J Mater Sci (2009) 44:1425–1426
DOI 10.1007/s10853-009-3328-8

Preface

G. M. Gladysz · K. K. Chawla · A. R. Boccaccini

Published online: 26 February 2009

A conference titled *Syntactic and Composite Foams*, under the auspices of Engineering Conferences International (ECI), was held in August 2007 in Davos, Switzerland. This conference was the second in the series, the first one was held in Banff, Canada, in 2004. Papers from that conference were published in Journal of Materials Science (Volume 41, Number 13). These conferences, both under the auspices of ECI, have provided an excellent forum for discourse among scientists and engineers from the academia, industry, and research laboratories on the subject of syntactic and composite foams.

Composite foams are cellular materials consisting of a binder phase, reinforcing/functional phase(s), and voids distributed evenly throughout. The reinforcing phase can be solid or hollow. *Syntactic foams* are a particular type of composite foam. In this case the reinforcing particles are hollow microspheres also called microballoons with a polymer, metal, or ceramic binder material.

Composite foams in general are multifunctional materials. The fact that they are foams, i.e., contain voids, suggests that they are suited for specific applications such as those requiring low density and/or bio-scaffolding. The incorporation of functional phases (fibers or particles) or microballoon shell material can tailor to another property: mechanical, thermal, electrical etc. In syntactic foams, the presence of hollow microspheres results in a foam of low density, high compressive strength, and generally a low thermal expansion coefficient. These foams are typically used in applications that take advantage of their very high specific properties, pore structure, and energy absorbing characteristics. If reinforcing and/or functional phase is added to a foam, we get a composite foam with some other desirable characteristics. These additions expand the potential applications beyond that of the traditional deep sea buoyancy into more complex structures. But in general, composite foams represent a distinct improvement over the conventional blown polymer foams, inasmuch as one can have the ability to control the resulting microstructure to meet specific applications.

This second conference in Davos, Switzerland, brought together leading researchers, manufacturers, and users of these materials. This conference provided a very valuable forum for discussions on the growing field of composite foams: aerospace, automotive, communications, biomedical, electronics, sporting, and transportation industries. The papers included in this special section cover the production and characterization of microballoons, foams made from them, functional foams for specific applications as well as fabrication, characterization, modeling, and applications of the foams. Below we provide some highlights from the presentations and papers.

- Ceramic/elastomer composites can be made by infiltrating porous ceramic preforms with an elastomer. Such composites show three-dimensional connectivity of phases and very desirable mechanical properties such as impact resistance and damage tolerance. Typical composite foams of this type can be made by infiltrating silica foam with a polyurethane elastomer.

G. M. Gladysz
Trelleborg Emerson Cuming Inc., Mansfield, MA 02048, USA

K. K. Chawla (✉)
Materials Science & Engineering, University of Alabama at Birmingham, Birmingham, AL 35209, USA
e-mail: kchawla@uab.edu

A. R. Boccaccini
Department of Materials, Imperial College London, London SW7 2BP, UK

Compressive strength and energy absorption of such composites were characterized as a function of strain rate and specific interface area. Parameters such as pore size and specific interface area can be used to tailor the mechanical properties.

- A relatively inexpensive processing technique (sintering in an inert atmosphere with a fugitive space holder) was used to produce titanium foams. Space holder was dissolved in hot deionized water. The energy absorbed per unit volume can be predicted as a function of relative foam density of different strains.
- Glass microballons (GMBs) have been predominantly used as filler materials since their development in the mid-twentieth century; the improved properties that have been realized are opening new applications. Beyond the traditional applications that incorporate GMBs into various composites, these materials are being considered for applications in which functional coatings are applied and the GMBs are not bound within a composite matrix. One of these exploits the heterogeneous photocatalytic capabilities of titania. Uses of photocatalytic characteristics of titania films and particles have been extensively documented in the literature. An innovative method of making titania-coated GMBs for water purification and wastewater treatment is quite promising. The use of GMBs as a substrate has the advantage of providing large surface area to volume ratios, while having low densities. The low density of the coated GMBs allows them to float on water, thus simplifying their separation in industrial scale processes, while simultaneously positioning them on the surface of the water where ambient UV radiation is strongest. Additional benefits of the system include the nontoxic nature of titania, the use of ambient solar UV radiation as an energy source, and the fact that titania, being a catalyst, is not consumed in the reactions.
- There is growing interest in using foam-like material structures with high porosity and pore interconnectivity in the biomedical field, specifically for scaffolds in tissue engineering. Composite foams with pore size ~ 300 μm and >95% porosity exhibiting bioactivity have been fabricated using a biocompatible ceramic, such as TiO_2, coated with polymer-bioactive glass layers. The biodegradable polymer layer, e.g., poly-(D,L-lactic acid) (PDLLA), increases the compressive strength of the ceramic foam, suggesting that the polymer phase acts as bridging element impeding crack propagation within the struts of the foams. The results confirmed the potential of these scaffolds for bone tissue engineering applications.
- The conference concluded with round table discussions on the broad range of topics with the goal to build partnerships between research and development, manufacturers, and users. Some of the topics included:
  - Bio applications
  - Deep sea applications
  - Testing/characterization techniques
  - Processing and performance
  - Emerging applications
  - Emerging materials

The move in industry is for increasing functionality; whether for reduced weight for fuel saving or for optimum functionality of biocompatible structures. With focused research and development and a growing awareness on the part of mechanical designers, the uses of composite foams can expand quickly. This is the message that came out of this conference on *Syntactic and Composites Foams*.

Conference organization

The conference was chaired by Dr G. M. Gladysz (Trellborg Emerson & Cuming, Inc. Mansfield, MA, USA), Professor K. K. Chawla (University of Alabama at Birmingham, Birmingham, AL, USA), and Professor A. R. Boccaccini (Imperial College, London, UK). An international organizing committee with representatives from universities, industries, and government laboratories was involved in reviewing the papers for publication in this special section of Journal of Materials Science.

Acknowledgments We acknowledge the generous support, financial and otherwise, of the following organizations and people: Engineering Conferences International; we are especially grateful to Ms Barbara Hickernell and Mr Kevin Korpics (both of ECI) for their help; US National Science Foundation—Dr H. D. Chopra, Dr B. A. MacDonald; and Trelleborg Emerson & Cuming, Inc. Last but not least, we are grateful to all the participants for making this event a great success.