Metallization of Composite Structures

Replacement of Glued Metal Foils or Electroformed Ni on CFRP

Dr. Arash Ghabchi, Mr. Marc Froning

Engineering, Operations & Technology

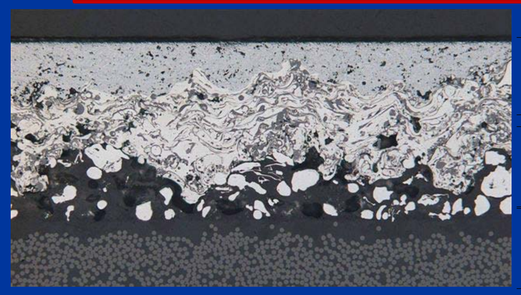
Boeing Research & Technology

Technology Need:

Carbon-fiber reinforced composite materials provide an option for weight savings while providing excellent fatigue, strength and corrosion resistance compared to metals. Unfortunately, there are no established methods for providing wear resistance or surface protection of composite parts except for adhesive bonding of metal foils. Developing application methods that efficiently and effectively produces a shield layer on composite materials without adding significant weight would enable the use of composite materials in entirely new areas.

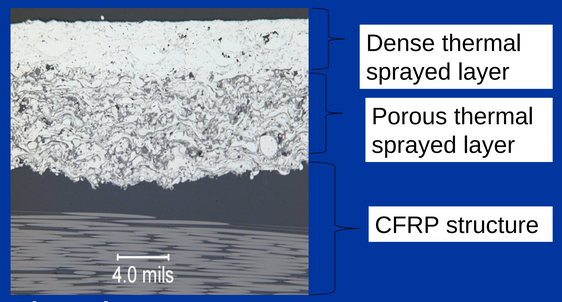
1st approach (Adhesion promoter):

Utilizes an intermediate layer (adhesion promoter - AP) to allow application of metallic or ceramic coatings with increased functionality (i.e. wear/erosion resistance, EME protection, non-spark) to fully cured CFRP components. AP provide thermal expansion compliance for increased cyclic life. Top coating can be electrically isolated from underlying carbon fibers.

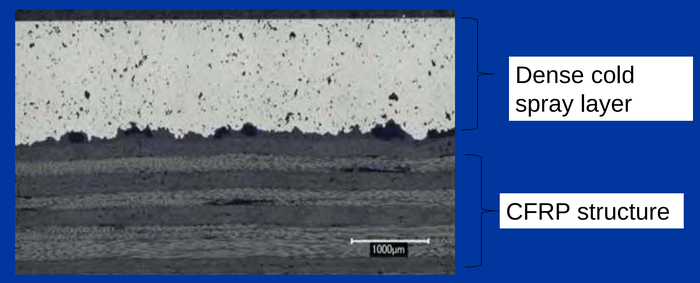


2nd approach (In-situ metallization):

Coatings are applied to lay up tool and co-cured with CFRP. Careful optimization of adhesion and coating internal stresses enables release of metallic layer that is well-bonded to the CFRP structure. This technique potentially provides improved adhesion compared to direct metallization technique.



Thermal spray

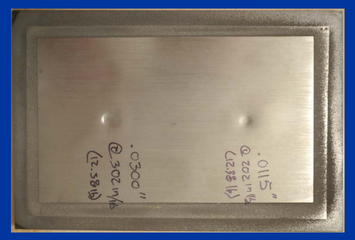


Cold spray

Durability tests:

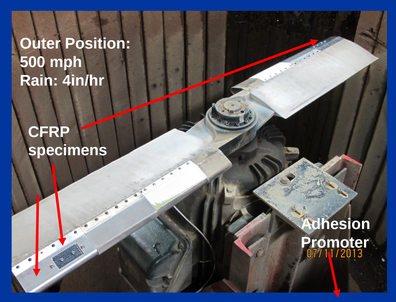
- Bond adhesion
- Environmental test
- Impact resistance
- Rain erosion

Adhesion:
2500 psi per ASTM C633

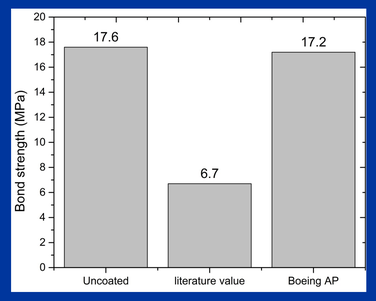


Environmental test:
2000 cycles - 65°F to 160°F

Impact Resistance:
300 in/lb without crack or spallation

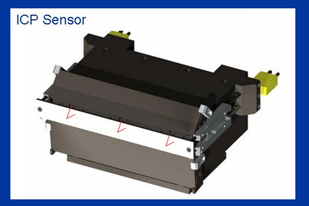


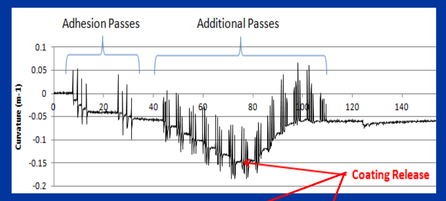
Rain erosion test:
90 mins@600 mph
<15mins for unprotected CFRP @600 mph

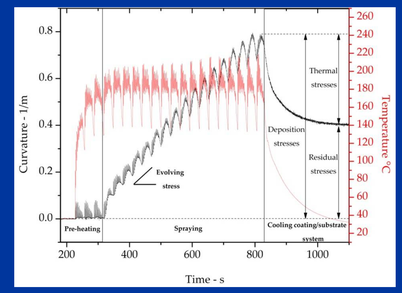


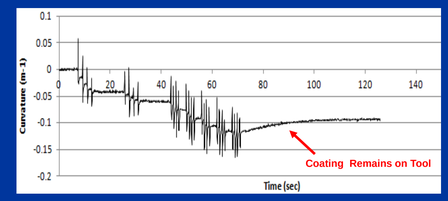
Bond strength values

Stress monitoring concept:









Repair of metallized CFRPs:

Metallized CFRP by thermal spray techniques can be repaired by using standard thermal spray coating repair techniques. It also makes it possible to carry out in the field repairs.

Point of contacts:
Dr. Arash Ghabchi, Arash.Ghabchi@Boeing .com, 206-662-1883
Mr. Marc Fronig, Marc.J.Froning@Boeing.com, 206-662-0264