Overview

The implementation and usage of tailored engineering materials in structural and engine design requires our understanding of their cyclic deformation behavior and fracture resistance. With such knowledge, we can proceed to determine the mechanistics of material response to service environments and establish inspection procedures and intervals commensurate with consumer usage. This particular symposium, which is the first of several planned on this topic, was outlined to encompass the cyclic deformation and fracture of advanced metallic, ceramic and polymeric monolithic, and composites, as well as methodologies for nondestructive evaluation of these same material systems. Such a joint venture required the cooperation of Subcommittees E9.03 on Fatigue of Advanced Materials and E9.01.07 Research on Nondestructive Evaluation of Advanced Materials.

Organization of presentation first covers crack initiation and propagation in monolithic and composite ceramics principally at elevated temperatures. Several interesting ramifications of phase changes occurring at high temperatures and their influence on smooth and notched fatigue behavior are examined. Contributions of matrix cracking, fiber bridging and pull out, and their effects on crack propagation are explained. Experimental methodologies and techniques for these "difficult to test" materials as well as short/long fatigue crack propagation threshold behavior is discussed. Modeling of crack growth resistance in ceramic and ceramic matrix composites is followed by constitutive modeling of a metal matrix composite for cyclic, isothermal, and thermomechanical behavior.

Initiation and growth of cracks are discussed for an in situ metal matrix composite (MMC). The influence of mean stresses on the fatigue behavior of single crystal and directionally solidified (DS) alloys as well as crack resistance and toughness of light weight alloys are presented in two subsequent papers.

Constituent properties of a polymeric laminate with discontinuities is followed by creep effects in bonded polymer composite joints and the interpretation of test information for residual strength and life prediction of composite systems complete the cyclic deformation and fracture portion of this STP. The latter presentation by K. L. Reifsnider of Virginia Polytectnic Institute and State University received "Best Paper" award for this symposium.

The final topic covered in the symposium was nondestructive evaluation (NDE) of tailored materials. About fifteen years ago, NDE began to evolve from testing with improved instrumentation along with a better understanding of materials behavior. NDE aims to detect and characterize flaws and microstructural changes in materials, and based on consideration of physical mechanisms controlling materials behavior in a specific application, to predict future performance and reliability of the component. In the present publication, ultrasonic surface wave and acoustic emission techniques are applied to monitor cyclic fatigue damage (microcracks) in whisker reinforced metal matrix composites and homogeneous materials. The so-called acousto-ultrasonic technique (a sophisticated form of the well-known "coin-tapping") as well as acoustic microscopy are used to determine damage due to monotonic loading of ceramic composites. Finally, one paper describes the application of eddy current in combination with ultrasonic techniques for process control of metal-matrix composites, with the possibility to provide *on-line*, closed-loop control of the fabrication parameters.

The symposium chairmen affably acknowledge the authors and reviewers of manuscripts. Their participation as well as that of the ASTM staff has made this publication possible. It is hoped that the subject matter of this symposium will generate interest and stimulate

participation in the sponsoring ASTM committees. We welcome your cooperation and contributions to the Second Symposium on Cyclic Deformation, Fracture, and Nondestructive Evaluation of Advanced Materials planned for November 1992, in Miami, Florida.

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