Evaluation of Type V, Polymedia-Lite™ DMB Processes for Depainting 0.025 Inch 2024-T3 Aluminum Alloy

Background:

The Flight Training System Program Office and the Air Education and Training Command (AETC), used Type V acrylic media for the removal of coatings from their aircraft. With the introduction of the T-1A and T-6 aircraft, the manufacturer recommended a wheat starch-based dry media blasting (DMB) process for the T-6, and further recommended a one-time use only of Type V on the T-1A. These recommendations have potentially major impacts on facilities, schedule, operational cost, and waste disposal for all AETC aircraft. The Program Office and AETC determined there was a requirement to change from a Type V DMB process to a wheat starch-based process for the T-1A or T6.

Objective:

The CTIO conducted an experimental test program to investigate the effects of Type V, Polymedia-Lite™, and Envirostrip™ DMB processes on 0.025-inch-thick clad 2024-T3 aluminum substrate. The material property tests included static tensile, low-cycle constant-amplitude fatigue, and constant-amplitude fatigue crack growth rate tests. The test data were analyzed using analysis of variance (ANOVA) techniques wherein the average mechanical property of the Control (unblasted) specimens was compared to the average mechanical property of the blasted specimens. All statistical tests were made at the 10% level of significance. In addition, damage assessment tests were also conducted. These evaluations included clad erosion, surface profile roughness, and residual stress peak/saturation tests.

Status:

The tensile tests measured the ultimate strength, peak elongation, and the 0.2% offset yield stress of the Control and Blasted specimens. There was no statistically significant difference in the average ultimate strengths across the Control and Blasted groups. Also, there was no statistically significant difference in the average peak elongation across the Control and Blasted groups. There was no statistically significant difference in the average yield stress between the Control, Type V, and Envirostrip™ groups.

However, there was a statistically significant difference between the Control and Polymedia-Lite™ groups, but the difference was less than 1 ksi, and the coefficients of variation were 0.6% or less. These differences were within the experimental error of the tests, and were not considered practically significant.

There were statistically significant differences in the average fatigue lives of the Control, Polymedia-Lite™, and Envirostrip™ groups. However, there was not a statistically significant difference between the Control and Type V groups. These results were contrary to expectations due to the known physical properties of the different media. Specimen conditioning procedures and test protocols were reviewed, confirming the viability of the data.

A brief hypothesis was developed to offer an explanation for this effect on fatigue properties associated with the three DMB processes. Most statistical analyses of fatigue crack growth rates indicated no difference between the Control and Blasted groups. Where there was a statistically significant difference, the percentage deviations fell within normal variations described in the ASTM standard test method. As such, it was difficult to distinguish any differences in crack growth behavior between the Control and Blasted groups.

The damage assessment test results were as follows. (1) The erosion of clad due to blasting with Envirostrip™ and Polymedia-Lite™ was nominally 1% clad weight loss per blast cycle for a total of 4% weight loss after four blast cycles. The clad loss due to using Type V averaged 4% per blast cycle, for a total 16% weight loss after four blast cycles. (2) On bare 2024-T3 aluminum alloy, there was no difference in the surface roughness of the test specimens after blasting with Type V, Polymedia-Lite™, and Envirostrip™. On clad 2024-T3, there was no difference in surface roughness due to blasting with Envirostrip™ and Polymedia -Lite™. However, the roughness due to Type V was initially three times greater than that due to blasting with the other media. This difference later decreased due to the smoothing effect from the slight erosion of the clad during subsequent blast cycles. (3) The specimens blasted with Envirostrip™ did not become saturated after 10 blast cycles. It was not possible to compare these test results with previous results for Type V and Polymedia-Lite™, since the test specimens were of a different thickness. The tensile and fatigue crack growth rate test results indicate that neither Type V, Polymedia-Lite™, nor Envirostrip™ DMB Processes produced statistically or practically significant differences in the average mechanical

properties between Control and Blasted groups. The damage assessment tests indicate that Polymedia-Lite™ and Envirostrip™ are equivalent in erosion of clad and roughening the aluminum surface. These effects were considered minimal. Further work is recommended to fully understand the effects of blast media on the interplay of surface roughness, residual compressive stresses, and fatigue cycling. A hypothesis has been proposed which offers a plausible explanation for the material effects demonstrated by the test results. However, the hypothesis is based upon a collection of cursory analytical models, observations, and analogies. Additional validating information would be required to develop a more fundamental understanding of the phenomena.