Ti-2011

Proceedings of the 12th World Conference on Titanium

Volume I

China National Convention Center (CNCC), Beijing
June 19-24, 2011

NFSOC The Nonferrous Metals Society of China

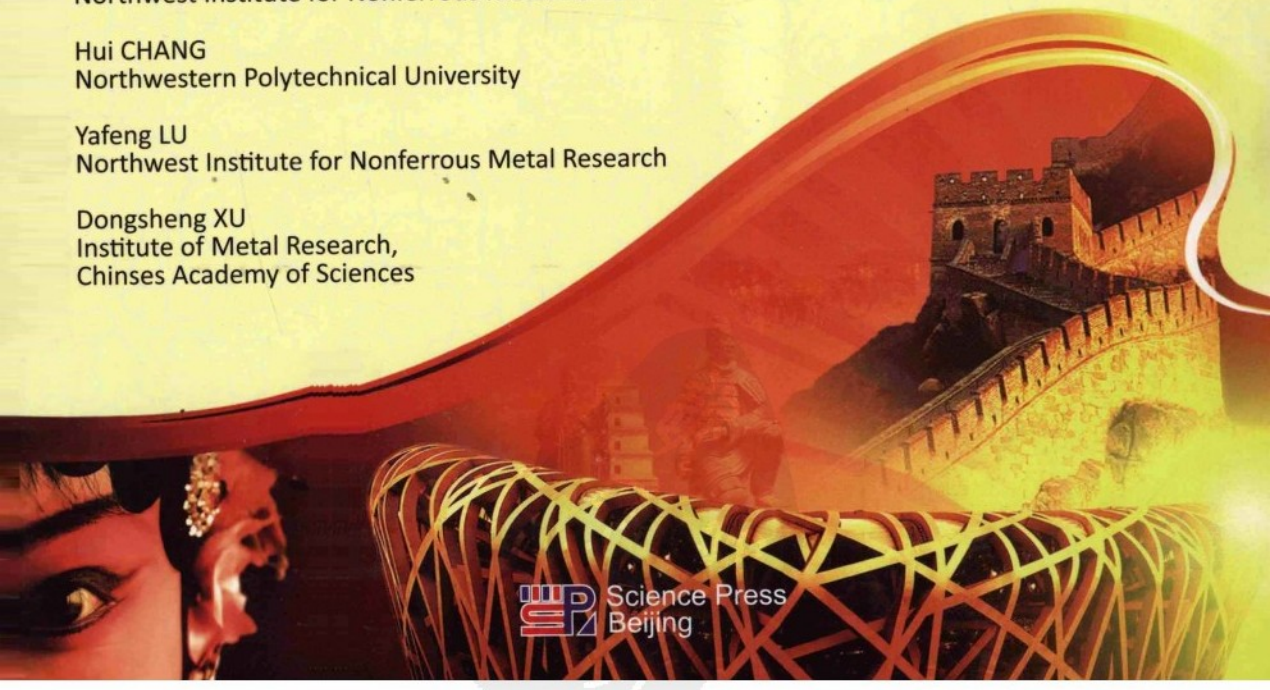
Edited by

Lian ZHOU
Northwest Institute for Nonferrous Metal Research

Hui CHANG
Northwestern Polytechnical University

Yafeng LU
Northwest Institute for Nonferrous Metal Research

Dongsheng XU
Institute of Metal Research,
Chinses Academy of Sciences



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IOC Societies

The Institute of Materials, Minerals and Mining, UK

The Minerals, Metals & Materials Society (TMS), USA

The American Society for Materials (ASM) International, USA

Association "Titan", CIS

The Japan Institute of Metals, Japan

Deutsche Gesellschaft für Materialkunde (DGM), Germany

Société Francaise de Métallurgie et de Matériaux (SF2M), France

The Nonferrous Metals Society of China, China

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Preface

The 12th World Conference on Titanium(Ti-2011)was held at the China National Convention Center(CNCC)in Beijing, China, from June 19 to June 24, 2011, hosted by the Nonferrous Metals Society of China. The World Conference on Titanium has been successfully organized in London(1968), Boston(1972), Moscow(1976), Kyoto(1980), Munich(1984), Cannes(1988), San Diego(1992), Birmingham(1995), St. Petersburg(1999), Hamburg(2003)and Kyoto(2007). This is the first time held in China.

