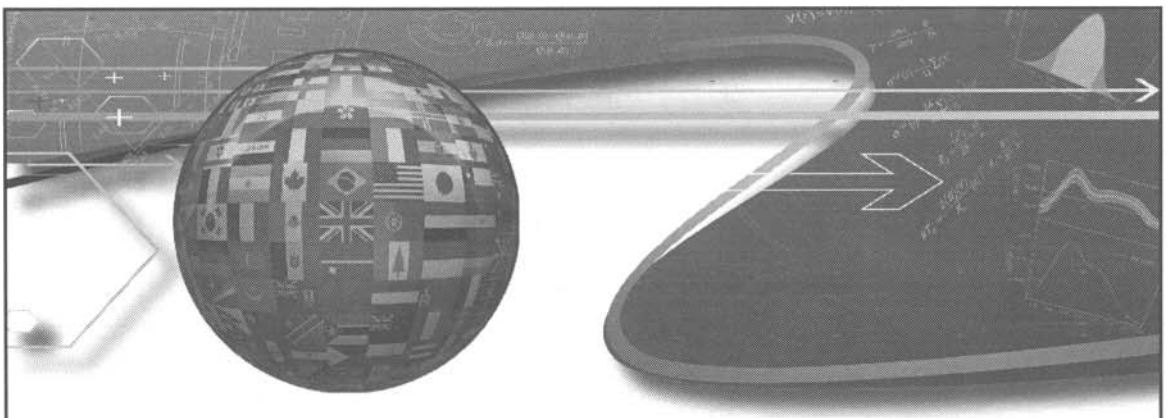
Magnesium Technology 2011



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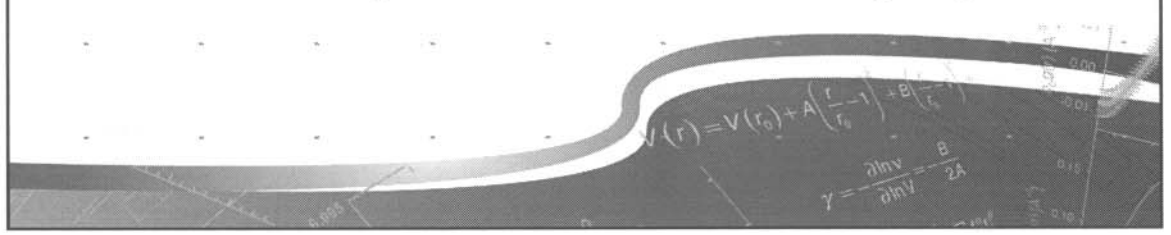

Magnesium Technology 2011

Proceedings of a symposium sponsored by the
Magnesium Committee of the Light Metals Division of
The Minerals, Metals & Materials Society (TMS)

Held during
TMS 2011 Annual Meeting & Exhibition
San Diego, California, USA
February 27-March 3, 2011

Edited by

Wim H. Sillekens
Sean R. Agnew
Neale R. Neelameggham
Suveen N. Mathaudhu

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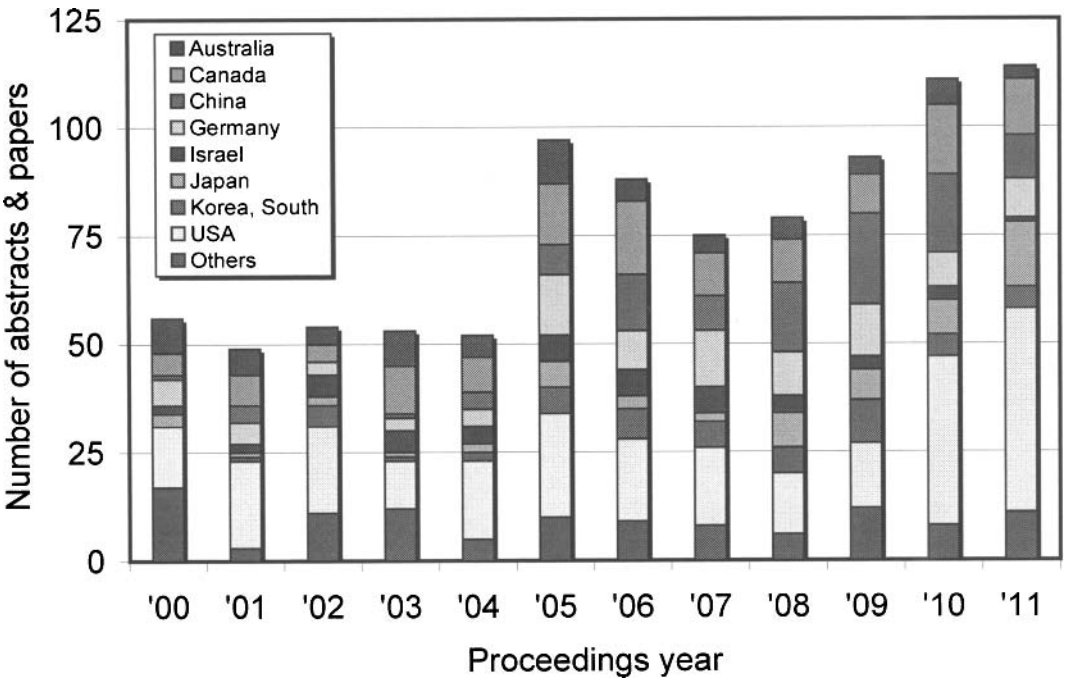
PREFACE

