Tuesday, June 11, 2019

09:00 ~ 09:05 Opening remarks
09:05 ~ 10:05 Oral session 1: General
10:05 ~ 10:25 Coffee break
10:25 ~ 12:15 Oral session 2: Mo-based 1
12:15 ~ 14:00 Lunch break & Poster session
14:00 ~ 15:20 Oral session 3: Co-based 1
15:20 ~ 15:40 Coffee break
15:40 ~ 17:10 Oral session 4: Eutectic composites

Wednesday, June 12, 2019

09:00 ~ 10:35 Oral session 5: High entropy alloys
10:35 ~ 10:55 Coffee break
10:55 ~ 12:35 Oral session 6: Nb-based 1
12:35 ~ 14:00 Lunch break & Poster session
14:00 ~ 15:20 Oral session 7: Other BCC-based
15:20 ~ 15:40 Coffee break
15:40 ~ 17:10 Oral session 8: Alternatives 1

Thursday, June 13, 2019

09:00 ~ 10:30 Oral session 9: Co-based 1
10:30 ~ 10:50 Coffee break
10:50 ~ 11:55 Oral session 10: Mo-based 2
11:55 ~ 14:00 Lunch break & Poster session
14:00 ~ 17:30 Excursion
18:00 ~ 20:30 Banquet (Kikusuiro Restaurant)

Friday, June 14, 2019

09:00 ~ 10:20 Oral session 11: Nb-based 2
10:20 ~ 10:40 Coffee break
10:40 ~ 11:50 Oral session 12: Nb-based 3 & Alternatives 2
11:50 ~ 11:55 Closing remarks
11:55 ~ 13:30 Lunch

Tuesday, June 11, 2019

09:00 ~ 09:05 Opening remarks
Conference Chair: Haruyuki Inui, Kyoto University, Japan

Oral session 1 : General (Session Chair: Howard J. Stone)

09:05 ~ 09:25 Invited talk
Beyond Superalloys - The Gas Turbine Challenge
Neil Jones, Rolls-Royce plc., United Kingdom

09:25 ~ 09:45 Invited talk
Co-base Superalloys: Balancing the Property Suite
Tresa Pollock, University of California, Santa Barbara, USA

09:45 ~ 10:05 Invited talk
Stress considerations and experimentally determined creep properties of various alloys and conclusions drawn regarding beyond nickel-based superalloys
Uwe Glatzel, University Bayreuth, Germany

10:05 ~ 10:25 Coffee break

Oral session 2: Mo-based 1 (Session Chair: Manja Krüger)

10:25 ~ 10:45 Invited talk
Molybdenum-based silicide alloys for structural applications beyond Nickelbase alloys: current status and future trends
Martin Heilmaier, KIT - Karlsruhe Institute of Technology, Germany

10:45 ~ 11:05 Invited talk
Mechanical Performance and High-Temperature Applications of MoSiBTiC Alloy
Kyosuke Yoshimi, Tohoku University, Japan

11:05 ~ 11:25 **Site preference of V and its influence on the elastic properties in $\text{Mo}_{5-y}\text{V}_y\text{SiB}_2$ in the Mo-XV-9Si-8B alloy**
Rachid St. Touzani, Institute of Materials and Joining Technology, Otto-von-Guericke University, Germany

11:25 ~ 11:45 **Polysilazane derived ceramic oxidation barrier coatings for Mo-base alloys**
Iryna Smokovych, Otto-von-Guericke University Magdeburg, Germany

11:45 ~ 12:00 **Estimation of the mechanical properties of high temperature Mo base alloys**
Olha Popovych, Otto-von-Guericke University Magdeburg, Germany

12:00 ~ 12:15 **Creep Strength, Room-temperature Fracture Toughness and Oxidation Resistance of Ti₅Si₃-containing MoSiBTiC alloy**
Tomotaka Hatakeyama, Tohoku University, Japan

12:15 ~ 14:00 Lunch break & **Poster session**

Oral session 3: Co-based 1 (Session Chair: Eric A. Lass)

14:00 ~ 14:20 Invited talk
Superalloys based upon the Co-Co₃Ti system
Howard J. Stone, University of Cambridge, United Kingdom

14:20 ~ 14:40 Invited talk
A comparison between novel Cobalt- and conventional Nickel-based superalloys
Steffen Neumeier, Friedrich-Alexander-Universität Erlangen-Nürnberg, Germany