The conference adopted the traditional style of the world conferences on titanium. Seven plenary lectures were given by the members of the International Organizing Committee(IOC)on the latest development of research and applications of titanium in their own countries during the past four years since Ti-2007 in Kyoto, and fifteen keynote lectures associated with the twelve conference topics were also presented by renowned specialists through the recommendation of IOC members. 7 parallel sessions were arranged daily all through the conference on the following twelve topics: Extractive metallurgy, Wrought processing, Microstructure evolution, Properties, Intermetallics & MMCs, Component manufacturing, Near net shape processing, Environmental behavior, Aerospace applications, Biomedical and healthcare applications, Emerging applications and market, Marine applications.

The conference shows that since the Ti-2007 in Kyoto, titanium alloys research and production has made great progress, near net shaping has made advances in improving performance and reducing cost. In the numerous fields such as chemistry, energy, aviation, marine and offshore, bio-medical applications, utilization of titanium has been expanded. Microstructure and processing technologies are emphasized; modeling has also experienced rapid development and application. In the conference, the current situation and future development trend of titanium has also been evaluated and estimated. It is generally believed that Ti-2011 was an outstanding conference that turned out to be a huge success.

For the great success of the conference, here I would like to express my gratitude to all the IOC members for their efforts on promoting Ti-2011 in their own countries, to all the plenary speakers, keynote speakers, general presenters, and session chairpersons for their contributions to Ti-2011. My co-workers really did an excellent job on preparing for Ti-2011, the perfect arrangements of the conference, the offered tours and the excellent food, etc, here special thanks also go to the NOC members and staff of the secretariat.

I hope that this set of proceedings will help to promote the academic exchanges among the worldwide titanium circle and stimulate related scientific & technological advancement to some extent.

At the IOC meeting held on June 22, The IOC members fully approved that the 13th World Conference on Titanium will be held at San Diego, California in August, 2015. We would like to congratulate Dr. V. Venkatesh, Dr. R. R. Boyer and their colleagues, and hope that Ti-2015 in USA will be a great success. Let's witness the new titanium progress in San Diego in 2015.

Zhou Lian

Chairman of the 12th World Conference on Titanium

December 2011

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R. R. Boyer	The American Society for Materials(ASM) International, USA
O. M. Ivasishin	Association "Titan", CIS
M. Niinomi	The Japan Institute of Metals, Japan
L. Wagner	Deutsche Gesellschaft für Materialkunde(DGM), Germany
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Lian ZHOU
The Nonferrous Metals Society of China
P. O. Box 51, Xi'an, Shaanxi 710016, P. R. China
Tel: +86-29-86266570, Fax: +86-29-86231101, E-mail: zhoul@c-nin. com

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Ministry of Industry and Information Technology of China
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◆Conference Secretariat(Secretary-general)

Hui CHANG
School of Materials Science and Engineering
Northwestern Polytechnical University
127 Youyi Western Road, Xi'an, Shaanxi 710012, P. R. China
Tel: +86-10-58768037, Fax: +86-10-58768047, E-mail: ch2006@nwpu. edu. cn

International Organizing Committee(IOC) Members and National Organizing Committee(NOC) Vice Chairmen

From left to right, Prof. B. Wei. (NOC Vice Chairman), Prof. W. Zou(NOC Vice Chairman), Prof. M. Niinomi(IOC Member from Japan), Prof. L. Wagner(IOC Member from Germany), Dr. R. Boyer(IOC Member from USA), Dr. V. Venkatesh(IOC Member from USA), Prof. L. Zhou(IOC Member from China and Chairman), Dr. A. Vassel(IOC member from France), Prof. M. Ward-Close(IOC Member from UK), Prof. O. Ivasishin(IOC Member from CIS), Prof. P. Zhang(NOC Vice Chairman), Prof. L. Xu(NOC Vice Chairman), Prof. X. Wang(NOC Vice Chairman).

