

Mechanics of PEI-epoxy interfaces

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Abstract

Fusion welding is a common joining technology for thermoplastic composites. This can also be applied to thermoset composites if a thermoplastic layer is located at the surface of the composite. However, this requires to join the thermoplastic layer to the composite prior to welding. This requires to form a tough interface during the curing between the thermoplastic layer and the composite resin. Potential candidates are thermoplastic compatible with the epoxy resin of the composite such as polyetherimide (PEI). Several studies investigated the influence of the curing parameters on the formation of PEI-epoxy interfaces and the mechanical properties of PEI-epoxy blends. Recently, Voleppe et al. (Q. Voleppe, W. Ballout, P. Van Velthem, C. Bailly, and T. Pardoën, “Enhanced fracture resistance of thermoset / thermoplastic interfaces through crack trapping in a morphology gradient,” *Polymer (Guildf)*, vol. 218, no. September 2020, p. 123497, 2021, doi: 10.1016/j.polymer.2021.123497) reported a high fracture toughness associated with a crack trapping mechanism for this kind of interface. The present goal is to understand this mechanism by: (i) determining the mechanical properties of PEI-epoxy blends and the failure mechanisms taking place depending on the morphology, (ii) investigating the variation of the properties along the interface through nanoindentation, (iii) in-situ crack propagation to investigate the failure mechanism and subsequent fractography analyses. This study reveals that the high G_{IC} observed by Voleppe et al. is due to initiation in a PEI-rich zone while subsequent crack propagation takes place at a weak interface between a PEI layer and the epoxy resin as PEI and epoxy lack chemical interactions. This highlights the fact that not only initiation must be considered when testing that kind of interfaces and that chemical interactions between the polymers are required to obtain a good interface.

Keywords: PEI-epoxy interfaces; fracture toughness; crack trapping