14:40 ~ 15:00 **Industrial design, process and high-temperature properties of novel polycrystalline oxidation-resistant γ' -strengthened Co-Ni superalloys**
Stephane Alexis Jacques Forsik, Carpenter Technology Corporation, United States

15:00 ~ 15:20 **Serrated flow behavior in a single-crystal Co–Al–W–Ni base superalloy**
Chuanyong Cui, Institute of Metal Research, China

15:20 ~ 15:40 Coffee break

Oral session 4: Eutectic composites (Session Chair: Easo P. George)

15:40 ~ 16:00 Invited talk
Complex metal silicide eutectics based on the Cr-V-Si system
Catherine M.F. Rae, University of Cambridge, United Kingdom

- 16:00 ~ 16:20 Invited talk
Development of MoSi₂/Mo₅Si₃-based in-situ composites for ultra-high temperature applications
Kyosuke Kishida, Kyoto University, Japan
- 16:20 ~ 16:40 **Room Temperature Plasticity in Multiphase V-rich V-Si-B Alloys**
Georg Hasemann, Forschungszentrum Jülich GmbH, Germany
- 16:40 ~ 16:55 **Microstructural Evolution and Creep Behaviour of Directional Solidified Mo-rich NiAl-(Cr,Mo) Alloys**
Camelia Anamaria Gombola, Karlsruhe Institute of Technology (KIT), Germany
- 16:55 ~ 17:10 **Formation Mechanism of Script Lamellar Pattern in MoSi₂/Mo₅Si₃ Eutectic by Phase-Field Method**
Chuanqi Zhu, Institute for Materials Research, Tohoku University, Japan

Wednesday, June 12, 2019

Oral session 5: High entropy alloys (Session Chair: Tresa Pollock)

09:00 ~ 09:20 Invited talk

Creep behavior of high- to medium-entropy FCC solid solution alloys

Easo P. George, University of Tennessee, United States

09:20 ~ 09:40 **Refractory High-Entropy Alloys with Balanced Room-Temperature Ductility and Oxidation Resistance**

Sheng Guo, Chalmers University of Technology, Sweden

09:40 ~ 10:00 **Development of NiCo rich high entropy single crystal superalloys**

Xidong Hui, University of Science and Technology Beijing, China

10:00 ~ 10:20 **Development of a Ta-Mo-Ti-Al alloy for high temperature applications**

Daniel Schliephake, Monash Centre for Additive Manufacturing, Australia

10:20 ~ 10:35 **Understanding the basis of Refractory Metal High Entropy Superalloys**

Tamsin Whitfield, University of Cambridge, United Kingdom

10:35 ~ 10:55 Coffee break

Oral session 6: Nb-based 1 (Session Chair: Xiping Guo)

10:55 ~ 11:15 Invited talk

A new alloy design methodology for Nb-silicide based alloys

Panos Tsakiroopoulos, University of Sheffield, United Kingdom

11:15 ~ 11:35 **Use of the spark plasma sintering potential to develop Nb silicides and TiAl intermetallics**

Jean-Philippe Monchoux, CEMES-CNRS UPR 8011, France

11:35 ~ 11:55 **Microstructure, sample preparation and TEM localized observations on Nb-Si-Ti based alloys**

David Reyes, Centre d'Élaboration de Matériaux et d'Études Structurales (CEMES-CNRS), France

11:55 ~ 12:15 **Effect of Zr and Mo on microstructure and mechanical properties of Nb-Si based alloys**

Yongwang Kang, Beijing Institute of Aeronautical Materials, China

12:15 ~ 12:35 **Structure Formation and High Temperature Oxidation Resistance of Composite Coatings Prepared on Nb-based Alloys**

Yanqiang Qiao, Northwestern Polytechnical University, China

12:35 ~ 14:00 Lunch break & **Poster session**

Oral session 7: Other BCC-based (Session Chair: Martin Heilmaier)

14:00 ~ 14:20 Invited talk

Stability of BCC1/BCC2/Laves three-phase microstructure in Cr-Mo-Nb system

Seiji Miura, Hokkaido University, Japan

14:20 ~ 14:35 **Alloying Effects in Vanadium Solid Solutions**

Christopher Müller, Otto-von-Guericke University Magdeburg, Germany

14:35 ~ 14:50 **Multiphase diffusion in chromium-based alloys for next generation turbine blades**

