Course M-4/R-7
Adhesive Bonding of Composites & Metals

Course Summary

This course is designed for engineers, technicians, and anyone else looking to advance their knowledge in adhesive bonding technology, while gaining a deeper understanding of surface preparation and the fundamental adhesion principles necessary to achieve a good bond to both (polymeric) composite and metallic surfaces.

Introduction

The course contains a balance of theory and practical application, with much of the time spent in the lab constructing and testing various test specimens made from aluminum and composite substrates. A comparison of aluminum surface preparation methods is examined using wedge-crack testing per ASTM D-3762 methods and practices. Aluminum plates are prepared using several industry standard methods including phosphoric acid anodizing (PAA) and sol-gel treatments, as compared to typical abrasion techniques. The plates are bonded with structural film adhesives, cured, and then cut into wedge test specimens. Wedges are inserted into the bondline creating a crack. The crack length is then measured, and the growth is monitored for each test specimen as they are exposed to various environmental conditions throughout the week. The data is collected daily, analyzed, and compared at week's end. In addition, a number of lap-shear coupons are prepared and bonded by the students using different surface preparation methods. The coupons will be bonded utilizing different film, liquid, and paste adhesives, and applicable processing methods. In some cases, deliberate contamination is introduced into the bondline to assess the effects. Specimens will also be made to evaluate bondline thickness control, utilizing media such as microbeads and knit or scrim carriers with both liquid and paste adhesives. All the test data is collected and compared in a spreadsheet format for each of the various tests with all of the results available to the students after each exercise.

Topics

Key Lecture Topics:

- Fundamentals of structural adhesive bonding
- Liquid, paste, and film adhesives, application, and cure requirements
- Bondline control medias and methods
- Typical joint designs and forces on bonded joints
- Bondline integrity and durability considerations.
- Contamination issues; direct and indirect sources
- Moisture problems; laminates, adhesives and core materials
- Surface preparation of metals vs composites
- Destructive testing methods and practices
- Open-time considerations and environmental effects

Workshop Exercises:

- Surface preparation of aluminum using grit blast, ScotchBrite®, abrasives, PAA & Sol-Gel materials.
- Manufacture and testing of wedge specimens in accordance with ASTM D-3762 methods and practices.
- Surface preparation of composite substrates using various abrasive and non-abrasive methods, including blown-ion plasma surface treatment using Enercon equipment
- Manufacture and testing of CFRP lap-shear coupons.
- Manufacture and testing of DCB specimens
- Vacuum bagging and curing of test specimens.
- Destructive testing and analysis of student-fabricated specimens.

Course Benefits

The student will have a good understanding of surface preparation and the fundamental adhesion principles necessary to achieve a good bond to both (polymeric) composite and metallic surfaces.

Prerequisites

None required - The M-1/R-1 course is suggested for basic subject knowledge prior to the course.

Teaching Method

Active classroom lecture and workshop exercises: 40% Theory and 60% Practical

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