Overview

Fractography is the detailed analysis of a fracture surface to determine the cause of the fracture and the relationship of the fracture mode to the microstructure of the material. Fractography techniques are used, for example, to identify the origin of a crack and to determine what type of loading caused the crack to initiate. They are also used to establish the direction of crack propagation and the local loading mode which drove the crack. Fractography is, perhaps, the most important analytical approach used by materials scientists in attempting to establish structure-property relationships involving strength and failure of materials.

The science of fractography has been developed into a tool which can be applied to all phases of material investigation. It plays a key role in the failure analysis of established materials. Fractography can also provide useful information in evaluating new materials and in defining their response to mechanical, chemical, and thermal environments.

The technological challenges of recent developments in the aircraft, power generation, and communications industries have led to the development and application of numerous advanced, high-performance materials. These include carbon fiber-reinforced composites, high-strength steel and nonferrous alloys, and superalloys. In addition to design requirements which demand increased strength and stiffness, these new materials are often subjected to harsh fatigue and environmental conditions which may limit their lives. Unfortunately, the development of the fractographic data required to interpret the failure modes of these materials has not always kept pace with their rapid advancement.

The objective of the Symposium on Fractography of Modern Engineering Materials was to provide a forum for presentation and discussions of results of fractographic investigations of these emerging materials. An excellent overview of this topic was presented by Professor R. W. Hertzberg of Lehigh University in his keynote address entitled "Fracture Surface Micromorphology in Engineering Solids."

In addition to the keynote address, 22 papers were presented at the symposium, which was jointly sponsored by ASTM Committees E24 on Fracture Testing and D30 on High Modulus Fibers and Their Composites. These presentations were divided equally between the fractography of metallic and composite materials. The bulk of the work presented on the latter topic discussed failure of continuous fiber graphite/epoxy material systems. This included several presentations on delamination propagation in these

materials. The effects of impact and radiation damage on these systems and the fracture surface characterization of notched laminates were also reviewed. The fractography of ferrous alloys comprised the majority of the papers presented on metallic materials. This included discussions of the fractography of steam turbine blading steels, steel weldments in pressure vessels, fatigue damage in carburized steel, and ductile-brittle transition in austenitic stainless steels. In addition, papers were also presented on fatigue crack growth in Inconel and high-strength aluminum alloys and on hydrogen-assisted cracking in titanium alloys.

The expanded use of all of these materials and the increasingly severe loading and service environments to which they are exposed necessitates a thorough knowledge of their fracture behavior. This is particularly true, for example, of composite materials since they are now being used in primary structural applications in the aircraft industry. The ability to correctly interpret the material's fracture mechanisms and to define component failure modes is critical in determining air worthiness and in investigating in-service component failure. The situation in this case is further complicated because these materials exhibit failure modes not normally encountered in metallic materials due to their anisotropic and heterogeneous nature.

It is hoped that the papers presented in this volume will aid investigators conducting failure analyses of advanced composite and metallic materials. It is also hoped that additional symposia will be held as this body of knowledge continues to be developed.

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