Alexander Josef Stenzel, DECHEMA Forschungsinstitut, Germany

14:50 ~ 15:05 **Tensile Creep Properties of Cr-Based Alloys with Cr > 90 at.%**

Petra Pfizenmaier, University Bayreuth, Germany

15:05 ~ 15:20 **Improving the Oxidation Resistance of the Cr_{ss}-Cr₃Si System by Ternary and Quaternary Alloying**

Anke Silvia Ulrich, DECHEMA Forschungsinstitut, Germany

15:20 ~ 15:40 Coffee break

Oral session 8: Alternatives 1 (Session Chair: Seiji Miura)

15:40 ~ 16:00 Invited talk

PGMS: Solutions to special problems

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

16:00 ~ 16:20 **Addition of Ge to Cr-Ta-Si Laves phase-based alloys**

Alison Wilson, University of Cambridge, United Kingdom

16:20 ~ 16:40 **Let us talk about σ**

Suzana G. Fries, Ruhr-University Bochum, Germany

16:40 ~ 16:55 **Intermetallic NiAl-based anchor phases for turbine sealing**

Megan Rose McGregor, University of Cambridge, United Kingdom

16:55 ~ 17:10 **Thermodynamic investigation of the oxidation of NiAl-(Cr, Mo) alloys**

Golnar Geramifard, Karlsruhe Institute of Technology (KIT), Germany

Thursday, June 13, 2019

Oral session 9: Co-based 2 (Session Chair: Catherine M.F. Rae)

09:00 ~ 09:20 Invited talk

Computational thermodynamics aided design of Co-based γ' -strengthened superalloys

Eric A. Lass, National Institute of Standards and Technology, United States

09:20 ~ 09:40 **Design of a novel γ/γ' multicomponent Co-based polycrystal superalloy using CALPHAD method**

Longfei Li, University of Science and Technology Beijing, China

09:40 ~ 09:55 **Influence of Thermo-mechanical processing parameters on microstructural evolution of a γ' strengthened cobalt-based superalloy during high temperature deformation**

Nithin Baler, Indian institute of technology Madras, India

09:55 ~ 10:10 **Accelerated discovery of $L1_2$ -strengthened Co-base superalloys using two-stage design based on machine learning**

Jinxin Yu, Xiamen University, China

10:10 ~ 10:30 Coffee break

Oral session 10: Mo-based 2 (Session Chair: Kyosuke Yoshimi)

10:30 ~ 10:50 Invited talk

Tailored Mo-Si-B alloys for powder metallurgical processing, directional solidification and additive manufacturing

Manja Krüger, Research Center Juelich, Germany

10:50 ~ 11:10 **High temperature creep of Mo-Si-B alloys – the influence of the manufacturing route**

Rainer Völkl, Metals and Alloys, University Bayreuth, Germany

11:10 ~ 11:25 **Oxidation protection for Mo-based alloys by magnetron sputtered Si-based coatings**

Ronja Anton, DLR - German Aerospace Center, Institute of Materials Research, Germany

11:25 ~ 11:40 **Density Optimized Mo-Si-B Alloys**

Julia Becker, Otto-von-Guericke-Universität Magdeburg, Germany

11:40 ~ 11:55 **Additive manufacturing of multi-phase refractory metal alloys**

Janett Schmelzer, Otto-von-Guericke University Magdeburg, Germany

11:55 ~ 14:00 Lunch break & **Poster session**

14:00 ~ 17:30 Excursion

18:00 ~ 20:30 Banquet (Kikusuiro Restaurant)

Friday, June 14, 2019

Oral session 11: Nb-based 2 (Session Chair: Panos Tsakiroopoulos)

- 09:00 ~ 09:20 Invited talk
Directionally Solidified Microstructure of Nb-Si Based Ultrahigh Temperature Alloy upon Transitional Withdrawing
Xiping Guo, Northwestern Polytechnical University, China
- 09:20 ~ 09:40 **Solidification and Densification Behaviour of Nb-Si-Ti Alloys Manufactured by Laser Additive Manufacturing**
Hongbiao Dong, University of Leicester, United Kingdom
- 09:40 ~ 10:00 **Why Sn improves the oxidation resistance of Nb-silicide based alloys**
Claire Utton, University of Sheffield, United Kingdom
- 10:00 ~ 10:20 **Selective laser melting mediated improvement in the oxidation resistance of Nb-Si based alloys**
Yueling Guo, Northwestern Polytechnical University, China
- 10:20 ~ 10:40 Coffee break

