Pliant Sponge Media[™] Abrasives and the Aerospace Industry:

Rain Erosion Coating Removal Utilizing Sponge Media[™] Abrasives

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ABSTRACT:

The Southwest Research Institute conducted micrograph imaging to compare conventional chemical stripping methods to Sponge Media[™] abrasive blasting on pre-flown C-130 fiberglass radome panels. The panels had a gray MIL-C-85285B topcoat, multiple coats of black, MIL-CAAPCOAT B-274/AS-P108 rain erosion resistant, polyurethane coating, and red military primer. Methylene chloride stripping for baseline comparison was performed by Texas Composites, while the Sponge Blasting was performed by Sponge-Jet, Inc.

Panels where Sponge Blasted with Silver Sponge MediaTM and White Sponge MediaTM abrasives removing part or all of the radome coatings. In one test, panels were completely stripped of all coatings. In another test, the gray topcoat was removed, leaving the black erosion resistant coating and red military primer. The last test removed the gray topcoat, the black erosion coating, leaving the red primer. Samples of the same panels where also chemically stripped with methylene chloride to illustrate comparative substrate damage with conventional procedures.

Scanning Electron Microscope (SEM) samples were made from the blasted and chemically stripped panels. A visual comparison was summarizes using the micrographic images (for the actual visual comparison, refer to page six through twenty-one):

Test One measured how the three stripping products remove all coatings without damaging the composite resin, and underlying glass fibers:

- Methylene chloride removed all coatings, but caused some resin cracks and exposed fibers (the total damage caused by this process was inconclusive due to the possibility that previous damage may have been caused by in-service rain erosion or prior scuff-sanding to the radome panel).
- White Sponge Media abrasive removed the coating, but yielded some broken fibers in addition to worn areas of composite resin.
- Silver Sponge Media removed the coating and established the most uniform stripping with minimal resin loss.

Test Two measured how Silver Sponge Media selectively strips gray topcoat, while leaving the black erosion coating exposed:

- Silver Sponge Media removed a gray topcoat without pitting or damaging the rain erosion coating.

Test Three measured how White Sponge Media removed gray topcoat, black erosion coating, leaving the red military primer:

 White Sponge Media removed gray topcoat and black erosion coating, but wore resin in selected areas causing broken bundles of glass fibers

CONCLUSION:

- 1. Visual comparisons suggest that Silver Sponge Media abrasive impregnated with 320-Grit Aluminum Oxide can selectively strip topcoat without damage to rain erosion coating.
- 2. The same process can remove all coatings on the test substrate and, unlike methylene chloride and White Sponge Media abrasives, Silver Sponge Media abrasives causes little to no additional damage compared to damage during in-service usage.

Southwest Research Institute (SwRI) has completed its evaluation of the coated surfaces of fiberglass radomes stripped with two types of Sponge-Jet media. The fiberglass radomes were previously in service and were being modified by Texas Composites Incorporated, Boerne, TX, for installation of forward-looking radar. According to Texas Composites, the in-service radomes were supposed to have a red primer over the fiberglass surface followed by the black rainerosion coating and then a clear coat. Texas Composites has found that the radomes were not consistently painted and that the radomes could have multiple layers of primer, rain-erosion coating, and gray topcoats (to match the gray coating on the aluminum structure).

Scrap fiberglass C-130 radome panels, Part Number 389154-1M, were obtained from Texas Composites. Some of the panels had the gray MIL-C-85285B topcoat. Underneath the gray topcoat was a black rain erosion resistant polyurethane coating, CAAPCOAT B-274/AS-P108 that was in accordance with MIL-C-83231A, Type II, Class A, Composition I. In conversations with CAAP Co., Inc., the supplier of the rain-erosion coating, it was discovered that there may be two layers of the black erosion coating. A base layer 0.011-0.012 inch thick may first be applied followed by a topcoat that may be 0.001-0.002 inch thick. It is impossible to distinguish between these two layers since both are black in color. The red primer was Aeroglaze 9947 Wash Primer. Information on the CAAPCOAT is provided in Attachment A.

