Fracture behavior of unidirectional and woven fabric C/PEKK – Titanium hybrid joints

V. Marinosci [1, 2], W. Grouve [2], M. De Rooij [2], S. Wijskamp [1], R. Akkerman [1, 2]

[1]Thermoplastic Composites Research Center (tprc) - Enschede (Pays-Bas), [2]University Of Twente, Engineering Technology - Enschede (Pays-Bas)

Co-consolidation is a technology to fabricate metal-thermoplastic composite (TPC) joints. With this technology, metal inserts can be integrated in a composite structure during composite consolidation. By heating up the two materials, the thermoplastic resin melts and acts as an adhesive. As such, consolidation of the composite and bonding to the metal are achieved in one step, thereby reducing costs and time compared to fastening or adhesive bonding. A recent study shows the possibility to obtain acceptable co-consolidated metal-TPC joints, by treating the metal surface to promote surface roughness [1]. However, it is well known that the mechanical response also depends on the type of adherends used. When using composites, properties like fiber content and fiber reinforcement architecture may play a significant role in the mechanical behavior of the interface. The present work investigates the differences in fracture behavior of co-consolidated metal-TPC joints manufactured with the same composite material system, namely carbon fibers and poly-ether-ketone-ketone (PEKK) resin, available in two forms: UD prepreg and woven fabric semipreg. Grit-blasted Ti6Al4V was used as the metal adherend. The titanium-composite joints were manufactured via autoclave co-consolidation. The interfacial fracture toughness was evaluated via a mandrel peel test. Microscopy was performed to assess co-consolidation quality and failure mechanisms. Mechanical and microscopy results show that the composite configuration influences the fracture behavior of the interface. Similar to what is found in the study of the fracture behavior of UD and woven fiber composites [2], the uniform fiber-matrix distribution of the UD prepreg led to an average fracture toughness of 1.4 kJ/m2 and stable crack propagation, predominantly characterized by fiber-matrix failure. The presence of local regions with higher resin content in woven composites resulted in an overall higher fracture toughness (2.5 kJ/m2) and unstable crack propagation (stick-slip behavior). This high resin content regions, in combination with fibers in both parallel and perpendicular direction with respect to the crack propagation, caused a more complex crack path, which partially followed the interface and partially the composite.

References

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