Preface

This proceedings contain selected papers from the International Conference on Advances in Metallic Materials and Manufacturing Processes for Strategic Sectors (ICAMPS-2012) being organized by The Indian Institute of Metals (IIM), Trivandrum Chapter, India during January 19-21, 2012 in Trivandrum, India. Selection of metallic materials for applications in high-technology areas like aerospace, nuclear research, defense, energy, etc. involves simultaneous consideration of a number of diverse scientific, technological, environmental and commercial factors. A synergy between material scientist, designer, processing engineer, fabricator and quality controller eventually leads to meeting the challenges and requirements of advanced systems for these sectors. ICAMPS-2012 aims to formulate an integrated multi-disciplinary approach involving R & D organizations, academia and industries which is very essential to achieve this synergy.

ICAMPS-2012 also felicitates Dr. P.P. Sinha who heads the Materials and Mechanical Engineering Entity of Vikram Sarabhai Space Centre, Indian Space Research Organization and will be superannuating from service on January 31, 2012, for his outstanding contributions to research, development and manufacturing of space materials and systems in India.

108 papers contained in this volume were selected on the basis of their quality and relevance to the theme of the conference. All the papers were peer reviewed by the experts. The papers represent the latest development in the field of materials and manufacturing technology, spanning from fundamentals to new technologies and applications. Specifically, the papers cover the topics of processing of advanced materials and characterization for performance critical applications. We believe that this book will provide a valuable reference to researchers in the fields of materials and metallurgical engineering, manufacturing science and technology. We also hope that the book will help to further their understanding in the processing of materials, microstructure-mechanical property correlations and underlying mechanisms, innovative and practical techniques and processes. It should also be of particular interest to manufacturing engineers.

We wish to express our appreciation to all the members of ICAMPS-2012 Organizing Committee and various sub-committees as well as to all reviewers for their tremendous efforts and dedication. We profusely thank all the invited speakers who readily agreed to give lectures at the conference. Finally, we would like to thank all the authors for their contributions to the proceedings.

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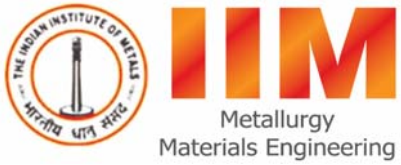
S.V.S. Narayana Murty
Editor, ICAMPS-2012

Trivandrum, India



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Dedication

Dr. P.P. Sinha (b. 18th January, 1948) obtained his B. Sc. and M. Sc. degrees in Metallurgical Engineering from Banaras Hindu University (BHU), Varanasi in 1969 and 1971 respectively. BHU awarded him Ph. D. for his work on the influence of heat treatment on microstructure and mechanical properties of 18 Ni Co free (250 grade) maraging steel in 1993. Dr. Sinha joined Vikram Sarabhai Space Centre (VSSC), Trivandrum in 1971. He has worked extensively in the areas of alloy design, metal processing including heat treatment and welding, phase transformation and microstructure-mechanical property correlations in high strength steels. He also has vast experience in titanium alloys, super alloys and aluminium alloys.

He is the architect of 'Materials Indigenisation Program' which made India self-sufficient in a host of materials for space applications. He has played a lead role in setting up a centre of excellence for advanced manufacturing processes for space materials. He initiated and successfully steered the ambitious programs for establishing cast house for aluminium alloys and titanium sponge plant in the country. He is a recipient of Metallurgist of the Year Award (1997), VASVIK Award (2000), Distinguished Alumnus Award of BHU (2001), ISRO Performance Award (2007), Dr. Biren Roy Trust Award (2008) and IIM-Tata Gold Medal (2010). He is the Fellow of The Indian Institute of Metals (IIM) and the Member of the International Academy of Astronautics (IAA). He has published more than 100 technical papers in national and international journals/proceedings. He also has four patents to his credit.

Dr. Sinha is currently heading the Materials and Mechanical Engineering Entity of Vikram Sarabhai Space Center of Indian Space Research Organization. He will be superannuating from service on January 31, 2012. On this occasion, ICAMPS-2012 felicitates Dr. Sinha for his outstanding contributions to research, development and manufacturing of space materials and systems.