IOC Members/Plenary Speakers

Malcolm Ward-Close

Malcolm Ward-Close is a world expert on the development and application of titanium alloys. His work is mainly concerned with developing new alloys and composite materials for demanding applications and in the design of effective manufacturing technology for structures and components. Two of Malcolm's previous technical innovations, on metal matrix composites and titanium production have now been scaled-up to industrial level and are moving to commercial spin-out. His latest research activities centre on low cost titanium and aerospace manufacturing, mainly via powder processing.

Rod Boyer

Rod Boyer has specialized in titanium for over 40 years. He has been involved in basic research, development and application of titanium in the aerospace industry. He has performed studies on the full range of conventional alloys, from commercially pure to alpha to alpha/beta to beta-alloys, and done research on all product forms and almost all of the processing technologies used in the titanium industry. He has over 250 technical presentations and publications and has edited 4 books, including the ASM Titanium Alloys Materials Properties Handbook. He has made over 25 invited presentations at regional, national and international levels, including 4 plenary or keynote lectures at the national level and 7 at the international level.

Vasisht Venkatesh

Dr. Venkatesh is a Manager at the Henderson Technical Labs of the Titanium Metals Corporation (TIMET). He has been with TIMET since 1998, conducting research activities in the areas of titanium processing for property enhancement, and the development and implementation of numerical modeling tools. Along with his research projects, he also manages a pilot scale research facility that supports internal R&D and manufacturing projects at TIMET. Dr. Venkatesh is an active member of ASM, and TMS. He is the current Chair of the TMS Titanium committee, and has organized symposiums at annual materials conferences. He has also been a Mechanical Engineering advisory board member at the University of Nevada at Las Vegas, since 1998.

Orest Ivasishin

Professor Orest Ivasishin is a member of the National Academy of Science of Ukraine. He received his PhD (1973) and (Dr Sci.) 1987 in Solid State Physics. He is currently Deputy Director of the Institute for Metal Physics. His focus research areas are phase and structural transformations in metals and alloys under highly non-equilibrium conditions, optimization of phase composition, microstructure and properties of aerospace materials, powder metallurgy of titanium alloys. He's a member of EMRS, SAMPE, TMS, and ASM.

Mitsuo Niinomi

Mitsuo Niinomi is a professor and director of Institute for Materials Research, Tohoku University. He graduated from graduate school of Nagoya University in 1979 and earned his Ph. D degree in the department of Metallurgical Engineering, and Steel and Iron Engineering in 1980. From 1980 to 2005, he was a research associate, associate professor, and professor at Toyohashi University of Technology. In 2005, he moved to Institute for Materials Research, Tohoku University as a professor. He was elected as a director of Institute of Materials Research, Tohoku University in 2009. He was a visiting associate professor at Carnegie-Mellon University (USA) from July 1988 to June 1989, a visiting professor at The University of Dayton (USA) and a foreign researcher at Wright Patterson Air Force Base, US Air Force from July1997 to December 1997. He was appointed as a visiting professor of Northeastern University, China from 2010-2015. He had worked in the area of fracture and microstructure relations of materials with focusing on titanium alloys for structural and

biomedical applications. Since 2005, he has been a professor at Institute for Materials Research, Tohoku University. Since 2009, He has been a director at Institute for Materials Research, Tohoku University. His recent research is focused on designing, development, and evaluation of biological and mechanical biocompatibility of titanium alloys for medical and dental applications.

Lothar Wagner

Prof. Lothar Wagner studied Mechanical Engineering with specialization in Materials Technology. He holds Dipl. -Ing. (1978) and Dr. -Ing. degrees (1981) from the University of Bochum and a Dr. -Ing. habil. degree (1989) from TU Hamburg-Harburg. From 1981-1983 he was an Alexander von Humboldt Fellow at the University of Rochester. In 1993, he was offered the Chair of Materials Technology at TU Cottbus and in 2002, the Chair of Applied Materials Science and Engineering at TU Clausthal where he became Head of the Institute in 2005. Prof. Wagner's main research interests are microstructure/property relationship in light alloys and methods for improving fatigue performance by means of mechanical surface treatments.

