

General Abstracts: Materials Processing and Manufacturing Division: Session I

Sponsored by: The Minerals, Metals and Materials Society, TMS Materials Processing and Manufacturing Division, TMS/ASM: Computational Materials Science and Engineering Committee, TMS: Global Innovations Committee, TMS: Nanomechanical Materials Behavior Committee, TMS/ASM: Phase Transformations Committee, TMS: Powder Materials Committee, TMS: Process Technology and Modeling Committee, TMS: Shaping and Forming Committee, TMS: Surface Engineering Committee

Program Organizers: Thomas Bieler, Michigan State University; Neville Moody, Sandia National Laboratories

Wednesday AM
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Room: 3022
Location: Moscone West Convention Center

Session Chair: To Be Announced

8:30 AM

Anisotropic Properties of Tantalum Processed by Equal Channel Angular Pressing: Joel House¹; Philip Flater¹; James O'Brien²; William Hosford³; John Bingert⁴; Robert De Angelis⁵; ¹US Air Force; ²O'Brien and Associates; ³University of Michigan; ⁴Los Alamos National Laboratory; ⁵University of Florida/REEF

The current study examines the effect of severe plastic deformation on pure tantalum via equal channel angular pressing (ECAP). After processing, three metallurgical conditions were characterized: as worked, fine-grain annealed, and large-grain annealed. A series of low strain rate, split Hopkinson Pressure Bar, and Taylor Impact experiments were conducted to characterize the mechanical properties. These experiments revealed orientation dependence in mechanical strength as a result of the processing history. This paper will describe the initial microstructures to include grain size and texture. Data will be given on the mechanical properties relative to orientation. The recovered specimens were analyzed to provide in-sight into the evolution of texture for the various experimental conditions. These data sets will be discussed in the contexts of processing by severe plastic deformation and the resulting anisotropic material properties.

8:50 AM

Corrosion Performance of Al/SiCP Composites with Multimodal Distribution under Humid Ambient and Aerated Chloride Solutions: Miguel Montoya-Dávila¹; Martin Pech-Canul¹; Maximo Pech-Canul²; ¹Cinvestav-Salttillo; ²Cinvestav-Merida

The effect of the multimodal distribution on the corrosion behavior of Al/SiCp composites was investigated. Composites with 0.6 volume fraction of reinforcements were prepared by the infiltration of preforms (silica-coated a-SiC powders of 10, 54, 86, and 146 μm) with the alloy Al-13.3Mg-1.8Si (wt. %) in Ar-N₂ at 1100°C for 60 min. Corrosion potential measurements were carried out in aerated 0.1M NaCl solutions; humidity tests were performed in 90 \pm 3% humidity chambers at 50 °C. Results show that weight gain augments with increase in particle size distribution. A possible explanation to this outcome is the formation of the unwanted Al₄C₃. Despite the weight gain registered, the composites show no evidence of degradation. Corrosion potential curves are characterized by two stages; in stage 1, E_{corr} tends towards the corrosion potential for aluminum; in stage 2 and after 4.33 h, E_{corr} oscillates within a well defined and approximately constant range.

9:10 AM

Fast Epitaxial High Temperature Brazing of Single Crystalline Nickel Based Superalloys: Britta Laux¹; ¹Technische Universität Braunschweig

A new brazing technology has been developed for the repair of cracks in turbine components. Conventional diffusion bonding technologies work with nickel based braze alloys which are enhanced by fast diffusing melting point depressants (MPD) like boron or silicon. An epitaxial growth can be achieved by a diffusion controlled isothermal solidification. Due to the poor solubility of the MPD within nickel, entire diffusion of the MPD out of the braze gap is essential. Otherwise, brittle secondary phases form which results in deteriorating mechanical properties. Since the required hold times for epitaxial solidification are very long, new manganese containing alloys were developed as manganese is completely solvable within nickel. Brazing times being up to 100-times shorter

could be achieved. By the addition of aluminium, chromium and titanium a microstructure very similar to that of the base material was produced over a gap width of 300 μm , whereas a complete epitaxial solidification occurred.

