



SHORT COURSE ON DURABILITY OF ADHESIVE JOINTS

When you make an adhesive joint as part of some device or product there is always the concern of joint durability whether the product is something as prosaic as a cereal box or as high tech as a jet aircraft. The consequences of joint failure can range anywhere from an annoying nuisance to the

endangerment of lives. Thus this seminar series will give an overview of the technology and tools available for evaluating beforehand the expected performance of adhesive joints subjected to the environmental and load conditions under which they must survive.

PART ONE: OVERVIEW OF TEST METHODS

1. **Two Aspects of Adhesive Action**
 - a. Interfacial bonding between adhesives and adherends
 - b. Bulk thermal-mechanical performance of adhesives
2. **Durability of Adhesive Joints**
 - a. Stress and Deformation in Material Bodies, a quick overview
 - b. Strength of Materials Theory (SOM)
 - c. Fracture Mechanics
3. **Direct Measurement of Joint strength**
 - a. Lap shear test
 - b. Double cantilever beam test
 - c. Four point bend test
 - d. ... etc
4. **Tests That Measure Practical Adhesion Between Adhesive and Adherend**
 - a. Peel test
 - b. Blister test
 - c. Indentation debonding test
 - d. Self loading tests
5. **Measuring Adhesive Thermal-Mechanical Properties**
 - a. Elastic properties
 - b. Viscoelastic properties
 - i. Creep behavior
 - ii. Concept of time-temperature superposition
6. **Role of Residual Stress**
 - a. Cantilevered beam methods
 - b. Ultrasonics
 - c. Photoelasticity
 - d. Strain relief methods
7. **Nondestructive Inspection**
 - a. Xray
 - b. Thermography
 - c. Shearography
 - d. Ultrasonics

PART TWO: DETAILED LOOK AT SPECIFIC TESTS AND CASE STUDIES

1. **A Closer Look at Interfacial Adhesion Through the Peel Test**
 - a. Peel testing on a shoe string
2. **The Peel Test in the Development Lab and Manufacturing Line**
 - a. Ranking effectiveness of adhesion promoters
 - b. Evaluating the effect of manufacturing procedures on bond durability
 - c. Developing improved process steps
3. **A Closer Look at The Thermal-Mechanical Properties of Polymers**
 - a. Common Test methods
 - i. Dynamic mechanical experiments
 - ii. Determination of glass transition, T_g
 - iii. Relaxation processes below T_g
 - b. Case Study on rubber modified epoxy structural adhesives
 - i. Time-temperature superposition for epoxies
 - ii. Variation of fracture toughness with loading rate and temperature
4. **Putting it All Together: A Guide to the Evaluation and Prediction of Bond Durability**
 - a. Structures that survive in the long term are in a state of unconditional stability
 - b. Stability maps: An engineering tool for putting it all together.
 - c. Case study: Adhering pins to a multi-chip module:
 - i. Pathology of pin failure, outline of the problem
 - ii. Modeling virtual crack propagation
 - iii. Creating a stability map