Alain Vassel

Alain Vassel is presently a scientific adviser to the French Titanium Association. He graduated from INSA Lyon in 1969 and earned his PhD degree on Materials Science from the University of Orsay. He spent his career at ONERA (1972-2007) where his research work focused essentially on conventional titanium alloys, as well as on titanium aluminides and metal matrix composites (Al, Ti). He was the project leader for numerous national programs and international collaborations with European countries, USA and China.

Lian Zhou

Prof. Lian Zhou, born in Jilin Province in March 1940, is a distinguished expert on superconducting and rare metal materials. Prof. Zhou graduated from the Metal Materials Department of Northeastern University in 1963 and was elected as one of the first batch of academicians of Chinese Academy of Engineering (CAE) starting from 1994. Presently, Prof. Zhou is Honorary President of Northwest Institute for Nonferrous Metal Research (NIN), honorary President of Chinese Materials Research Society (CMRS), and Consultant of the National Basic Research (973) Program. Prof. Zhou's main research field is superconducting materials, titanium alloys and biomaterials etc. With high prestige, Prof. Zhou has been actively engaged in the materials circle at home and abroad. He was once president of the International Union of Materials Research Societies (IUMRS) in year 2005-2006.

NOC Vice Chairmen

Prof. Pingxiang Zhang is president of Northwest Institute for Nonferrous Metals Research. With Doctor's degree in Material Physics from Northeastern University, he has been engaged in the R & D of superconducting materials. He also serves as ICMC board member, and adjunct professor in several universities. He has published more than 100 papers in scientific journals, and was honored as "Distinguished Expert of Science and Technology" by the State Council of China.

Dr. Bingbo Wei(B. Wei) is professor of materials science and vice president for scientific research at Northwestern Polytechnical University, Xi'an, China. His research activities include: thermophysical properties of undercooled liquid metals and alloys; rapid solidification and microstructure control under extraordinary conditions; space simulation research by containerless processing with levitation techniques. He has published more than 200 papers in refereed journals and holds 6 patents. He also serves as the vice president of Chinese Materials Research Society.

Dr Rui Yang is a deputy director of the Institute of Metal Research CAS in charge of research planning and management, especially in the R & D of engineering materials. His personal research interest is in the field of titanium aluminides for aero-engine applications and biomedical titanium alloys for implant use.

Mr. Wuzhuang Zou, graduated from Xi'an Communication University with Master's Degree. He is the president of Baoti Group Ltd, the chairman of Baoji Titanium Industry Co., Ltd, and the Chairman of China Titanium Association(CTA). He has been involved in production management, market and application development of products of rare metals materials especially titanium and its alloy for a long time.

Mr. Xiang-dong Wang is the vice President and secretary general of the titanium zirconium & Hafnium branch of China non-ferrous metal industry association(that is the Chinese Titanium Association). He is mainly engaged in the Chinese titanium industrial production statistics, market analysis and industry planning work.

Li Xu, a male of Han Ethnic Group, was born on May 17th, 1969 in Zunyi City, Guizhou Province. He was a nonferrous metallurgy major in Kunming Institute of Technology, and then graduated in 1990. As a party member of CCP, he acts as the Director of Zunyi Titanium Plant. His social activities: a deputy of 11th and 12th Guizhou Provincial People's Congress; a member of 8th Committee Congress of Guizhou Provincial Youth Federation; the vice president of China Nonferrous Metals Industry Association Ti - Zr - Hf Branch; the vice president of Guizhou Nonferrous Metals Industry Association; the vice president of Zunyi Enterprises & Enterprise Directors Confederation.

