Introduction

Two related, but separate, disciplines have been brought together in the ASTM Symposium on Delamination and Debonding of Materials, held in Pittsburgh, Pennsylvania, on 8–10 November 1983. ASTM Committees D-30 on High Modulus Fibers and Their Composites and E-24 on Fracture Testing sponsored the event. The two disciplines, delamination of composite materials and debonding of adhesive joints, both essentially involve the separation of materials held together by polymer resins. The differences between the delamination and debonding problem become even less distinct when one considers that a composite is nothing more than a complex adhesive joint that bonds high-strength fibers together in an orderly, predetermined arrangement.

Both problems are quite complex because of several factors:

- At least two material systems are involved: the polymer resin and the adherend (the fibers for composites).
- The path of the delamination or debond is usually restricted between the adherends or laminae; therefore a mixture of peel, shear, and tearing stresses may be present at the debond tip.
- A rigorous analytical procedure involving anistrophic and nonhomogeneity is usually required to calculate the stresses influencing delamination and debonding.
- Composites and adhesive joints contain singular stress fields in both the uncracked and the damaged states.

Currently, composite materials are used in a wide variety of high-performance applications, and the number of such applications is expected to increase markedly in the near future. Edge delaminations have been found to initiate at a cyclic stress level of approximately 30% of the static strength of a quasi-isotropic layup. This initiation stress level can be raised significantly by optimizing the stacking sequence to minimize interlaminar stresses. Composite delamination also occurs at holes and ply drop-offs. A complete understanding of what causes delamination and how to design against it is mandatory if optimum use of composite materials is to be realized.

Adhesive bonding of structural components is desirable in many instances because it eliminates the stress concentration factors caused by mechanical fastener holes. Also, weight and fabrication costs may be saved. Because composite material strength is significantly reduced when a hole is introduced, composites are extremely attractive candidates for adhesive bonding. A complete understanding of the static and fatigue behavior of bonded joints is needed before they will be widely used with confidence.

One major concern for composite materials and bonded joints is inspection for both initial quality and service conditions. The extent of delamination and debonds are rarely discernible from visible observations of the surface; therefore various nondestructive inspection (NDI) techniques must be used to quantify the damage.

A rather focused symposium was planned to bring together many of the important aspects of the delamination/debonding problem. Twenty-five papers are included in this volume. The papers are classified into three categories:

- *Stress Analysis*—This section contains papers on the latest state of the art in finite element and approximate methods for analyzing stresses in cracked and uncracked laminates.
- *Mechanical Behavior*—Many examples of delamination and debond behavior are given as functions of loading, environment, fracture mechanics parameters, and specimen type. This section gives a comprehensive view of the delamination/debond process, what affects it, and how it may be predicted.
- *Fractography/NDI*—This section presents papers on how to assess and monitor the damage growth (NDI) and how to interpret the failure process after the test by observing the failure surfaces (fractography).

By having a focused symposium and assuring that the foremost experts in the delamination/debonding area participated, a definitive treatment of the subject has resulted.

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