Table 1 lists the radome panels supplied by Texas Composites Inc. to SwRI and the coating layers on each panel. The panels were shipped to Sponge-Jet for stripping using either aluminum oxide or acrylic media embedded in the sponge. Sponge-Jet stripped the coatings on each panel leaving just the bare fiberglass. In addition, on Panel 4, Sponge-Jet selectively stripped just the gray topcoat leaving the black erosion coating and red primer. On Panel 6, the black erosion coating was selectively stripped leaving just the red primer. Scanning electron microscope (SEM) samples were taken from each of the panels, including those areas selectively stripped. Table 1 also lists the SEM samples, the material or coatings remaining after stripping, and the stripping media used on each sample.

Panel	Coating Lavers	SEM	Material or Coating Layer	Strinning Media
I.D.	Coating Layers	Sample	Remaining After Stripping	Surpping Media
3	Red primer	3-1	Bare fiberglass	Aluminum Oxide
4	Gray topcoat, black	4-C	Bare fiberglass	Control (chem strip)
	erosion coating, red	4-1	Black erosion coating	Aluminum Oxide
	primer	4-2	Bare fiberglass	Aluminum Oxide
5	Gray topcoat, black	5-1	Bare fiberglass	Acrylic
	erosion coating, red			
	primer			
6	Black erosion coating,	6-C	Bare fiberglass	Control (chem strip)
	red primer	6-1	Red Primer	Acrylic
		6-2	Bare fiberglass	Acrylic

 Table 1 Panel and SEM Sample Identification

The Sponge-Jet stripping parameters for each media are listed in Table 2. The stripping process was determined by Sponge-Jet for this evaluation. After stripping, the panels were returned to SwRI for evaluation of the surface conditions. SEM samples were cut from the stripped areas of the radome panels and coated with gold-palladium to ensure that the surfaces could be observed in the SEM.

Media	Acrylic	Aluminum Oxide 320°F
Blast Pressure (psi)	35-40	35-40
Media Flow Rate	40 psi (3-5 lbs./minute)	40 psi (5-6 lbs./minute)
Nozzle Standoff Distance (in)	4-6	4-6
Nozzle Angle (degrees)	45-60	45-60
Projected Production Rate	0.25	1.25
(square feet/minute)		

 Table 2 Sponge-Jet Stripping Parameters

In addition, two SEM samples were chemically stripped by Texas Composites using off-the-shelf chemical stripper. Usually, Texas Composites chemically strips the radomes to just the red primer. However, SwRI requested that they strip the samples to the bare fiberglass so that the condition of the glass fibers could be observed. Although it was known that the chemical stripper may possibly attack the epoxy resin, SwRI wanted to know the baseline condition of the glass fibers. Broken fibers may have resulted from in-service damage (rain impacts, for example) or previous paint-removal operations. CAAP Co. confirmed to SwRI that when rain impacts the coated surface of the radome, the energy may be transmitted through the elastic coating to the substrate underneath. The fibers in the comparatively brittle substrate may then break due to the energy of the impact. As such, the rain erosion coating may not show any damage from the rain impacts, but the underlying substrate may have broken fibers and pitted resin. The chemically stripped samples would provide the means necessary to compare the baseline condition of the in-service panels to the post-stripped specimens.

The SEM micrographs of the Panel 4 Control sample, 4-C, are shown in Figures 1 through 4. At 25X and 50X (Figures 1 and 2), the weave of the fiberglass cloth is clearly visible and few areas of exposed fibers are observed. Cracks can be seen in the resin layer, particularly at 50X. At 200X (Figure 3), some resin cracks and exposed fibers are seen, and at 500X (Figure 4), many of the exposed fibers are found to be broken. Particles of resin are evident on the surface at 200X and 500X. Although it may be assumed that the resin deteriorated due to the chemical stripper, the presence of the broken fibers is likely due to in-service rain erosion damage and/or previous removal of the radome coatings by scuff-sanding or other means.

