COATINGS FOR COMPOSITES

A classic pinhole filling on carbon composite: Pinholes and voids need to be filled to prevent moisture penetration

Jim Rowbotham, managing director of aircraft paint system specialist, Pexa, provides a step by step guide for painting composites in aerospace applications.

In addition to aesthetics, image and camouflage, there are several technical reasons for painting composites. Among the most important is the prevention of fluid damage. Some resins are affected by prolonged water contact and freeze/thaw action can be damaging to the composite structure. The right paint system will provide a moisture barrier and protect the composite from damaging fluids such as hydraulic fluid, fuel and de-icer.

Aircraft paint systems need to be lightweight and highly flexible, resistant to fluids and corrosion and provide long term durability with gloss and colour retention over long service intervals.

Composites are rarely completely smooth so the paint system needs to accommodate this. Pinholes and voids need to be filled to prevent moisture penetration. Pinholes are holes of less than 0.5mm in diameter which occur in the composite surface and cannot be filled using a spraying process. The sprayed coating will bridge the pinhole and the bridge will break through, either by gassing out from the pinhole, by shrinking back as the coating dries or by sanding through.

Pinhole filling is achieved by pushing the filler into the holes using a tool such as a squeegee. A low viscosity filler is preferred, as this can be wiped off the composite surface leaving filler in the pinhole and reduces process time and weight. The filler must be wiped in multiple directions to ensure that angled pinholes are filled.

For larger voids a thicker putty or mastic consistency is needed. Fillers are typically epoxy-based, but faster drying is approved for some specifications. These are mixed and applied using a filling knife or similar tool.

More contentious is the filling of any textured surface of the composite caused by the weave pattern. Most engineers will say that there is no benefit to smoothing this surface as there is no effect on airflow and the extra weight is undesirable. However, purchasers of composite parts prefer a completely smooth surface. This is achieved using spray filler or high build primer. For this process a dual purpose filler/primer is advantageous as it reduces process time and layer thickness. A typical product will allow a build of up to 125µm in 2-3 coats and be sandable in 2-4 hours. Prior to topcoat, a thin layer of primer may be applied. This can be omitted if dual-purpose spray filler has been used and there is no breakthrough after sanding. The same topcoat is usually applied to the entire external surface including metal parts.

Composites are often painted as if they were metal although there are some applications where this isn't ideal. One of these is in the area of corrosion inhibition. Composites do not corrode; therefore corrosion inhibiting pigments do not function on composites. The principal corrosion inhibiting pigments used in aerospace primers are metal chromates, the most common being Strontium chromate.

A key function of chromate pigments is that they are hygroscopic and partially dissolve in water, delivering corrosion protection to exposed metal. This solubility is undesirable for composite primers as it causes water absorption.

Chromate free primers will normally provide a better water barrier.

Another feature of chromate pigments is that they are classified as carcinogenic and as substances of very high concern (SVHCs) under REACH. Aerospace designers are now trying to engineer them out of specifications where not essential, and for composites they are not essential and will rapidly fall from use in this area. Some corrosion control may still be required for composites with a metallic content, but this can probably be achieved without chromates.

The body electric

Most composite materials have little electrical conductivity, but this can be added by using conductive coatings. The main electrical performance properties required include electrostatic discharge, RF/EM shielding and lightning strike protection.

Airflow over composite surfaces causes an electrostatic charge to build up, which can occur on exterior panels and on propellers/rotor blades. The use of conductive paints allows static to bleed away into the metal airframe through metal fasteners and by wicking, using contained wires to provide a discharge path to the air. Static build up can interfere with electronic equipment and, if sufficient charge builds up, can cause a spark to earth when on the ground.

Carbon fibre reinforced plastic (CFRP) typically has sufficient conductivity to deal with static build up without extra help. On non-carbon composites, carbon containing paints are used to provide anti-static performance. Generally there are two types of material, either for components such as fairings, where the conductivity is normally required to be less than 50kOhms^2 or for use on radomes or antenna covers where conductivity must be lower, ensuring transparency for radar and radio transmissions. For these areas the conductivity of the coating is usually controlled in the range of 5-100MOhms^2.

Stripped for action

Paint removal on aircraft is usually accomplished by the application of chemical paint removers; classically-based on dichloromethane and now superseded by activated benzyl alcohol in water-based paint removers.

It is not permitted to apply these strippers to composite areas, due to the risk of damage to the composite. Composite areas are covered with polythene or aluminium foil and are abraded after the paint is removed from the metal areas.

On aircraft with large composite areas, paint systems with a 'selectively strippable' intermediate coat can be used. The intermediate coat is a layer between the primer and topcoat, based on paint stripper resistant polymers, such as polyamide. Application of a composite friendly 'paint softener' chemical will cause the topcoat to break down, leaving the intermediate coat and/or primer intact. The intact primer layer prevents contact of the paint stripper with the composite.

Alternative methods of removal include dry stripping using a pressurised stream of particles, such as acrylic media or wheat starch. This is an efficient way of removing paint from the surface under low pressure and with soft particles which do not damage the composite.

It's what's inside that counts and one area where composite components are widely used is the cabin interior including sidewalls, bulkheads and ceilings. The major performance feature for interior coatings is the addition of flammability test requirements.

The key requirements are burn length, toxic gas emission, smoke density and heat release. Paint suppliers offering products for cabin interior applications will be able to provide test results for these important properties.

In addition to fire resistance, finishes need to have resistance to knocks and chips and a wide range of substances which are spilt on them inside the aircraft cabin. Current systems are water-based and are offered on a rapid turnaround to cope with in-service delivery requirements. I

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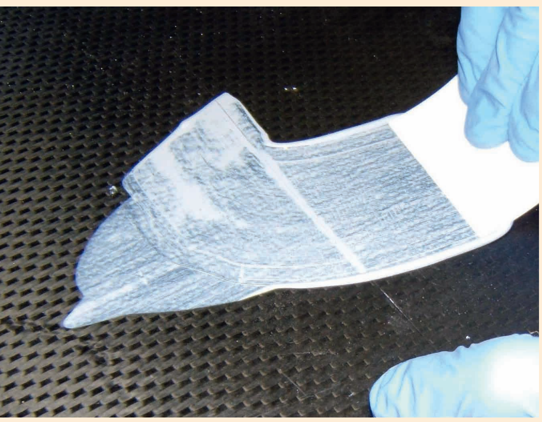

Smooth operator: An application of a pore/weave filler for composites using a spreader

Tall tails: The A380 tail comprises a substantial amount of composite material