Significant Technical Contributions of Dr. P.P. Sinha

A. Alloy Design & Development

- Development of detailed processing parameters of 18Ni-8Co-5Mo type maraging steels during early seventies. These parameters served as base line data for the processing of the steel on industrial scale in India.
- Design and development of new variety of 250 grade stainless maraging steel (Trans IIM, 35 (2), April 1982). This steel has been named as **"Indian Maraging Steel"** by no less a person than Prof. R. F. Decker – the father of 18Ni-Co-Mo type maraging steels.
- Design and development of new filler wire for welding 18Ni-8Co-5Mo type maraging steel to achieve a minimum of 90% weld efficiency over both tensile properties and fracture toughness.
- Design and development of a low nickel Co-free maraging steel (Mater. Sci. & Tech., Inst. of Metals, 1, (1991), 1082).
- Development of number of cryogenic materials for the indigenous cryogenic engines for Indian space programmes. These include development of a N_2 – bearing stainless steel, an austenite–martensite class high strength stainless steel, Ni-base super alloys and stainless steel/Al alloy bimetallic rings through explosive bonding.
- Development of a low alloy ultra high strength 0.3C-1.5Cr-1.0Mo-0.25V-0.1Nb (ESR) steel for use as structural material in future ISRO's Launch Vehicles.
- Development of a number of special purpose materials like magnetic materials, constant modulus alloy and shape memory alloy for control and guidance systems of launch vehicles and space crafts.

B. Heat treatment

- Development of heat treatment parameters for a number of critical components for aerospace guidance and control systems made out of a wide spectrum of special alloys such as AISI 440C, Radio metal, Mu-metal, Elgiloy, P6 alloy.
- Development of local ageing parameters for large welded structures of maraging steel.
- Studies on the effects of 'quenching media' and 'quench delay' on the mechanical properties of 15CDV6 steel [Trans. IIM, 35 (1), Feb. 1982]
- Development of heat treatment parameters to improve fracture toughness and grain size in an embrittled maraging steel [J. of Heat Treating, 9, (2) (1992), 25]

C. Welding Metallurgy

- Development of welding parameters for 18Ni-8Co-5Mo type maraging steel.
- Extensive studies on microstructure/mechanical property aspects of maraging steel welds.
- Studies on the repair welding of aged 18Ni-8Co-5Mo type (250 grade) maraging steel weldments [Weld. Res. Suppl. Aug (1993) 391-s]
- Studies on Aluminium alloy AA2219 for pressure vessels.

D. Phase Transformation

- Establishment of ageing characteristics of 18Ni-8Co-5Mo (250 grade) maraging steel, stainless maraging steel and Co-free maraging steel.
- Identification of strengthening precipitates in 18Ni-8Co-5Mo and Co-free maraging steels and associated strengthening mechanism.
- Establishment of microstructure-mechanical property correlation in a Co-free maraging steel [Trans. IIM, 49, No.39 (1996), 163]
- Establishment of austenite reversion mechanism in Co-free maraging steels [Steel Research, 66, No.11, (1995), 482]
- Establishment of mechanism of thermal embrittlement in Co-containing and Co-free maraging steels [Mat. Sci. & Tech., 12, No.11, (1996) 945].
- Establishment of grain growth mechanism in maraging steels [J. Mat. Sci. 26, (1991), 4155].
- Extensive phase transformation studies in 15CDV6 steel [Trans. IIM, 35, (4), Aug. 1982]
- Establishment of microstructure-mechanical property correlation in a 0.3C-1.5Cr-1.0Mo-0.25V-0.1Nb low alloy ultra high strength steel.

E. Materials Processing under Micro Gravity Conditions

- Studies on the disorder entrapment in drop tube processed Ni3Al [Scripta Metall. 28(11), June (1993), 1365].

F. Failure Analysis

- Failure analysis of a number of satellite launch vehicle components made out of maraging steels such as cracking of rocket motor segments at HAZ / parent metal interface [J. Mater. Sci., 25, (1990) 4587], failures of merman bands and explosive bolts.
- Failure analysis of AFNOR 7020 Aluminium alloy toroidal water tank of the second stage of Polar Satellite Launch Vehicle (PSLV).