Adhesion and Strippability of High Performance Coating Systems on Composite Materials

Background:

The High Performance Advanced Coating System (HPACS) initiative was a project within the "near-term" plan of the USAF Aircraft Coating Systems Strategy. The initiative was focused on the evaluation and acceptance of commercial off-the-shelf (COTS) products meeting the 1998 NESHAP compliant coatings systems standards. Industry claimed several products had been developed with higher performance characteristics. The AF decided to test these products for possible integration into maintenance operations throughout the aircraft fleet. As part of the HPACS evaluation, the Coatings Technology Integration Office (CTIO) was tasked by the AF Coatings Technology Screening Committee (CTSC) to evaluate the adhesion and strippability of selected coating systems on graphite/epoxy and glass/epoxy composite materials.

Project Sponsor/Customer: Air Force wide
Period of Performance: Aug 95 – Sep 97

Objective:

The purpose of this project was to evaluate the adhesion and strippability of the eight selected coatings on graphite/epoxy and glass/epoxy composite materials. The selected coatings offered the best potential for near-term integration into the USAF painting and stripping operations.

Status:

The testing evaluated the adherence of the eight coating systems to graphite/epoxy and glass/epoxy composite materials. The adherence tests consisted of a modified pull-off test. The surface of the pull-off specimen was evaluated for either cohesive or adhesive failures of the substrate, primer, topcoat, or their interfaces.

Strippability was evaluated using plastic media blasting (PMB) and medium-pressure water (MPW) stripping supplemented with sodium bicarbonate. For the strippability tests, the only substrate evaluated was graphite/epoxy, since both PMB and MPW can

damage glass/epoxy. The graphite/epoxy substrate was inspected under a scanning electron microscope (SEM) to document the morphology of the stripped surfaces.

Utilizing a SwRI modified Patti^{TM} Tester (a.k.a. pull-off test) and holding/alignment fixture, the adhesion strength of each coating system was evaluated. The higher-strength coatings cohesively failed in their primers, which were either waterborne epoxy or high-solids epoxy. The cohesion of the non-military specification polyurethane topcoats and the adhesion of the topcoats to the primers was exceptional, since failures occurred in the primers only. Other coating systems using a waterborne epoxy primer or high-solids epoxy primer generally failed at the topcoat/primer interface or in the topcoat, which was indicative of relatively lower adhesive or cohesive strengths, respectively, in the topcoats.

The adhesion strengths and failure locations for the coating systems were reflected in the ability of the PMB and MPW processes to strip the coatings from the graphite/epoxy substrates. It was difficult to strip the primers of higher strength coatings (those which cohesively failed in their primers). At higher traverse speeds, PMB and MPW left both the topcoats and primers on the substrate. At slower traverse speeds, PMB stripped both the primers and topcoats of the other coating systems from the graphite/epoxy substrate. MPW, on the other hand, was amenable to selective stripping. It stripped the topcoat and left the primer at all but the slowest speeds. It was noted at slower traverse speeds (0.50 inch/second), MPW damaged the graphite/epoxy. However, at a slightly higher traverse speed (0.83 inch/second), MPW left the primer on the substrate. The velocity at which selective stripping takes place should be fast enough to avoid damaging the graphite/epoxy.

The project concluded adhesion strengths of the HPACS coating system was dependent upon the chemistry of the primer and topcoat system. Higher strength coatings cohesively failed in their primers. These primers were either waterborne or high-solids epoxies. Other coatings, which also had waterborne or high-solid epoxy primers, had lower adhesion strengths due to cohesive failures in the topcoat or adhesive failures at the topcoat/primer interface. These failures were probably due to the proprietary differences in the chemistries of the coating systems. The adhesion strengths and failure locations were reflected by the ability of PMB and MPW processes to strip the coatings. The primers of the higher strength coatings were difficult to strip by either PMB or MPW. PMB did, however, strip both the topcoats and primers of the

lower strength coatings. MPW generally left the primer on the graphite/epoxy substrate, which may make it amenable to selective stripping. However, at slower strip rates, MPW had the potential to damage the substrate.

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