Shenglong Dai, male, Ph. D, Professor, is General Director and Chief engineer of Beijing Institute of Aeronautical Materials, AVIC. He is advisor of the executive board of China Foundry Association, a member of the executive board of Functional Materials Committee of the Chinese Society for Metals, member of the Materials Academy Committee and the Processing Committee of the Nonferrous Metals Society of China. He belongs to the executive board of Uranium Separation Association of Chinese Nuclear Society. He also assumes the position of committee member of Editorial Board of China Aeronautical Materials Handbook and of Editorial Board of Aluminum Alloy. In his outstanding personal career, he won a great number of national titles and honors, for example, the "Central Enterprise National Model for Youth Job", "the Returned Overseas Doctor with Distinguished Contributions", etc

Keynote Speakers

Kuang-O(Oscar) Yu

Dr. Kuang-O(Oscar) Yu is Senior Director of Research and Development of RTI International Metals, Inc. He has broad experiences in processing of titanium alloys and nickel-based superalloys. Dr. Yu has more than 100 publications and seven patents. He is an ASM Fellow and has received numerous awards for his work. Dr. Yu is also the editor of a book "Modeling for Casting and Solidification Processing".

Keynote: Recent Changes and Developments in Titanium Extraction

Yu He

Dr. Yu He is now director of Science and Technology of Shaanxi Non-ferrous Metals holding group Co. Ltd. He used to work in Baoti Group as Vice Chief Engineer. He got his master degree in University of Science and Technology Beijing and has engaged in scientific research on titanium material processing for years.

Keynote (manuscript not available): Status and Prospect of Processing Technologies for Titanium and Titanium Alloys

Helmut Clemens

Helmut Clemens, born in 1957, studied materials science and is head of the Department of Physical Metallurgy and Materials Testing at the Montanuniversität Leoben, Austria. Since 1991 he is working on intermetallic materials, with special focus on titanium aluminides. His research interest centers on alloy development, processing and microstructure-property relationships.

Keynote: Microstructure Evolution in Intermetallic Titanium Aluminides

David Dye

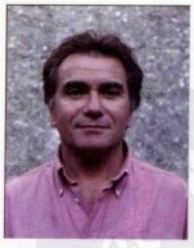
Dr David Dye is a Senior Lecturer at Imperial College, London, UK. He did his PhD at the University of Cambridge on the weldability of Nickel-base superalloys and was a Visiting Fellow at the NRC Chalk River neutron laboratories in Canada. At Imperial, he has focussed on the hot working, deformation and fatigue behaviour of titanium alloys, particularly Ti-10-2-3, Ti-5553, Ti-6-4 and the Gum metal class of superelastic beta-titanium alloys.

Keynote: Microstructure Formation in Alpha + Beta Titanium Alloys

Manfred Wollmann

Dr. Manfred Wollmann studied Mineralogy with specialization in Crystallography and Metal Science at TU Clausthal. He holds a Dipl.-Min. degree (1991) from TU Clausthal, a Dipl.-Ing. degree (1993) from MFH Iserlohn and a Dr. rer. nat. degree (1994) from TU Clausthal. After various positions in the industry (Deutsches Kupferinstitut Düsseldorf, KM Europa Metal Osnabrück, Center of Technology Transfer Northeim) he became Senior Research Engineer and Lecturer (2007) at the Institute of Materials Science and Engineering of TU Clausthal. Dr. Wollmann's main research interests are surface performance of light alloys and corrosion mechanisms as well as protection methods.

Keynote: Properties and Applications of Titanium Alloys in Transport



Patrick Villechaise

CNRS Senior Researcher at the Pprime Institute (Department of Physics & Mechanics of Materials) in the ENSMA Engineer School, Poitiers-Futuroscope, France. Doctorate of Materials Science (1991). Specialist of deformation and damage processes (fatigue, creep-fatigue,...) in structural materials (steels, titanium alloys, Ni-based superalloys,.../ numerous collaborations with aeronautic, energy industries) in relation with their microstructures

and textures at different scales. Influence of surface treatments, ageing effects, oxydation...
Keynote(manuscript not available): Slip activity and crack initiation in titanium alloys; influence of crystallographic orientation at different scales