The world of today faces a number of immense challenges relating to such diverse issues as sustainability (environmental concerns, long-term availability of energy and mineral resources), security and quality of life. Most interestingly, magnesium can – and likely will – increasingly contribute to the resolution of several of these issues. Weight saving by introducing magnesium alloy components in vehicles is a recognized means of enhancing fuel efficiency and thus of reducing energy consumption and greenhouse gas emissions. Different from several other metals, magnesium is virtually inexhaustibly available from natural resources. By using attributes of magnesium-based materials other than low density (such as impact resistance, bio-compatibility and chemical affinity), a variety of new applications relating to ballistic armor, biomedical implants and hydrogen storage rises at the horizon.

It is against this background that the Magnesium Committee of the Light Metals Division of TMS has organized and sponsored its 12th edition of the Magnesium Technology Symposium, held at the TMS Annual Meeting in San Diego, CA (USA) from February 28 to March 3, 2011. The symposium was organized in an opening session, a poster session and nine technical oral sessions, covering a broad range of topics. This included primary production and characterization, casting and solidification, alloy design, high-temperature and high-strength alloys, deformation mechanisms, formability and forming, new applications, advanced materials and processing, and corrosion and coatings.

The volume at hand represents the Proceedings of this Symposium. Like in previous years, contributions come from countries around the globe that are active in magnesium research and development and reflect the latest advancements in the field. To ensure TMS standards, all papers were peer reviewed by a pool of volunteers acting on behalf of the Magnesium Committee. In addition to these Proceedings, some Symposium contributions on biomedical applications will be published in full in an upcoming JOM Special Issue sponsored by the Magnesium Committee and entitled "Biomedical Applications of Magnesium" (issue 63/4, April 2011).

The bar chart on the next page visualizes the development of the TMS Magnesium Technology Symposium since its inception in the year 2000 in terms of size and international participation. In the initial years, the number of contributions was quite steady, but as of 2005 when parallel sessions were introduced this number rose steeply – although variations between the successive years exist. Contributing countries can roughly be divided into two categories, depending on if their market emphasis is on magnesium supply (e.g., China and Israel) or consumption (e.g., Germany, Japan and the USA). The largest share of the Proceedings publications comes from the listed eight countries while the remaining category "others" comprises more than 20 other countries from Europe and Asia (with the United Kingdom and Norway being the most prominent of these). Overall, the USA accounts for roughly a quarter of all abstracts and papers to date, followed by Canada (14%), China (11%) and Germany (10%). Notably, the chart also reflects the market changes that the magnesium sector has seen over the last decade, the most pronounced example of this being the large increase in Chinese contributions along with the country's development of primary and alloy production during the more recent years.



Keystone data of the TMS Magnesium Technology Proceedings (country of origin of each contribution is based on the affiliation of the main author)

The organization of the Magnesium Technology Symposium and the realization of its Proceedings would not have been possible without the support of numerous engaged volunteers. Hence this is the place to acknowledge the contribution of all authors, reviewers and session chairs that have been instrumental in making this happen. Further, the continued support by TMS staff has definitely facilitated the job and is well-appreciated.

While Symposium Proceedings traditionally reflect the state-of-the-art and spirit of the age, may this volume become a valuable part of your reference library for the years to come and in retrospect mark a memorable period in advancing the field of magnesium technology.

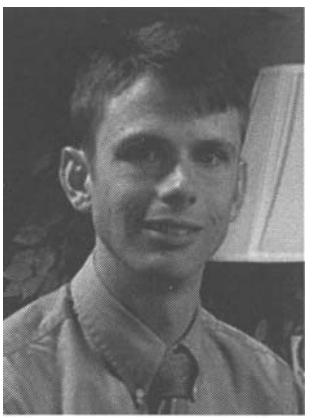
Wim H. Sillekens
Sean R. Agnew
Neale R. Neelameggham
Suveen N. Mathaudhu

ABOUT THE EDITOR

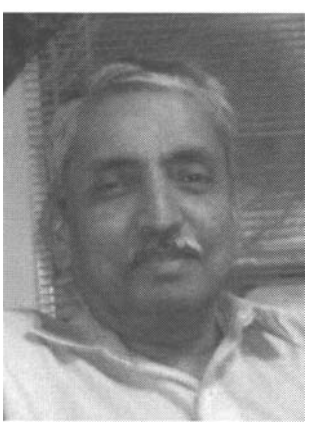
WIM SILLEKENS
MAGNESIUM TECHNOLOGY 2011 EDITOR

