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Engineering Fracture Mechanics 69 (2002) 1519–1520

Engineering Fracture Mechanics

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Editorial

Fracture of functionally graded materials

Scientific research on functionally graded materials (FGMs) considers, in a large sense, functions of gradients in materials comprising thermodynamic, mechanical, chemical, optical, electromagnetic, and/or biological aspects. In essence, FGMs are characterized by spatially varied microstructures created by non-uniform distributions of the reinforcement phase with different properties, sizes and shapes, as well as by interchanging the role of reinforcement and matrix materials in a continuous manner, as illustrated by Figs. 1 and 2. The second figure shows an example of a large-bulk ceramic/metal engineering FGM. This new concept of engineering the material microstructure marks the beginning of a paradigm shift in the way we think about materials and structures as it allows one, due to recent advances in material processing, to fully integrate material and structural design considerations.

In the present edition, a collection of technical papers is presented that represents current research interests with regard to the fracture behavior of FGMs. The papers include a balance amongst theoretical, computational, and experimental techniques. All the participants have contributed to advancing the state of knowledge in FGMs, and this special issue demonstrates that our understanding of fracture of FGMs is becoming increasingly clear. However, it also indicates areas for further development, such as constraint

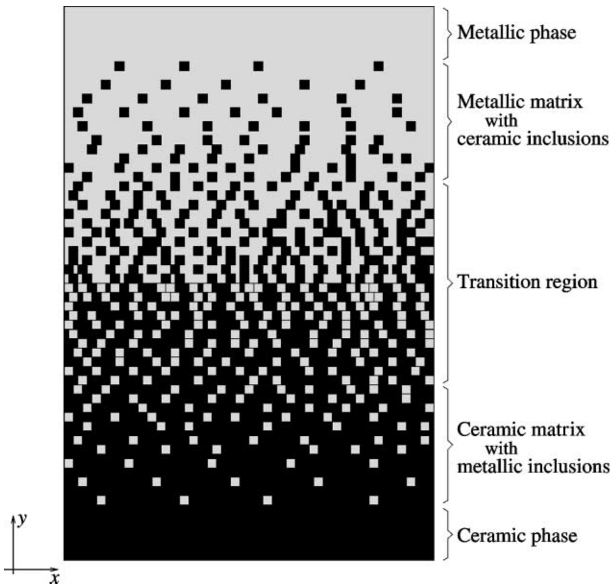

Fig. 1. Schematic illustration of an FGM with continuously graded microstructure.

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PII: S0013-7944(02)00045-0

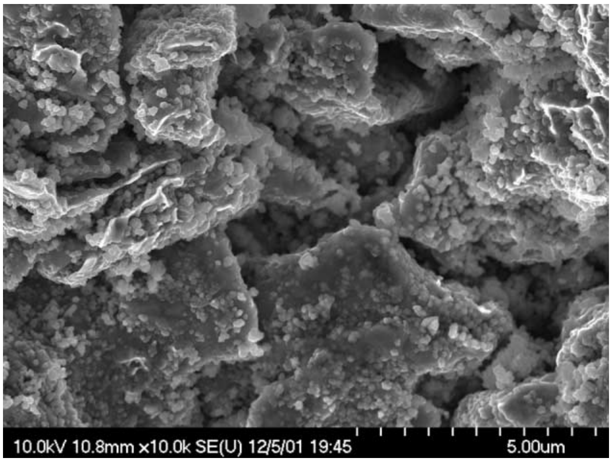

Fig. 2. Detail of an 11-layer ZrO_2(3Y)/stainless-steel FGM of 100 mm diameter and 15 mm thickness. The illustration above is a scanning electron micrograph (SEM) of a layer containing 10% zirconia and 90% stainless-steel volume fraction. Notice the submicron ceramic particles clustered around the metal microparticles. The material was synthesized using spark plasma sintering technique (SPS) by Sumitomo Co. (Japan). The SEM was obtained by graduate student Zhaoxu Dong at the Center for Microanalysis of Materials, University of Illinois, which is partially supported by the US Department of Energy under grant DEFG02-96-ER45439.

effects full (i.e. for the entire range of material composition) experimental characterization of engineering FGMs under static and dynamic loading, development of fracture criteria with predictive capability, multiphysics and multiscale (space and time) failure considerations, and connection of research with industrial applications. In fact, this latter aspect needs to be emphasized so that FGMs can find wide use in engineering applications.

The Editor would like to thank Prof. Dodds for his invitation to assemble this set of papers on Fracture of FGMs, the authors and reviewers for their scientific contributions and constructive criticism, and the staff of Elsevier for their timely publication of this special issue.

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