TMS

1997 TMS Annual Meeting: Wednesday Abstracts

SYNTHESIS OF LIGHT-WEIGHT METALLIC MATERIALS II: Session VI: Powder Processing (Part II)

Sponsored by: MSD Synthesis/Processing Committee
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Room: 330F

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Session Chairpersons: L. Christodulou, Imperial College, Prince Consort Rd., London SW7 2BP; O. Senkov, University of Idaho, Moscow, ID 83844-3026

2:00 pm

REACTIVE PROCESSING OF ALUMINIUM METAL-MATRIX COMPOSITES: M.J. Capaldi1, J.L.F Kellie2, and J.V. Wood1, 1Department of Materials Engineering and Materials Design, University of Nottingham, UK; 2 London & Scandinavian Metallurgical Co Ltd, Rotherham, UK

Two distinct processes have been used to produce in situ reactions in aluminium in order to form composites with varying amounts and types of additive. The first involves fluoride salt reactions which result in the production of TiB_2 particulate finely distributed in a wide range of aluminium base alloys (both cast and wrought). The particulate concentration is limited to about 12 vol% before problems of inclusion entrapment and porosity become evident. Brief details of the process and properties after conventional and pressure die casting will be reported. The second process uses a self-propagating high temperature synthesis reaction to make carbides, nitrides, borides or mixtures. A particular reaction to be reported will be for A1+TiC. Details of the SHS reactions involved will be correlated with processibility and properties.

2:20 pm

REACTIVE MILLING AND SINTERING OF ALUMINIUM BASE POWDER METALLURGY COMPONENTS: C.C. Degnan, J.V. Wood, Department of Materials Engineering and Materials Design University of Nottingham, UK

A form of mechanical alloying has been employed to create a range of structures in aluminium +X powders. The emphasis has been on partial mixing so that the energy of mixing can subsequently be utilised during sintering. A similar process has been employed to make intermetallica and sintering aids. The prime objective of the work is to allow conventional pressing and sintering to be employed for making high strength structurally sound powder metallurgy components.

2:40 pm

THERMOMECHANICAL STUDY IN COMBUSTION SYNTHESIZED Ti-Ni SHAPE MEMORY ALLOY: F.M.H. Zarandi, K. Sadrnezhaad, Sharif University of Technology, Tehran, Iran 11365-9466

The thermal explosion mode of self-propagating high-temperature synthesis, by which time and energy can be saved and the cast product has the least interstitial contamination and high homogeneity, is used to successfully producing Ti-Ni shape memory alloys. The specimens, after hot and cold rolling, are solution treated and aged. The Rhombohedral(R)-phase transformation is observed in the Ti-50.03 at%Ni alloy. MS(1) and TR(2) have their maximums at aging temperatures of 773 and 723 k, respectively, and rise with Ni-contents. The rate of rising of TR, in aged specimens, depends on the composition and in the Ti-50.33 at%Ni alloy, in spite of the Ti-50.23 at%No alloy, MSis more than AS(3).After cold rolling of solution treated specimens, more than 50 percent reduction in thickness, and aging treatment the rate of variations of MSand AS versus aging temperature decreases and up to aging temperature of 723 k, TR is higher than that is in the not cold worked specimens. Also variations of MSwith amount of old working strains do not show uniform behavior. All Round Shape Memory Effect occurs completely in the Ti-50.33 at%Ni alloy. 1: Start temperature of martensitic transformation; 2: Start temperature of R-phase transformation; 3: Start temperature of reverse martensitic transformation.

3:00 pm

STRUCTURAL METAL FOAMS FROM BONDED ALUMINIUM ALLOY HOLLOW SPHERES: N.E. Naxter, J.K. Cochran, T.H. Sanders Jr., Georgia Institute of Technology, Atlanta, GA 30332-0245

The demand for ultra low density structural materials that are economical is increasing. The feasibility of bonding monosized hollow spheres at points of contact to fabricate net-shaped foams with isotropic properties has been demonstrated. Currently, research efforts are focusing on adapting existing technology developed at Georgia Tech to fabricated low density hollow metal spheres. Spheres are fabricated directly from the melt using a coaxial nozzle process. Molten aluminium is injected through the outer orifice of the nozzle with gas passing through the centre orifice. As instabilities form on the liquid jet, surface tension serves to pinch off hollow monosized spheres Parameters such as melt and nozzle temperature, liquid and gas flow rates, and temperature gradient of the drop zone are controlled. As in-depth study relating sphere cooling rates to microstructural evolution and corresponding mechanical properties has been undertaken and the results of these investigations will be the subject of this presentation.

3:20 pm

EFFECT OF THE FABRICATION METHOD ON THE AGING BEHAVIOR OF 6061 Al COMPOSITES REINFORCED WITH 20 VOL% SiC WHISKERS: S. Ryu1, Y. Choi2, S.S. Cho3, H. Kwon3, S.I. Hong4, 1Tongyang Nylon Co. Ltd., Ulsari Kyungnam, Korea; 2Sunmoon Univ., Asari, Chungnam, Korea; 3Kookmin University, Seoul, Korea; 4Chungnam National University, Taedok Science Town, Taejon, Korea

Age hardening behaviors of SiC whisker reinforced composites with 6061 Al matrix fabricated by powder metallurgy and squeeze casting were investigated to examine the effect of the fabrication method on the aging kinetics. In squeeze cast composite, numerous triangular particles which is believed to be $MgAl_2O_4$ were observed at Al/SiC interfaces whereas no visible interface particles were observed in P.M. composites. P.M. composites showed faster age hardening and reached the maximum hardness earlier than in squeeze cast composites. The decrease of the aging kinetics in squeeze cast 6061 Al matrix composites compared to that in P.M. composites is thought to result from more severe depletion of Mg atoms due to interfacial reactions in squeeze cast composites. The uniformity of whisker distribution is suggested to influence the general aging behavior through its effect on the local dislocation density. Data on the aging kinetics and the interfacial reactions in other Al alloys were also examined to study various factors which can influence the aging kinetics.

