Polymedia-Lite® Evaluation for Composite Structures

Background:

The advent of the National Emission Standard for Hazardous Air Pollutants (NESHAP) and the concomitant requirements for minimal release of hazardous air pollutants has compelled the U.S. Air Force to adopt mechanical paint stripping technology to replace traditional chemical strippers. Dry media blasting has been widely accepted as a replacement technology, though there have been continual concerns about the effects of the blasting process on the mechanical properties of thin-skinned aluminum and composite material structure. The U.S. Air Force currently uses Type V acrylic which has been shown not to damage either thin-skinned aluminum or graphite/epoxy composite laminate. However, Type V acrylic can damage glass/epoxy composite if extreme care is not taken to control the blast parameters. The sensitivity required of the blasting process to prevent damage has effectively negated the use of Type V acrylic for depainting this composite material.

Project Sponsor/Customer: SA-ALC, C-17 SPD, B-1B SPD
Period of Performance: Sep 96 - Feb 99

Objective:

A new blast media, Polymedia-Lite®, is effective in depainting thin-skinned aluminum, and during initial testing did not change the mechanical properties of the aluminum, and was not as aggressive to the aluminum surface as Type V Acrylic. However, Polymedia-Lit®'s effectiveness in depainting composite materials has not been objectively verified. Verification was required for complete integration of Polymedia-Lite® into the U.S. Air Force's paint stripping processes.

The objective of this project was to evaluate the effects of Polymedia-Lite paint stripping on composite material substrates, establish optimum process parameters for depainting graphite/epoxy and glass/epoxy composite materials, and to prepare the groundwork necessary to integrate Polymedia-Lite® into the U.S. Air Force's paint stripping strategies. The CTIO was selected by AFMC/CEV to manage the task and be responsible for reducing the pollution effects caused by the painting and depainting of aircraft and other vehicles, structures, etc.

Status:

The project testing evaluated the effects of the dry media blasting (DMB) process using Polymedia-Lite® media on the mechanical properties of AS4/1338H graphite/epoxy and DMS 1926/Fiberite MXB-7704 glass/epoxy composite laminates. In accordance with the draft AF Engineering Qualification Plan (EQP) for Coatings/Paint removal techniques (Apr 94) all mechanical tests were conducted on a minimum of ten valid baseline and experimental specimens each. Two types of specimens were evaluated: (1) Test specimens were painted, aged and blasted. The test panels were subjected to four blast cycles, and test specimens were removed after each cycle in order to test for any deleterious effects. (2) Baseline (control) specimens were not painted or blasted. However, since the test specimens were aged, the baseline specimens were also aged in order to eliminate any variability. To simulate the aging of paint, the panels were conditioned at ambient conditions for seven days, followed by a 210 degree F cure for 96 hours. A 0.5-inch nozzle at a stand-off distance of 21 inches and an angle of attack of 60 degrees was used to blast the test panels. The strip rate on the graphite/epoxy was 1.15 ft^2/minute, and the strip rate on the glass/epoxy was 0.85 ft^2/minute. Tensile, shear, and compressive tests were conducted on all materials. The data were analyzed using classical analysis of variance and the nonparametric Kruskal-Wallis rank test.

The tensile test results for graphite/epoxy showed no statistically significant difference in the median failure stress, failure strain, or chord modulus between the control and blast cycle groups. A statistical difference was observed in the median shear response between the Control and Blasted graphite/epoxy specimens, but this difference was of no practical significance. The maximum difference in the average material properties was only 4%, which was an acceptable difference. The coefficients of variation were nominally 1-2%, which was testimony to the precision of the data and the ability to replicate the measurements over ten observations. Also, there was no trend in the behavior to indicate a true degradation of the material properties, supporting the fact that the data scatter, while statistically significant, was not practically significant. Finally, Polymedia-Lite® did not have a statistically significant effect on the average compressive failure stress or modulus of the graphite/epoxy. Scanning Electron Microscope (SEM) micrographs of the graphite/epoxy surface indicated that Polymedia-Lite® did not expose any fibers to the surface. It was noted that after four cycles the surface did appear to be slightly rougher.

For the glass/epoxy material, there was no statistically significant difference in median tensile failure stress or chord modulus. A statistical difference was observed between the median tensile failure strains between the Control and Blasted specimens. But, the maximum scatter in the average strains was only 5%, and the coefficient of variation within each group was also only 5%. In addition, there was no trend in the data to indicate a true degradation of the material properties, and it was concluded the differences were not practically significant. There was also no practical difference in the average shear responses of the glass/epoxy. The maximum scatter in the averages was 2-4%, the coefficients of variation were 0-4%, and there was no trend in the data. Finally, there was no statistically significant difference between the average compressive strength or modulus of the compressive specimens.

SEM micrographs of the as-manufactured glass/epoxy panels revealed there were large regions of dry or resin-poor material with exposed fibers readily apparent. After four depaint cycles, additional resin had been removed from the surface, and some fibers had been broken. Resin protects the fibers from damage, and with this layer of protection missing in the as-manufactured material, some damage to the fibers was expected. Nonetheless, the minimal amount of damage resulting from stripping the resin-poor material with Polymedia-Lite® did not affect the mechanical properties of the glass/epoxy.

It was concluded that Polymedia-Lite® did not degrade the material properties of the graphite/epoxy and glass/epoxy composite materials after four depaint cycles. This project gave the ALC's the test results to implement Polymedia-Lite® as a depaint media.

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