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Jim Proft

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SMST-2006, the International Conference on Shape Memory and Superelastic Technologies, was held May 7–11, 2006 at the Asilomar Conference Center in Pacific Grove, California, USA. Although other sites were considered for SMST-2006, returning to this location, the original venue for SMST Conferences, for the fifth time proved to be a welcomed decision. Asilomar once again proved to be the idyllic setting with its casual atmosphere facilitating a dynamic exchange of ideas amongst the industry’s leaders and best known researchers, academics and government personnel as well as many considered “new” to the technology. Over 430 people from 18 different countries participated in SMST-2006, indicating that interest in this technology continues to rise around the world! The diversity and depth of the technical program as reflected by these Proceedings indicates that SMST events remain at the forefront of research and development of shape memory and superelastic technologies. The continued growth of our industry was also reflected by a record number of participants at the Nitinol Workshop. A total of 172 students attended the preconference course on Sunday titled “Nitinol—Beyond the Fundamentals.” The title itself is exemplary of the continued growth in that a deliberate effort was made to provide deeper insights in 6 different areas of the technology. Also indicative of the continued growth of our industry, 25 companies, the largest number ever, exhibited the latest in products and services for the shape memory industry at our Tuesday evening Product Exhibition. The Conference Banquet at the Monterey Bay Aquarium on Wednesday evening brought the week to a crescendo.

As with past SMST Conferences throughout the world, the contributions of many individuals helped make SMST-2006 a success. First, I would like to acknowledge the tremendous effort, insights and creativity of the Technical Program Co-Chairmen, M.R. Mitchell and Brian Berg. Their enthusiasm from the very start of planning the conference made the process easier and actually fun. Their dedication to creating an exciting and thought provocative program as well as their efforts following the conference to assure a thorough review of the manuscripts leading to these proceedings is greatly appreciated. Second, I would like to thank the Session Chairs for supporting our idea of their early involvement in the construction of the program, their efforts during the conference to assure a smooth and timely flow, and finally for their assistance.
with reviewing the manuscripts. Session Chairs for SMST-2006 included Kaushik Bhattacharya, Jeff Brown, Tom Duerig, Gunther Eggeler, Harald Fischer, Ken Gall, Brad James, Dave Grummon, Andreas Melzer, Ken Perry, Frank Sczerzenie, Huseyin Sehitoglu, Natalia Shevchenko, Terry Woods, and Ming Wu. Third, I would like to thank the instructors of the Workshop for their time and effort to take the participants “Beyond the Fundamentals.” The faculty included Tom Duerig, Brad James, Dave Grummon, Neil Morgan, Ken Perry and Krishna Venugopalan.

I would like to recognize and thank the members of the Organizing Committee for each of their respective contributions: Neil Morgan and Valentina Imbeni, who assembled the well attended Workshop; John Boylan, who solicited a record number of our generous Sponsors; Jeff Simpson and Jonathan Wan, who organized the outstanding Product Exhibition; Dave Plumley and Joe Kain, who organized the Poster Sessions with efficiency; Jeff Brown, for helping coordinate the Audio Visual activities including making sure presentations were ready for each session; and Shellee Perkins, for her local support in the Monterey Peninsula area to both the organizing committee members and to ASM personnel in a multitude of areas including the Conference Banquet.

The SMST-2006 Conference was the first conference organized under the new affiliation with ASM International as announced at SMST-2004 in Baden-Baden. As such, we were navigating new waters and I will admit it was a learning curve for both parties. On one hand it was clear that we needed the resources and event organizing skills of the ASM team. On the other, we were committed to preserving the unique culture of SMST events. In the end, I am confident in stating that SMST-2006 was successful because of an overall effort from both SMST members and ASM staff. I am grateful for the efforts and hard work by the ASM team including Jennifer Arnold, Christine Lajara, Sarina Pastoric, Lana Shapowal, Kim Simpson and Michelle Underwood. I am especially grateful to Thom Passek for his facilitation along the way and numerous discussions that helped keep us on the right path.

I owe a very special thank you to the founding fathers of SMST which include Tom Duerig, Darel Hodgson and Alan Pelton. I sincerely appreciate the faith they had in my taking the SMST baton at the conclusion of the 2003 Conference and running with it. Their numerous suggestions and guidance along the way were invaluable and I sincerely appreciate their support and continued friendship. The Advisory Committee for SMST-2006 consisted of the above three individuals as well as Matthias Mertmann, Ming Wu and Jay Yang. I thank all of you for helping with the overall planning of this event and for your insights and suggestions. I would also like to thank the members of the Metallurgical Solutions team and the companies it represents for their support and encouragement throughout the period of planning and preparing for the conference.
Finally, I would like to thank our sponsors for their generosity and support to SMST-2006. Their financial contributions helped assure its success and for this we are grateful.

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SAES Getters Group
Special Metals Corporation — Shape Memory Alloys Division
Ulbrich Stainless Steels and Special Metals, Inc.

