ADVANCED ENGINEERING MATERIALS

Germany

How Large is the Place?

The past few years have seen an increasing interest in porous metallic materials, especially in foams made of aluminium or aluminium alloys. The stimulus for this lies in recent process developments which promise materials with better quality and lower cost. Moreover, the environment for the application of new materials has greatly changed. Nowadays higher demands for passenger safety in automobiles or for easy materials recycling make metal foams attractive where, a few years ago, the same materials would have been ruled out for technical or economical reasons.

A number of companies in Europe, Japan, and North America now produce aluminium foams in commercial quantities. Many companies are evaluating their possible structural and functional applications. Universities and research institutes have initiated major characterisation programmes, and design issues are being addressed. Metal foam research work is now sponsored on a large scale by governments. Presently there are two European projects (BRITE-EuRam), a Multidisciplinary University Research Initiative (MURI) in the USA, and various national projects which are focusing on the evaluation and further development of production processes, characterisation of properties and the investigation of possible applications.

The conference "MetFoam '99" held in Bremen in June 1999 provided a forum for researchers active on the field of porous metallic materials as well as for industrial materials engineers and product designers seeking new materials to solve specific problems. MetFoam'99 focused on the advances of production and manufacturing technologies for metal foams, on the understanding of the fundamental relationships between their structure and their properties, and on the exploration of potential applications.

With about 150 participants from 18 different countries the conference was a very successful event. The 65 papers in the conference proceedings represent the current knowledge of most of the researchers who currently work in this fast growing research area. The editors wish to provide a selection of these articles to the readers of "Advanced Engineering Materials" to demonstrate the potential which lies in this class of materials.

The first block of presentations at the conference was entitled "Applications and Industrial Use" and contained 8 papers. As at the moment the driving force for the development of aluminium foams is the automotive industry, the conference was opened with several contributions from this industrial sector. The work of FIAT in collaboration with the University of Trondheim represents this group in this series of articles. As cost estimations plays a crucial role in the industrial implementation of a new technology this issue is addressed in a paper from Cambridge University.

A second block of papers labelled "Production and Processing" was devoted to the wide spectrum of manufacturing methods for cellular metals and ways to process them. With 23 contributions this was a strong group. Powder compact, liquid foaming and sintering methods were given almost equal coverage. In this issue of AEM an overview and a comparison of the methods available is given by the group at the University of Erlangen, after which seven articles go into further detail: contributions by the German Schunk GmbH that commercialises the powder compact method in collaboration with the Fraunhofer Institute in Bremen, by Cambridge University with a novel liquid state foaming process, by the Japanese Shinko Wire Ltd. producing foam from liquid aluminium, by research groups from Nagoya and Osaka that make ultra-light magnesium structures by casting, by Fraunhofer Institutes in Bremen and Dresden with cast aluminium sponges and sintered hollow sphere structures and finally, the group at the research centre in Jülich that has developed highly porous titanium materials.

The third and largest block of the conference contained 34 papers on "Characterisation and Properties" of cellular metals. For AEM a group at Harvard University presents a method for characterising the complicated plastic deformation phenomena in aluminium foam. The helicopter company "Eurocopter" investigates fatigue failure of foams. Finally, there are two contributions on the behaviour of composite structures made of metal foam and dense metal: the group at Cambridge University treats the bending of sandwich structures with an aluminium foam core, whereas a group at Massachussets Institute of Technology evaluates the crashworthiness of aluminium foam filled steel tubes.

Any material innovation must, sooner or later, establish a foothold in the real world - meaning a profitable application - if it is to survive. The future of metal foams depends on their finding profitable applications in the near future. Interestingly, it is not the cheapest, but the most expensive foams (those manufactured by ERG) that have so far had the greatest commercial impact, exploiting their very low weight combined with unique heat-transfer and mechanical properties. The lower cost, closed-cell, structures, most of them based on aluminum, have yet to achieve commercial success. There are several promising avenues, some with sufficient industrial interest to persuade large-scale investors to support them. Among these: low-weight sandwich-structural applications in transport; impact protection and energy management in packaging and automobile safety; and the production of thin-walled castings with foamed cores. There is little question that metal foams have a place in the future of engineering; the question is rather: how large is that place?

John Banhart

Norman A. Fleck

Michael F. Ashby