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Experimental and numerical investigation of role of contamination on tensile and shear strength of adhesively bonded joints in carbon fiber reinforced composites

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ABSTRACT

Adhesively bonded joints are commonly used in airframe structures due to their superior strength to weight ratio, lower maintenance cost, and longer service life. The bonded joint reliability is affected by the environmental conditions, such as moisture, temperature, and service environment. In this study, the role of contamination during the bonding process on the joint mechanical integrity is examined for a set of common in-service hydraulic oils. An adhesive (Hysol EA 9394)/ adherend carbon fiber composite (Hexply IM7/8552) were examined for different contaminants exposure level. The fracture characteristics are evaluated from Double Cantilever Beam (DCB) test and Single Shear Lap. The fractal surface is analyzed by surface topographic analysis. An FEM study employing cohesive zone method was implemented. The cohesive zone properties for Mode-I and Mode-II were calibrated from a reference DCB and End-Notched Flexure tests, respectively. The experimental and modeling study showed a major effect of the contamination to lower the joint fracture toughness through both a reduction in the adhesion strength as well as shielding of plasticity within the adhesive layer. In addition, it is found that a trace level of hydraulic fluid, which is accepted as clean surface according to military standards, still degrades the bond-line strength to 70% of its rated level.