The Panel 6 Control sample, 6-C, had more damage than Sample 4-C. As seen at 25X and 50X (Figures 5 and 6), the weave pattern is still evident but more resin is missing and the majority of fibers are exposed to the surface. Again, some of the damage may be due to the chemical stripper, but it is likely that the multitude of pits in the surface resulted from rain impacts because the depth and magnitude of the holes in the resin layer were not observed in the Panel 4 Control sample that had been subjected to the same chemical stripper. At 200X and 500X (Figures 7 and 8), broken fibers throughout the weave are noted.

Figures 9 through 12 show the surface of SEM Sample 3-1. This sample had only red primer on the surface, and had been stripped to the bare fiberglass using aluminum oxide media. Extensive pitting is observed at 25X and 50X (Figures 9 and 10), and is similar to the conditions seen in Sample 6-C. The causes of the pitting and the broken fibers around the pits are unknown. However, visual examination of the unstripped regions of Panel 3 showed similar surface features and roughness, indicating that the aluminum oxide media likely did not cause the pits and broken fibers.

Sample 4-1 had the gray topcoat selectively stripped, leaving the black rain erosion coat exposed. Figures 13 through 16 are micrographs of the surface. These figures are relatively unremarkable since the surface is relatively smooth and undisturbed. No pitting of the rain erosion coating is observed in any of the micrographs. These figures indicate that the aluminum oxide sponge jet may be used to selectively strip a topcoat without damaging the underlying coating.

Figures 17 through 20 show the surface of SEM Sample 4-2. This sample was stripped to the bare fiberglass using the aluminum oxide media. At 25X and 50X (Figures 17 and 18), the surface is uniform, and there appears to be minimal resin loss. Some pitting of the resin surface is evident. Comparing these figures to Figures 1 and 2, Sample 4-C has more exposed fibers, less resin, and the weave of the fiberglass is evident. Aside from the pitting, the aluminum-oxide-stripped sample appears to show less damage than the chemically-stripped sample. At 200X and 500X (Figures 19 and 20), some exposed fibers are seen, but the number of broken fibers is minimal and there is little resin loss. It appears that the damage to the surface of the aluminum-oxide-stripped sample is no worse (perhaps less?) than the surface damage that resulted during in-service usage.

Sample 5-1 had the same number of coating layers as Sample 4-2, but was stripped to the bare fiberglass using acrylic media. As seen at 25X and 50X (Figures 21 and 22), the weave of the fiberglass is apparent, there is less resin on the surface, and there is more pitting compared to what was seen with Sample 4-2. Examination of the surface at 200X and 500X (Figures 23 and 24) reveals that almost two-thirds of the fibers are exposed. Although it is unknown whether the media or in-service usage caused the broken fibers, the acrylic media is more damaging to the fiberglass surface than the aluminum oxide media.

Sample 6-1 had the black erosion coating selectively stripped, leaving only the red primer. As seen at 25X and 50X (Figures 25 and 26), areas of the coating are still present. Fibers are exposed in some areas. At 200X and 500X (Figures 27 and 28), it is seen that the fibers are broken in bundles in both directions. It appears from these micrographs that the fiberglass surface may be sensitive to the acrylic process, meaning that the potential for damage caused by the acrylic media may vary between locations and operator error.

Figures 29 and 30 show the surface of Sample 6-2. This sample was stripped to the bare fiberglass, and pitting of the surface is seen. More importantly, at 50X (Figure 30), the fibers are exposed and there is very little resin remaining on the surface. This is seen at 200X and 500X (Figures 31 and 32). As compared to Sample 4-2, the number of exposed fibers is clearly greater. This comparison indicates that the acrylic media is more damaging to the surface of the fiberglass than the aluminum oxide media. Service history may have caused the pitting and some

of the broken fibers, but the extent of the fiber's exposure on the surface likely resulted from the acrylic media.