Wim H. Sillekens (1963) is a Senior Scientist at the Netherlands Organization for Applied Scientific Research (TNO), where he is involved in national and European research projects. He obtained his Ph.D. from the University of Technology Eindhoven, Netherlands, on a subject relating to metal-forming technology. Since he has been engaged in light-metals research (aluminum and magnesium), amongst others on (hydro-mechanical) forming, (hydrostatic) extrusion, forging, recycling/refining, and more recently on biomedical applications. His professional career includes positions as post-doc researcher at his alma mater and as a research scientist / project leader at TNO. International working experience covers a placement as a research fellow at the Mechanical Engineering Laboratory (AIST-MITI) in Tsukuba, Japan, and – more recently – shorter stays as a visiting scientist at GKSS in Geesthacht, Germany, and at PNNL in Richland WA, USA. He has co-authored a variety of journal and conference papers (about 50 entries to date). Current research interests are in the physical and mechanical metallurgy of light metals in general and magnesium wrought alloys in particular.

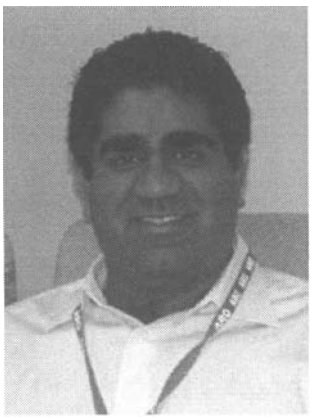
ABOUT THE ORGANIZERS



Sean R. Agnew is the Heinz and Doris Wilsdorf Distinguished Research Chair and Associate Professor in the Department of Materials Science and Engineering at the University of Virginia. He earned his Ph.D. in Materials Science and Engineering at Northwestern University in 1998. His dissertation focused on fatigue behavior and texture of ultrafine grain copper produced by severe plastic deformation. He first began working on magnesium as a Wigner post-doctoral fellow at the Oak Ridge National Laboratory in 1999, with research into the mechanical behavior of both cast and wrought alloys. Since moving to UVA in 2001, his magnesium research has focused on the development of constitutive models that account for dislocation- and twinning-based deformation mechanisms; modeling and control of texture development; measurement and modeling of the hot workability and sheet metal formability; and alloy design. His research group also conducts research on fatigue, creep, diffraction-based characterization, and non-destructive testing of a variety of metallic alloys.



Neale R. Neelameggham is the Technical Development Scientist for US Magnesium LLC. He has 38 years of expertise in magnesium production technology, having been with the plant from its startup company NL magnesium. Dr. Neelameggham's expertise includes all aspects of the magnesium process, from solar ponds through the cast house including solvent extraction, spray drying, molten salt chlorination, electrolytic cell and furnace designs, lithium ion battery chemicals and by-product chemical processing. In addition, he has an in-depth and detailed knowledge of alloy development as well as all competing technologies of magnesium production, both electrolytic and thermal processes worldwide. Dr. Neelameggham holds 13 patents and has several technical papers to his credit. As a member of TMS, AIChE, and a former member of American Ceramics Society he is well versed in energy engineering, bio-fuels and related processes. Dr. Neelameggham has served in the Magnesium Committee of LMD since its inception in 2000, chaired it in 2005, and has been a co-organizer of the Magnesium Symposium since 2004. In 2007 he was made a Permanent Co-organizer for the Magnesium Symposium. He has been a member of the Reactive Metals Committee, Recycling Committee and Programming Committee Representative of LMD. In 2008, LMD and EPD created the Energy Committee following the symposium on CO_2 Reduction Metallurgy Symposium initiated by him. Dr. Neelameggham was selected as the inaugural Chair for the Energy Committee with a two-year term. He is also a member of LMD council. Dr. Neelameggham holds a doctorate in extractive metallurgy from the University of Utah.



Suveen N. Mathaudhu is a Program Manager with the US Army Research Office (ARO), Materials Science Division. Dr. Mathaudhu also concurrently serves as an Adjunct Assistant Professor in the Department of Materials Science and Engineering at North Carolina State University. Dr. Mathaudhu received his B.S.E. from Walla Walla College and his Ph.D. in Mechanical Engineering from Texas A&M University. Upon graduating in 2006, he accepted a post-doctoral fellowship, and subsequently a civil servant position at the US Army Research Laboratory with the purpose of establishing deformation-processing laboratories for research on advanced metallic and composite materials. Since joining ARO in 2010, he manages programs which focus on the use of innovative approaches for processing high performance structural materials reliably and at lower costs. Dr. Mathaudhu's current research interests include: ultrafine-grained and nanostructured materials by severe plastic deformation, microstructural optimization and homogenization, consolidation of metastable particulate materials and processing-microstructure-property relationships of refractory metals and lightweight metals, integrated computational materials engineering, and thermally stable nanocrystalline materials. He has co-authored over 40 technical publications in these areas. He is also an active member of TMS where he is the primary organizer of the Ultrafine-Grained Material Symposium, and also serves on the Magnesium Technology Committee, and the Nanomaterials Committee.