

## **Book Review**

**Ceramic Containing Systems: Mechanical Aspects of Interfaces and Surfaces.**  
Edited by A. G. Evans. Noyes Publications, New Jersey, 1986. Price: \$36.00.

This volume is a collection of 12 papers covering five aspects of the mechanical behaviour of materials: monolithic ceramics; ceramic matrix composites; ceramic/metal bonded systems; polymers; and water drop impact. The book was prepared from another volume written in 1984. The logic for the selection of topics is no more than the research projects awarded to Professor Evans by the US Office of Naval Research. The Editor is in fact co-author of all the papers.

The first section concerns monolithic ceramics. An analysis is provided of the microcracking in polycrystalline ceramics of anisotropic crystal structure due to the combined influence of residual stresses and applied loads. This leads to the prediction of microcrack densities and hence the stress/strain curves of microcracking materials. This information is then used to consider microcrack toughening, involving computations of the fracture toughness from the stress/strain data. Toughness variations with grain size are discussed in terms of the model. Discussion then turns to a thermal stressing technique to evaluate surface and corner flaw populations in barium titanate multi-layer capacitors. Corner flaws are identified as the major source of failure during typical in-service thermal cycling.

The second section deals with ceramic matrix composites. Unidirectional silicon carbide fibre/glass ceramic composites were investigated during tensile and bend loading. Behaviour is discussed in terms of multiple matrix cracking followed by fibre fracture and pullout. The relevance of

fracture mechanics principles to the systems is discussed, and the principles then applied in more detail to such systems. The matrix cracking stress is calculated from a stress intensity approach, influenced by the fibres that bridge the matrix crack. It is possible to relate the matrix cracking stress with material properties.

Some important aspects of ceramic/metal bonded systems are discussed in the next section. The mechanics of failure are considered and implications for optimised strengths of ceramic/metal bonds are given. Calculations are presented for the residual stresses that develop during cooling of metal/ceramic strips. A second geometry considered, as relevant to micro-electronics packaging systems, is a cylindrical metal cylinder through a ceramic matrix.

In the fourth section attention is turned to polymers, with discussions of the mechanisms of toughening in rubber-toughened polymers and of the toughness of particulate-filled polymers. Quantitative predictions are made for various toughening mechanisms which should aid the development of tougher materials. The co-authors of the papers in this section appear to be associated with the University of Cambridge, England, although no acknowledgement of this fact is given.

The final section is concerned with water drop impact. A computer simulation is given for the impact damage process which gives information about the crack patterns in the impact zone. Further theory estimates the inner radius of the crack damage field during impact, and this is expressed as a function of drop size, impact velocity and Rayleigh velocity of the target.

Each of the papers presented is a good balance between background theory, which is generally developed expressly for the topic under consideration, and a comparison with relevant experimental data. The volume is a clear testament to the innovative and broadly based research interests of Professor Evans. As a book it must be regarded less favourably and of rather limited usefulness. Much of this work, in some form or other, has been published independently in the technical literature. The breadth of subject matter is unsuitable for a single subject volume (although probably no more varied than some conference proceedings). The publishers claim that advanced composition and production methods and special techniques have been used as aids to speed of production and reduction in costs. This involves use of camera-ready text but the papers are produced in a wide range of styles and the general result is extremely untidy. The reproduction of photographs is particularly poor; these and a lot of the text give the impression of a second or third generation photo-copy.

**R. W. Davidge**