Preface

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In October of 1996, a symposium on “Advances in Failure Mechanisms in Brittle Materials,” was held at the ASME International Conference and Exposition, in Atlanta, GA. The symposium, co-sponsored by the Materials and Applied Mechanics Divisions, addressed the need for identification and modeling of failure initiation and growth in structures and machine components made of high strength polycrystalline brittle materials and fiber composites. Several methodologies were presented ranging from the derivation of thermodynamically consistent constitutive equations, calculation of interface crack stress fields, the use of impact experiments to examine the loss of shear resistance in glass ceramics, molecular dynamics calculations of brittle fracture, statistical aspects of brittle fragmentation, the measurement of penetrator tail velocities during penetration, the use of computer vision to obtain full field displacement maps during damage and failure, and finite element modeling of impact damage in brittle and quasi-brittle materials.

In this special issue of Mechanics of Materials, full length papers of topics presented at the symposium are published. The contributions are grouped into the following areas.

Mechanisms for crack initiation and propagation are presented for three different deformation fields. First, sliding microindentation of brittle materials is investigated by examining the stress field under the indenter. Conditions for the initiation and propagation of lateral and median cracks are examined. Second, crack initiation by damage of multimeaterial joints is studied using a thermodynamically consistent constitutive law with damage and the complex potential method. Third, threshold conditions for dynamic fragmentation of ceramic particles are investigated using particle-impact experiments and high speed photography. Analyses of the experimental results in the context of dynamic interface cohesive laws are discussed. Insight into the validity of various cohesive laws is obtained.

Compressive and shear strength of brittle materials are reviewed with a particular emphasis on inelastic deformation mechanisms (crystalline plasticity and brittle fracture), kinetic and viscous effects, and in-material stress and velocity measurement techniques particularly suitable to impact recovery experiments.

The effect of a glassy phase on high strain rate material response and fatigue life is investigated through pressure-shear impact experiments and compression fatigue life modeling of ceramic microstructures containing amorphous grain boundary phases.

Modeling of wave propagation experiments in ductile and brittle materials is accomplished by means of new computational tools such as mesh adaptivity, consistent transfer operators of field variables, dynamic contact/interface laws with finite kinematics, and a multiple-plane microcracking model for brittle failure.

Applications include the use of thermomechanical damage models to estimate spallation time of airfield concrete pavements under very rapid heat-
ing and cooling processes due to high temperature exhaust gas from vectored thrust engines, and the prediction of failure in bolted joints used in composite materials. In the later application, a fiber microbuckling failure criterion is presented including the effect of nonlinear matrix stress/strain behavior.

It is hoped that this publication of current and on-going research will provide valuable insights and perspectives to a wide range of researchers and design engineers with interests in the general area of brittle failure.

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