Table 3 provides a summary and subjective ranking of the SEM samples from worst to best. In summary, it appears that the acrylic media results in more surface damage than the aluminum oxide media. The aluminum oxide media demonstrated its ability to selectively strip the gray topcoat and not damage the underlying rain erosion coating. Due to the baseline condition of the fiberglass panels, it is unclear to what extent in-service usage caused damage to the surfaces (pits and broken fibers) and what damage resulted from the stripping process. However, it does appear that the aluminum oxide stripping process left the surface in no worse condition than that left by in-service usage.

Ranking	Sample Identification	Comments
Worst	6-1	All fibers exposed; lacks resin
	6-2	Fibers exposed; some primer still present
	5-1	Exposed fibers, some resin present
	3-1	Patchy, areas with and without resin
	4-1	Uniform surface; coating still present
Best	4-2	Most uniform; fewest exposed fibers

 Table 3 Subjective Ranking of the Stripping Results

A next step in evaluating the use of the Sponge-Jet medium, particularly the aluminum oxide media, would be to perform quantitative evaluations on virgin fiberglass panels. The in-service usage of the radome panels prevents a conclusive determination of the potential for measuring the damage to the fiberglass substrate, and comparisons of as-manufactured virgin panels to stripped virgin panels would provide a quantitative and conclusive assessment of the damage potential.



Figure 1 Micrograph of Control Sample 4-C at 25X (#S1081)



Figure 2 Micrograph of Control Sample 4-C at 50X (#S1082)



Figure 3 Micrograph of Control Sample 4-C at 200X (#S1085)



Figure 4 Micrograph of Control Sample 4-C at 500X (#S1086)



Figure 5 Micrograph of Control Sample 6-C at 25X (#S1077)



Figure 6 Micrograph of Control Sample 6-C at 50X (#S1078)



Figure 7 Micrograph of Control Sample 6-C at 200X (#S1079)



Figure 8 Micrograph of Control Sample 6-C at 500X (#S1080)



Figure 9 Micrograph of Sample 3-1 at 25X (#S1053)



Figure 10 Micrograph of Sample 3-1 at 50X (#S1054)



Figure 11 Micrograph of Sample 3-1 at 200X (#S1055)



Figure 12 Micrograph of Sample 3-1 at 500X (#S1056)



Figure 13 Micrograph of Sample 4-1 at 25X (#S1057)



Figure 14 Micrograph of Sample 4-1 at 50X (#S1058)



Figure 15 Micrograph of Sample 4-1 at 200X (#S1059)



Figure 16 Micrograph of Sample 4-1 at 500X (#S1060)



Figure 17 Micrograph of Sample 4-2 at 25X (#S1061)



Figure 18 Micrograph of Sample 4-2 at 50X (#S1062)



Figure 19 Micrograph of Sample 4-2 at 200X (#S1063)



Figure 20 Micrograph of Sample 4-2 at 500X (#S1064)



Figure 21 Micrograph of Sample 5-1 at 25X (#S1049)



Figure 22 Micrograph of Sample 5-1 at 50X (#S1050)



Figure 23 Micrograph of Sample 5-1 at 200X (#S1051)



Figure 24 Micrograph of Sample 5-1 at 500X (#S1052)



Figure 25 Micrograph of Sample 6-1 at 25X (#S1041)



Figure 26 Micrograph of Sample 6-1 at 50X (#S1042)



Figure 27 Micrograph of Sample 6-1 at 200X (#S1043)



Figure 28 Micrograph of Sample 6-1 at 500X (#S1044)



Figure 29 Micrograph of Sample 6-2 at 25X (#S1045)



Figure 30 Micrograph of Sample 6-2 at 50X (#S1046)



Figure 31 Micrograph of Sample 6-2 at 200X (#S1047)



Figure 32 Micrograph of Sample 6-2 at 500X (#S1048)