

Processing, Properties, and Performance of Composite Materials

Here are four of the more than 60 presentations during these Composite sessions at MS&T 2008 in Pittsburgh, Oct. 5 - 9. For more details, visit www.matscitech.org.

Reinforcement of Aluminum

by AlB₂ Flakes at

High Volume Fractions and Alignment

Jacob Meyer, University of Illinois at Urbana-Champaign

High aspect-ratio aluminum diboride (AlB₂) single-crystal flakes have been shown to provide effective reinforcement to an aluminum matrix with strength and modulus values increasing with volume fraction and degree of flake alignment. High aspect-ratio flakes were prepared from a commercial material consisting of low aspect ratio AlB₂ in aluminum, by heating near the peritectic temperature of 956°C.

The flake volume fraction was increased by filtration at 675°C, and alignment was increased by melt shear and hot pressing. At 30 vol%, a 95% increase in modulus was observed over the matrix material to 125 GPa, with similar increases in the flexural and tensile strength. Melt shear and hot pressing have been observed to improve the alignment from 0.21 at 30 vol% to over 0.55. With these enhancements to the alignment, a modulus of 149 GPa and flexural strength of 273 MPa were achieved. These results demonstrate that highly aligned AlB₂ flakes provide excellent improvements to the strength and modulus of an aluminum matrix.

Review: Self-Healing Composites

Eyassu Woldesenbet, LSU and Southern University

The growing interaction between biological and material sciences is leading researchers to incorporate biomimetic features into newly developed materials. The study of self-healing materials is inspired by biological systems in which damage triggers an autonomous healing response. The field of self-healing now involves several disciplines, including biology, chemistry, mechanics, and materials science and engineering. In the late nineties, suggestions were made that autogenous healing of cracks in concrete is possible with water permeability. However, the first report of a manmade self-healing material was made in 2001, when microcapsules filled with healing agent were dispersed within an epoxy matrix incorporating a catalyst in suspension. Since then, advances have been made in self-healing composite materials, all demonstrating self-healing functionality in engineering materials. Currently, new concepts are being developed, such as hollow fibers and microvascular networks.

Processing and Properties of Syntactic Foams

Nikhil Gupta, Polytechnic University

Syntactic foams are hollow particle-filled composites. The importance of these lightweight materials for industrial applications is rapidly increasing because they can lead to significant reduction in structural weight, result in saving of energy in transportation and service, and can be tailored for specific properties. The processing techniques, properties, and applications of syntactic foams are discussed in this paper. Use of industrial waste materials such as fly ash hollow particles in synthesizing syntactic foams presents possibilities for making environmentally friendly composites. Such possibilities are also discussed in terms of their effect on cost and energy. New possibilities exist in designing these materials for shock resistant and highly damped components. Additionally, recent advances include developing functionally graded and smart syntactic foams. These possibilities have long term impact on the applications of lightweight materials for industrial applications.

Sliding Wear and Damping Characteristics of Fly Ash Reinforced

A356 Al Matrix Composites

M. Surappa, Indian Institute of Science

Sliding wear characteristics of 6 and 12 vol.% fly ash-reinforced A356 aluminum alloy composites have been studied with a pin-on-disk machine. Tests were done with loads of 10, 20, 50, 65, and 80 N at a constant sliding velocity of 1 m/sec. Composites were made by the stir cast route and subsequently hot extruded. Results show that the dry sliding resistance of Al-fly ash composite is similar to that of Al₂O₃ or SiC reinforced aluminum alloy. Composites exhibit improved wear resistance compared to unreinforced alloy up to a load of 80 N. Particle size and volume fraction of fly ash particles significantly affect the sliding wear and friction characteristics of composites. At high loads (>50N), where fly ash particles act as load-bearing constituents, the wear resistance of A356 reinforced with a narrow size range (53 to 106 μm) fly ash particles was superior to that of the composite having the same volume fraction of particles in the wide range (0.5 to 400 μm).

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