3:40 pm BREAK

4:00 pm

SOLIDIFICATION BEHAVIOURS AND POWDER MAKING MECHANISMS OF THE EMULSIFIED METALLIC POWDERS: Chang-ki Min, Kyong-tae Nam, *Woo-young Yoon*, RASOM, Dept. of Metallurgical Engineering, Korea University, 1,5 Ka, Anam-dong, Sungbuk-ku, Seoul, 136-701, Korea

New metallic powder making processes, named "Centrifugal Emulsification Process (CEP)" and "Mixer and Settler (MS)" have been developed to synthesize rapid solidified metallic powders. The underlying principle of CEP and mS was to emulsificate the liquid metals with inorganic oil (or salt) using centrifugal force. Through CEP and mS processings, the high temperature metals as well as the low temperature alloys are fabricated. The mean particle size and size distribution could be controlled by various processing parameters that could be managed easily. The morphology of the particles could also be customized using spherodization vs. Solidification time ratio in CEP. The powder formation mechanisms in CEP and MS were rationalised through the energy balance between the input energy by centrifugal force and the increment of total surface energy of metallic liquids. The calculated mean size of powders agrees relatively well with that of the experiments. Also, the effects of rapid solidification undercooling, solidification rate and crystallisation behaviours can be evaluated effectively through the processes. The possibility of the customised not only size and morphology control but microstructure control was also shown. Both of the new methods can be applied to continuous powder making processes without oxygen contamination.

4:20 pm

Ti-6A1-4V HOLLOW SPHERE FOAMS: *C. Uslu*, J.K. Cochran, K.J. Lee* and T.H. Sanders, Jr, Georgia Institute of Technology, Atlanta, GA 30332-0245: *Ceramic Fillers, Inc., Atlanta, GA 30318

Structural foams, formed to near-net-shape by bonding monoxides hollow metal spheres at points of contact, offer the possibility of strong, light-weight, reasonably priced materials. The technology of making titanium hollow sphere foams has been developed using the coaxial nozzle powder slurry technique. Titanium hydride hollow powder spheres of 3 mm diameter and 20 mm wall thickness were fabricated from a high solids content acetone slurry. The powder shells were controlled atmosphere sintered and point contact bonded using the initial alloy hydride powder to form hollow sphere foams that were 20% of theoretical density. The sphere wall microstructures obtained by pressureless, solid-state sintering of the hydride alloy were compared to the conventional alloy microstructures and quantitative measures of sintering kinetics were established. Initial mechanical properties such as compressive yield strength and modulus will also be considered.

4:40 pm

METAL FOAMS FROM FUGITIVE BURNOUT: *A.R. Nagel*, J.K. Cochran, T.H. Sanders, Jr, K.J. Lee*; MSE-Georgia Institute of Tech Atlanta GA, 30332-0253; Ceramic Fillers Inc., Atlanta, GA

Metallic foams are being made from powders using naturally occurring organic fugitive burnout material. Most forms are fabricated by introducing pores from a gas phase into a liquid system. This tends to produce pores of irregular cell size due to pore coalescence. The object of this effort is to introduce porosity utilising a fugitive solid phase to allow greater precision in forming pore systems. The foams being investigated are nickel and titanium alloys formed from slurries with starches as the fugitive materials. Starches are inexpensive and clean burning sacrificial materials. Because replication of fugitive starches requires fine particle size powders, brittle precursor powders (i.e. metal hydrides or oxides) are initially used to form the foam and subsequently decomposed or reduced to form metallic foams. Using particle packing and theological theories, the percolation value of closed cell porosity should be increased, and the microstructure of the foam should be made more uniform. Porosity and mechanical properties are being characterised for comparison to other forma geometries.

5:00 pm

MODELING AND CONSOLIDATION OF NANOCRYSTALLINE ALUMINUM: J.S. Idasetima, R.B. Bhagat, M.F. Amateau, The Pennsylvania State

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The consolidation of nanograined powder metals presents a major problem of grain growth to micrometer size thereby lowering the potential benefits expected of the nanocrystalline microstructures. The aim of this investigation is two fold: (a) to present our results of consolidating nanograined alumium powder in conjunction with process modeling using Ashby's HIP program. The preliminary modeling results suggest that the nanograined aluminum powder can be consolidated into full density with minimal grain growth without using any grain growth inhibitor by optimizing combined sintering and vacuum hot pressing. The predicted hot pressing temperature for aluminum nanopowders (20-200 nm) ranges from 300 to 400 K for a fixed pressure of 19 MPa; time being less than 10 minutes. Boundary diffusion mechanisms dominate in both stage 1 and stage 2 of the densification. The as-received nonograined powder and the fabricated specimens have been characterized by optical, scanning, and transmission electron microscopy, x-ray diffraction and microprobe analysis. Density and microhardness of the consolidated specimens are also reported and discussed.