Junpin Lin

Prof. Lin Junpin is the deputy director of State Key Laboratory for Advanced Metals and Materials. He has been honored "Cheung Kong Scholar" Professorship by the Ministry of Education of China. He got his Bachelor degree at Harbin Institute of Technology in 1983 and Ph. D. degree in 1989. His major research fields include structural intermetallics (high temperature TiAl alloys, Fe-Si alloys et al.), severe deformation and structure controlling for hard-deformed materials, advanced porous materials, and new materials for extra-strong liquid zinc resistance. He is the Chief Scientist of the Major State Basic Research Development Program of China(973 Program).
Keynote: Development of High Temperature TiAl Alloys


Sergii Akhonin

Sergii Akhonin is Head of Department in E. O. Paton Electric Welding Institute (Kiev, Ukraine). He earned his Ph. D and Doctorate degrees in Metallurgical Engineering at this Institute in 1990 and 2003, respectively. His former research interests were in the area of vacuum metallurgy and electron beam melting of titanium and other reactive and refractory metals, current research is focused on investigation of welding of titanium alloys by different methods and development of new weldable titanium alloys.
Keynote: Development of Welding Technologies in Titanium Component Manufacturing


Xinhua Wu

Professor Wu is the Director of the ARC Centre of Excellence for Design in Light Metals in Australia. The Centre consists of 100 researchers and academics from six universities. Professor Wu completed her degrees at South-Central University, the Institute of Metal Research, CAS and the University of Birmingham. Her research is on Ti alloys and near net-shape manufacturing processes.
Keynote(manuscript not available): Advances in Net-shaping of Titanium Alloy Parts


Craig A. Brice

Craig A. Brice is a materials research engineer within the Advanced Materials and Processing Branch at the National Aeronautics and Space Administration Langley Research Center in Hampton, Virginia, USA. Mr. Brice's research focuses on net shape processing through additive manufacturing techniques in titanium and other light alloy materials.
Keynote: Net Shape Processing of Titanium Alloys for Enhanced Performance and Improved Affordability


Takumi Haruna

Prof. Takumi Haruna graduated at Department of Metallurgical Engineering, Osaka University in 1992, and worked in the same department in the same year with Prof. T. Shibata. He worked as a post doctoral researcher in the Center of Advanced Material, the Penn State University, USA with Prof. D. D. Macdonald between 1995 and 1996. He moved in Department of Materials Engineering, Kansai University, Japan as a Lecturer in 2005, and has promoted as an Associate Professor since 2006.
Keynote: Development of Titanium Alloys with Corrosion Resistance in Aqueous Fluoride Solutions

Gaël Khelifati is a metallurgist, PhD in Materials Science at the University of Rouen (France). He joined EADS about 10 years ago and is now working at Airbus Design Office (Structure Centre of Competence; M&P Department), where he is Responsible of Research, Development and Innovation on Hard Metals.
Keynote: Extending the Use of Titanium Alloys on A350XWB


Rui Yang

Dr Rui Yang is a deputy director of the Institute of Metal Research CAS in charge of research planning and management, especially in the R & D of engineering materials. His personal research interest is in the field of titanium aluminides for aero-

engine applications and biomedical titanium alloys for implant use.

Keynote (manuscript not available): Recent developments in titanium alloys for implant applications

Akio Okamoto

Mr. Akio Okamoto is the Section Manager of the Titanium Marketing and Technical Service Section in the Titanium Division of Kobe Steel, Ltd. and has been in charge of development of manufacturing technology and the new applications in titanium for over 27 years. He has a doctor's degree of engineering with a study of titanium heat exchanger.

Keynote: Research and Development for Practical Use of Ocean Thermal Energy Conversion

V. Mikhaylov

Dr. V. Mikhaylov has been working in the field of titanium alloys and their welding for more than 30 years. He got his doctorate degree for research in metal science of welded joints and development of new welding technologies for titanium. Dr. Mikhaylov's main research interests include structure/properties relationship achieved with various welding techniques, forming of cold and hot cracks in metals, working capacity of welded joints. Currently Dr. V. Mikhaylov is heading Laboratory in CRISM "Prometey" which deals with problems of weldability of high strength titanium alloys to be used in marine applications.

Keynote: Titanium Application in Structures Operating in Sea Water

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