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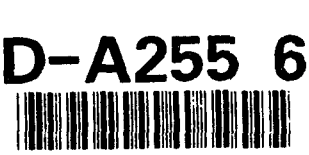

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6. AUTHOR(S)

Neil Paton
HOWMET CORPORATION
1500 Warner St, Whitehall MI

F.H. Froes
University of Idaho
Moscow, ID 83843-4140

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

UNIVERSITY OF IDAHO
Moscow, ID 83843-4140

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This report covers the 7th World Conference on Titanium held in San Diego California, June 28 to July 2 1992. The purpose of the conference was to exchange information on advances in technology in titanium alloys, titanium processing, and applications of titanium alloys. Over 300 oral and 180 poster presentations were made by attendees from over 40 different countries including the former Soviet Union, Japan, China, and Europe. Total attendance was over 700, which exceeded conference expectations.

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Summary Report

Seventh World Conference on Titanium
June 28 - July 2, 1992
San Diego, CA

Introduction

The International Titanium Committee (represented in the U.S. by the Titanium committee of TMS), has for some years held an international titanium conference every four years. The first such conference was held in London in 1968 followed by a conference in Boston in 1972. Subsequent conferences have been held in various other countries with the 1992 conference returning to the United States for the first time in 20 years. The conference represented an opportunity for researchers in government, industry and university to exchange developments in titanium based materials in both formal and informal atmospheres. Emphasis was on titanium alloy development, processing of titanium alloys, properties of titanium alloys and applications, particularly new applications of titanium alloys in both aerospace and non aerospace industries.

The technical sessions began with a group of plenary presentations and continued throughout the week with several invited critical reviews, technical papers, and poster presentations. There was also an exhibition attended by several corporations displaying their capabilities in titanium technology. The meeting was hosted by The Minerals, Metals & Materials Society in cooperation with the Titanium Development Association. Co-sponsoring organizations included: ASM International, Deutsche Gesellschaft fur Materialkunde, The Academy of Sciences, The Institute of Metals, The Japan Institute of Metals, and the Societe Franciase de Metallurgie et de Materiaux.

Plenary Session and Critical Reviews

The conference began with six plenary presentations. Each member country of the International Organizing Committee (United States, Germany, France, United Kingdom, former Soviet Union, and Japan) was invited to give one plenary presentation. This session took place without any competing parallel technical sessions to allow all of the conference participants to attend. The six talks dealt with

sessions to allow all of the conference participants to attend. The six talks dealt with key aspects of titanium technology: process modelling (United States), advanced alloys and processes (United Kingdom), alloy theory and phase transformations (France), surfaces and elevated temperature effects (Germany), issues in the production of titanium sponge and ingot (Japan), and new horizons of applications for titanium (former Soviet Union). This session was well attended and represented a summary of the advances in the state of the art of titanium-based metallurgy since the last World Conference in 1988.

Other sessions which addressed new technical capabilities in titanium included; a plenary session which Paul Blankensop from the UK described a titanium metal spray process using cold hearth melting. Cleanliness of resulting products was reputed to be excellent. A new process for the manufacture of high purity titanium sponge using distillation rather than leaching was described by Mr. S. Tamamoto, from Osaka Titanium in Japan. The new process can produce very pure low chlorine titanium sponge at lower cost than current methods. A Russian speaker, I.V. Gorynin from the Central Research Institute for Standard Material, Moscow, Russia, described a titanium casting furnace capable of producing castings of the order of 3.5 tons, which is significantly larger than any US capability. A thermal treatment using hydrogenation followed by de-hydrogenation (TCP treatment) was described to produce improved properties in titanium alloys which is receiving increasing attention.

A total of twelve critical reviews were presented at the conference. Each member country of the International Organizing Committee was invited to present two critical reviews. These papers covered key aspects of titanium-based metallurgy and materials science, along with the business interests of the titanium community: from physical and mechanical properties of titanium based alloys to quality assurance for titanium applications; from microstructure property relationships in conventional titanium alloys to those same relationships in Ti_3Al and TiAl based alloys; from current forming and fabrication techniques to new development of titanium applications as an ecological metal. These critical reviews were scheduled throughout the week of the conference to make them as accessible as possible to the attendees.

