BONDING POLYMER COMPOSITES WITH PEI FILM: CRACK TRAPPING AND ENHANCED FRACTURE RESISTANCE

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INTRODUCTION

Fiber reinforced polymer (FRP) composites offer many advantages such as lightweight and high strength motivating their intensive use in aircrafts. However, the manufacturing of complex composite parts often requires bonding composite parts in an efficient way [1]. Adhesives can be used, but with low to moderate toughness [2] and difficulties to develop integrated manufacturing approaches. Several strategies have been proposed to increase the joint toughness. One option is replacing the adhesive by a thermoplastic film, but which necessitates a tough thermoplastic-thermoset interphase.

Recently, Voleppe et al. observed an enhanced fracture resistance of thermoplastic/thermoset interfaces owing to a crack trapping mechanism in a morphological gradient when inserting a PEI film in the epoxy resin RTM6 [3]. The interface is characterized by a fracture toughness equal to 800J/m², similar to that of good structural adhesives for composite bonding, while the one of the epoxy resin is only about 100 J/m². The crack is trapped between the PEI film and a co-continuous morphology (Figure 1). The goal of the current research is to apply this concept to composite bonding and to better understand this toughening mechanism.

JOINING COMPOSITES WITH PEI FILM

FRP composites are joined together during the curing process in a Resin Transfer Molding (RTM) press by inserting a PEI film in the middle of the plate. The co-curing of the composite parts and PEI creates the right morphology gradient to trigger the crack trapping. Double cantilever beam (DCB) specimens are manufactured from the composite plate.

The DCB specimens are tested according to the ISO 25217 standard to evaluate the fracture toughness of the manufactured joints. PEI films of different thicknesses are inserted in order to determine if the thickness influences the joint toughness as it has already been reported for toughened epoxy adhesives [2].

UNDERSTANDING THE ORIGIN OF ENHANCED FRACTURE RESISTANCE

In order to unravel the origin of the enhanced fracture resistance observed in [3], blends with different PEI weight percentage ranging from 0 to 20 % are manufactured. Compression, nanoindentation and single-edge-notch bend (SENB) tests are performed on these homogeneous blends. Nanoindentation mapping is also performed along the interphase created when inserting a PEI film in RTM6 to evaluate the local properties.

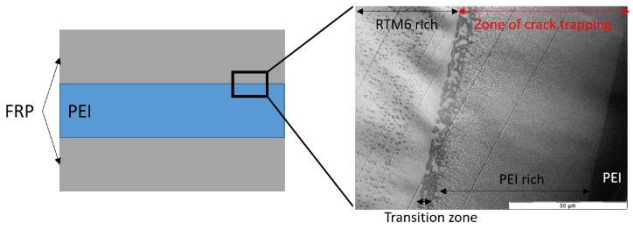

Figure 1: composites bonded with PEI and the gradient morphology observed at the PEI-FRP interface

CONCLUSION

The enhanced fracture resistance observed for PEI-RTM6 interfaces is transferred to the joining of composites by inserting a PEI film between two composite parts during a co-curing step. The toughness of the joint is improved and is similar to that of structural adhesives for composite bonding.

References

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