9:30 AM

GTAW-Assisted Laser Welding of Galvanized High-Strength Steel in Gap-Free Lap Joint Configuration: Shanglu Yang¹; Radovan Kovacevic¹; Robert Ruokolainen²; ¹Research Center for Advanced Manufacturing; ²General Motors Corporation

Laser welding assisted by GTAW preheating is introduced for welding of galvanized DP 980 in gap-free lap joint configuration. The controlled heat management during the preheating by GTAW will transform the zinc coating at the top surface into the zinc oxides, which will dramatically improve the coupling of the laser power to the welded material. The keyhole is readily formed with the help of zinc oxides, which allows the high-pressurized zinc vapor to be vented out. The completely defect-free laser welds have been obtained. Furthermore, a CCD video camera is used to on-line monitor the molten pool. By the analysis of the video film, it is revealed that when the welding process is stable, the keyhole is kept open. However, the keyhole is readily collapsed when the welding process is instable. The results from the micro-hardness and shear tensile tests reveal that the high strength is obtained in the laser welds.

9:50 AM

Uniform Metallic Coatings on High Conductivity Graphite Foams: Ben Poquette¹; Stephen Kampe²; ¹Keystone Materials LLC; ²Virginia Tech

In the late 90's, a novel technique for fabricating high conductivity graphite foam was developed by Oak Ridge National Laboratory. With its unique properties, this foam has shown promise to revolutionize the performance of many commercial and defense related systems not limited to: high surface area electrodes and catalysts supports, power electronics cooling, personal cooling, evaporative cooling, radiators, nuclear reactor core, space radiator, brake and clutch cooling, high temperature bearings, EMI shielding, thermal and acoustic signature management. Until recently, difficulties in joining graphite foam to other materials have hindered its incorporation into current platforms. A technique was developed, through cooperation with ORNL and Virginia Tech, which allows a strongly adhered, uniform metallic coating to be applied throughout the thickness of graphite foam. These metal coatings should serve to both solve existing short-falls (brittleness, lack of joinability, etc.) as well as lend their properties (magnetic, catalytic, etc.) to graphitic foam.

10:10 AM

Microstructural Evolution during Grain Boundary Engineering of Stainless Steel: Benjiman Albiston¹; Megan Frary¹; ¹Boise State University

Grain boundary engineering (GBE) is a method for controlling the microstructure to improve the material properties. The purpose of GBE is to reduce the interconnection of general grain boundaries (i.e., those susceptible to intergranular degradation) and to increase the fraction of "special" boundaries (i.e., those resistant to attack). The objective of the present work project is to modify the microstructure of 316L stainless steel using GBE. An iterative processing technique involving cold working and annealing steps was developed and electron backscatter diffraction (EBSD) is used to characterize the resulting microstructures. The special boundary fraction was increased from 50% to 80%, effectively reducing the size of connected general boundary clusters. The reduced general boundary cluster size makes it more difficult for cracks to propagate through the material. By controlling the properties of the grain boundaries in the material, its performance can be enhanced by increasing its lifetime and reliability.

10:30 AM

Modeling Uncertainty Propagation in Deformation Processes: Nicholas Zabarav¹; Babak Kouchmeshky¹; ¹Cornell University

We will present a non-intrusive method for modeling the propagation of uncertainty in process conditions and initial microstructure on the final product properties and geometry in a deformation process. The stochastic multiscale deformation problem is modeled using a sparse grid collocation approach that allows the utilization of a deterministic simulator to build interpolants of the main solution variables in the stochastic support space. The ability of the method in estimating the statistics of the macro-scale properties such as ductility and hardness of the product of the metal forming process is shown through examples featuring randomness in initial texture and process parameters. Comparisons are made with the results obtained from Monte-Carlo method.