RECENT ADVANCES IN DYNAMIC FAILURE MECHANICS

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ABSTRACT

A brief overview of the mini-symposium on Advances in Dynamic Failure Mechanics is provided. Major areas of research and key issues, as well as implications to a wide variety of technological problems, spanning several scales, are included. An overview of research in dynamic failure mechanics supported by the Solid Mechanics Program of the Office of Naval Research (ONR) is also provided.

Dynamic failure processes are extremely complex events, and there is active research in establishing an improved understanding of the response of materials (metals, polymers, ceramics, composites), devices, and structures (including sandwich structures), to dynamic/impact loading leading to damage and failure, and on the need to control these failure processes through a variety of approaches. At a different scale, recent attempts to understand certain phenomena related to earthquakes, have shown the existence of exciting synergisms between laboratory studies of dynamic failure in layered materials and composites, and failure processes in the earth's crust resulting in earthquakes.

This mini-symposium will explore the mechanics of physical processes involved in these dynamic failure events at a multitude of scales. It includes innovative experimental approaches to the delineation of highly dynamic events in real time, leading to an improved understanding of these processes, and to the establishment of physically based models for these processes. It also includes recent advances in computational approaches to the simulation of dynamic response and failure in materials and structures.

An overview will also be provided of recent research in failure and fracture of solids, with the focus on the dynamic response and failure of structural materials, supported by the Office of Naval Research. It will include discussions of: the rationale for investments in dynamic failure research; assessments of critical research issues; recent research accomplishments; and directions of future research.

Naval structures operate in severe environments, and are designed to withstand complex multi-axial loading conditions, including highly dynamic loadings. The effective design of these structures requires an understanding of the deformation and failure characteristics of structural materials. The Office of Naval Research supports research addressing some of the basic issues in the dynamic failure of homogeneous, heterogeneous, functionally graded, laminated and sandwich structures comprised of brittle and/or ductile, metallic and nonmetallic materials. Experimental, analytical and numerical studies are being pursued by leading researchers, with the goal of elucidating and quantifying physical processes, identifying dominant controlling mechanisms, and providing guidance for the optimum use of materials, and for the design of reliable structures.

A recent development is the increasing use of composite materials and composite sandwich structures in marine applications, due to many attractive attributes, including reduced life-cycle costs. Key aspects of the dynamic response and failure of these systems are being explored, including: dynamic constitutive equations and strain rate effects, dynamic failure modes, mode coupling, dynamic failure criteria, and dynamic fracture toughness. The material systems studied include polymer matrix composites (glass and carbon/vinylester), sandwich core materials (foam core, balsa wood core), and nanocomposites. The utilization of full field optical experimental techniques (e.g. Coherent Gradient Sensor Technique), coupled with high speed photography (up to 100 million frames per second), in studies of dynamic fracture in solids with interfaces, have revealed the existence of intersonic crack propagation. These studies have provided insights into the dynamics of certain classes of earthquakes, thereby providing synergisms between solid mechanics and seismology.