הטכניון - מכון טכנולוגי לישראל

TECHNION - ISRAEL INSTITUTE OF TECHNOLOGY

הפקולטה להנדסה כימית
ע״ש וולפסון
The Wolfson Department of Chemical Engineering

Wolfson Department of Chemical Engineering Seminar

Monday, August 14th, 2023 at 13:30
Room 1

A multi-scale level study to join C/PAEK to C/Epoxy via a material driven approach

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Common joining approaches to connect dissimilar materials are based on intermediators, such as mechanical fasteners and adhesives. The co-curing approach can be used to join thermoplastic composites (TPCs) to uncured thermoset composites (TSCs) based on direct contact between the substrates. The approach allows in principle a cost effective, efficient and repairable joining solution for structural aerospace applications. The co-curing approach has been presented in the literature through various techniques, but a profound and quantified understanding of the joining mechanisms at the micro, meso and macro levels is still lacking. Furthermore, the stability of the so-manufactured joints to long term service conditions is yet to be substantiated. Consequently, the aim of this study is to produce a robust and sustainable joining methodology with a full, multi-scale understanding of the employed co-curing approach. Exploratory research has been carried out based on different configurations: (i) thermoplastic PAEK films interleaved in carbon epoxy plies; (ii) Carbon/PAEK (C/PAEK) to Carbon/Epoxy (C/Epoxy), that were joined at elevated temperature and pressure. UV-ozone treatment was shown to be essential to enhance the surface energy of TP/TPC constituents. Surface analysis of the UV-treated PAEK films revealed increased wettability and higher concentrations of oxidized/reactive groups with the increase of UV exposure time that support the bonding behavior at the PAEK-epoxy interface. The mandrel peel test was used to investigate the fracture behavior and assess the interfacial fracture toughness. Results of the interleaved PAEK based sample showed intraply failure, where the crack propagated through the C/Epoxy ply, with a fracture toughness value of about 0.5 kJ/m^2. A value which is comparable to the reference sample that consisted of C/epoxy plies cured without the interleaved PAEK film. Results of the fiber reinforced TP polymer, i.e. C/PAEK joined with C/PAEK, showed higher fracture toughness values compared to C/Epoxy, with combined intraply and interfacial failures. Increased values and favorable failures of the later joint were found to be with correlation to increased UV intensities. Characterization and analysis tools have been utilized to evaluate the bonding behavior at multiple length scales. For the micro and meso scales, the chemical principles and physical mechanisms that underlay the generation of the bond strength have been studied. The macro scale is being analyzed by mechanical evaluation of the joint strength. Future work is aimed towards further understanding of the role of the surface treatment and the exposure to more practical, humid and cyclic conditions.

Refreshments will be served at 13:15.