Technical Sessions

The technical sessions represented the bulk of the conference. Over 300 oral and 180 poster presentations occurred during the week. The oral presentations occurred in

five parallel sessions. As with the critical reviews, the technical sessions were divided into twelve focal areas: (1) raw materials, melting, recycling, and primary processing; (2) alloy theory and phase transformation; (3) powder metallurgy, thermomechanical processing, and nanostructures; (4) intermetallics; (5) forging, forming, joining and casting; (6) microstructure and properties; (7) inspection, nondestructive evaluation, quality assurance, and defects; (8) surfaces, environmental effects, and protection; (9) metal matrix composites and interfaces; (10) physical and mechanical properties; (11) aerospace applications; and (12) non-aerospace applications. Some highlights of these sessions are presented below.

Numerous talks on conventional titanium alloys highlighted the latest developments in these alloys. J. E. Allison (Ford Research Laboratories) discussed the effect of thermal exposure on the microstructure and properties of Ti 6242S, Ti-1100, and IMI 834. He showed that exposure at 550-650°C led to reduced ductility and impact strength in all three alloys. The mechanical properties were most influenced by the starting microstructure with an alpha-beta structure providing the best combination of ductility and impact strength. G. W. Kuhlman (Alcoa) presented the results of a study on Ti-6Al-2Sn-2Zr-2Mo-2Cr + Si (Ti-6-22-22S) alloy. This is a high strength alpha-beta alloy suitable for fracture critical applications. Typically, this alloy is forged in the alpha-beta range and then given an alpha-beta heat treatment. S. Prigent (Laboratoire de Metallurgie et Physico-Chemie des Materiaux in France) discussed the use of ultra-high purity calcia crucibles for melting commercially pure titanium. The crucibles were preheated to 1200°C, the titanium was melted inside a molybdenum resistance furnace and allowed to solidify inside the crucible. The specimens did not show any alpha case. M. Cianci (Howmet Corporation) presented a paper on the recent advances in investment cast titanium. New demands on this industry have required shorter turn around times, higher yields, more innovative processing and gating techniques, and the use of Total Quality principles to produce a quality product. The challenge of investment casting new titanium-based alloys (e.g., Timetal-21S, formerly beta-21S, and gamma TiAl) was also discussed.

Research and development on the titanium-based intermetallic alloys took a prominent role in the conference. These presentations were not only limited to the Intermetallic sessions – they occurred throughout the rest of the sessions. One of the overriding themes in several papers was the belief that applications for alpha-2 (Ti_3Al) titanium aluminides were dwindling because of the emergence of higher temperature

conventional titanium alloys and the increased confidence in gamma (TiAl) alloys. C. Austin (General Electric Aircraft Engines) presented a review of their gamma alloy development program. He highlighted the fact that cast gamma alloys are slowly closing the gap in mechanical properties with wrought alloys.

In the composites sessions several speakers addressed advances in fabrication of composite materials and an interesting approach to producing composites was described by Dr. Abkowitz of the US in which a titanium carbide and titanium 6Al 4V composite using powder metallurgy methods to produce such composites. Increase in elastic modules from around 15 for a standard titanium alloy to 18.4 to a composite system is a major reason for interest in this technology. Provide the possibility to make greater use of the availability of this additional modules. Further research in the area of aluminum elasticity would appear to offer considerable promise for these reasons.

Technical Exposition

Over twenty companies, both large and small, took part in the technical exposition. This was the chance for a wide range of corporations to highlight their company's titanium processes, products, or services. Primary alloy producers including TIMET, OREMET, and RMI; melting and processing companies such as Axel Johnson Metals, CONSARC, EG&G KT Aerofab, Leybold Technologies, and Retech; investment casting and ingot production from Howmet Corporation; and companies associated with the former Soviet Union: PROMETEY and TIRUS had booths as the exposition. The exhibition was well attended with many booths the site of lengthy technical and business discussions. This part of the conference gave the participants a chance to see the most up-to-date capabilities of the world-wide titanium based industry.

Summary

Since its fairly recent emergence on the metallurgical scene, titanium has made a significant impact in materials technology. Current technological accomplishments would not be possible without the attractive mix of mechanical and physical properties of titanium-based metals. The Seventh World Conference on Titanium gave researchers and industrial personnel the time to reflect on the current state of the art and ponder what the future has to offer. The next such gathering of this community will occur in three years (1995) in the United Kingdom.