Jim Proft
SMST-2006 Conference Chairman
These SMST-2006 Proceedings are divided into fourteen sections. The first section is entitled **Fatigue and Fracture**. Following the lead of SMST-2004, it was decided that this subject was again worthy of its own session at the conference and in these Proceedings. Research continues in the area of surface effects, the significance of melt practice and microstructure on fatigue, and deployment of fracture mechanics-based approaches as exemplified in these ten papers devoted to this important subject matter.

The second section deals with **Materials Characterization and Experimentation** and includes ten papers ranging from the “very practical” to new and novel techniques for characterizing shape memory alloys. On the more practical side, the significance of the \( A_f \) temperature is presented. Another paper expounds on the pros and cons of traditional strain measurement techniques. Finally, more advanced methods are included on strain measurement and characterization of deformation and recovery at the nanometer scale.

Though addressed at past SMST conferences, it was determined that the subject of **Surface Processing and Biological Response** should be addressed separately from **Corrosion and Biocompatibility** and hence a section on each subject is included in these Proceedings. A third section focuses on surface modifications and the implications of these treatments to in-situ biochemical reactions, while a fourth section contributes further understanding to the corrosion characteristics of nitinol relative to other engineering alloys, the effect of test methodologies, and further addresses the specific cases of fretting and crevice corrosion that may result from the utilization of overlapping stents. The final paper in this section takes a closer look at the relative corrosion characteristics of austenite and martensite with considerations of both thermally-induced and stress-induced martensite.

The interest in shape memory alloys based on **Thin Films, Powder and Porous Materials** continues to grow with the predominant format in this section being thin films. Papers in this fifth section focus more on processing and characterization as opposed to applications. Such work can be expected to contribute to the commercialization of devices based on this technology.
In the sixth section on **Alloy Production and Processing** five interesting papers are presented ranging from a single crystal copper-based alloy to a comprehensive look at the effects of cold work and heat treatment on the $A_f$ temperature in nitinol. It is worth noting that fewer papers were presented at this conference on processes such as laser cutting and joining although some of these have been included in other sections for particular applicability to those sections.

Although the commercialization of medical applications based on superelasticity has far outpaced **Actuators and Other Nonmedical Applications** over the past several years, a revitalized effort in this area appears to have commenced. Whether it is via novel processing methods, new characterization techniques, or modeling, there appears to be a renewed interest and we remain hopeful that commercial success will be the fruit of this labor. Papers in this seventh section range from automotive applications to seismic response to an animated movement of a sculpture. Three of the eight papers herein pertain to damping, including one involving composites based on shape memory alloys.

Section eight represents the more analytical presentation and discussion of events that can occur during the cyclic use of shape memory alloys in higher temperature, cyclic environments. Papers in **Thermal Mechanical Fatigue** represent the latest thinking, principally those in academia, with respect to either thermal cycling at a constant stress or strain cycling at a constant temperature. Explanations are offered regarding the degradation of these alloys with regard to parameters such as recoverable strain, transformation temperature shifts, and overall life to mechanical failure. With such research topics being introduced at SMST conferences, it is hoped that stimulation of industrial interests and applications will soon follow.

The history and focus of SMST conferences has been on the engineering aspects of shape memory and superelastic alloys and for these reasons, we have included a section titled **Exemplary Applications**. These three papers were selected for inclusion in this ninth section based on either the uniqueness of the application or the particular challenges faced in the design and engineering of the device. They include two medical applications and one nonmedical application.

As highlighted at SMST-2003 and SMST-2004, the area of **Device Modeling and Testing** continues to be an important area for the design and development of devices based on nonlinear material response. The Proceedings for both of those conferences emphasized the “micro-sizing” of the models being developed as well as the actual testing of those models and the eight papers included in Section 10 show a continuation of those efforts. They address a wide range of medical device applications as well as subjects such as how the anisotropy of a drawn tube impacts finite element analysis.

The eleventh section titled **Metallurgical Fundamentals** was created after the initial review of abstracts submitted for SMST-2006. It was decided that there were several papers that simply contributed to the fundamental metallurgy of nitinol alloys as well as a Ti-Nb alloy. These papers help build the foundation and further understanding of microstructure-property relationships.
The twelfth section, **Theory for Design and Discovery** highlights papers that address enhanced models for incorporating microstructure features and aiding in the development of new alloys.

Several papers exhibiting innovative areas of research, characterizations critical to the success of medical applications, and novel process methods are included in the thirteenth section titled **Future Directions**. These papers span a wide range of subjects including nanostructures, wear resistance, carbon and oxygen content implications, as well as a new method of joining.

Although there are many examples of medical applications throughout the above sections, this particular section on **Medical Applications** was organized with assistance from the Society for Medical Innovation and Technology (SMIT). In conjunction with additional papers presented at the conference, the one included here exemplifies the continued proliferation of nitinol in the medical device field spanning vascular applications to laparoscopic surgery to orthopaedic implants.

These Proceedings contain a total of 77 papers. The papers have been carefully reviewed by the respective Session Chairs and in particular cases, peers of their choice as well as the Editors. As with past SMST Conferences, an effort was made to favor submissions that exhibited forward thinking and new research. As such, we suggest that you carefully weigh the opinions or hypothesis contained herein and not assume that every statement or conclusion has been proven or accepted by the nitinol community.

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SMST-2006 Editors