Oral session 12: Nb-based 3 & Alternatives 2 (Session Chair: Steffen Neumeier)

- 10:40 ~ 10:55 **Effect of Zr and Ta Additions on Oxidation Properties of Niobium Silicide-based Alloys Manufactured by Direct Laser Deposition**
Andrew Douglas, University of Leicester, United Kingdom
- 10:55 ~ 11:10 **Effect of Zr and Mo Additions on Mechanical Properties of Nb-Si based Alloys Manufactured by Laser Solid Forming**
Yunlong Li, Northwestern Polytechnical University, China
- 11:10 ~ 11:30 **Creep behaviours and strengthening mechanisms of Ni-Fe-based alloys for AUSC boilers application**
Fei Sun, IMR/AIMR, Tohoku University, Japan
- 11:30 ~ 11:50 **Developing TiAl-Nb Alloys Competitive with Polycrystalline Cast Superalloys**
Ji Zhang, China Iron and Steel Research Institute Group, China

11:50 ~ 11:55 Closing remarks

11:55 ~ 13:30 Lunch

Poster Presentation (Lunch time, Tuesday through Thursday)

Main poster session: 12:15 ~ 14:00, Thursday, June 13, 2019

(Session Chairs: Uwe Glatzel, Lesley A. Cornish, Kyosuke Kishida)

- P01 **Effect of Ni addition on solidification characteristics of Co-Al-W based single crystal superalloy**
Chen Ai, Chang'an University, China
- P02 **Diffusion path of a B-modified silicide coating on an Nb-Si based alloy**
Wei Shao, Beihang University, China
- P03 **Mechanical properties of a novel single-crystal intermetallic compound γ' -Co₃(Al, W) at room and high temperatures**
Jiangbo Sha, Beihang University, China
- P04 **Phase-field simulation of directional solidification in MoSi₂/Mo₅Si₃ eutectic alloy with elastic anisotropy**
Jimpei Yamamoto, Osaka University, Japan
- P05 **Micropillar compression of single crystals of Fe-Cr sigma phase**
Masaomi Okutani, Kyoto University, Japan
- P06 **Mechanical Properties of Single Crystals of Cr-Co-Ni Equiatomic Medium Entropy Alloy**
Kazuki Ehara, Kyoto University, Japan
- P07 **Influences of growth conditions on microstructures and mechanical properties of directionally solidified MoSi₂/Mo₅Si₃-based eutectic composites**
Kosei Takeda, Kyoto University, Japan
- P08 **Developments of a thermodynamic database for Ni-based superalloys**
Reza Naraghi, Thermo-Calc Software AB, Sweden
- P09 **Deformation Behaviors and Microstructure Evolution in HfNbTaTiZr High Entropy Alloy During Thermo-mechanical Processing at Elevated Temperatures**
Rajeshwar Reddy Eleti, Kyoto University, Japan
- P10 **Influence of Small Misorientation from [111] on Creep Properties of a Ni-Base Single Crystal Superalloy**
Bin Hu, Beihang University, China
- P11 **On the Development of Oxidation-Resistant Refractory High Entropy Alloys**
Kai-Chi Lo, National Tsing Hua University, Taiwan, R.O.C.
- P12 **Hierarchy Microstructure in High Entropy Superalloy**
Yung-Ta Chen, National Tsing Hua University, Taiwan, R.O.C.

- P13 **On the Development of Cast and Wrought High Entropy Superalloys**
Yao-Jen Chang, National Tsing Hua University, Taiwan, R.O.C.
- P14 **Fine-grain γ' -strengthened Co-Ni superalloy for high-temperature**
Mario Ernest Epler, Carpenter Technology Corporation, United States
- P15 **Mechanism of Eutectic Growth in Directional Solidification of an $\text{Al}_2\text{O}_3/\text{Y}_3\text{Al}_5\text{O}_{12}$ Crystal**
Jian Zhang, Institute of Metal Research, Chinese Academy of Sciences, China
- P16 **Effect of Carbide Inoculants in Inconel 718 Processed by Selective Laser Melting**
Kai-Chun Chang, National Tsing Hua University, Taiwan, R.O.C.
- P17 **Synergistic Strengthening Symphony of Nanograins, Nanophases and Nanotwins**
Bin Gan, Central Iron and Steel Research Institute, China