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Carbon Fiber Manufacturing Conditions to Improve Interfacial Adhesion

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Abstract : Although carbon fibre composites are becoming ever more prominent in the engineering industry, interfacial failure still remains one of the most common limitations to material performance. Carbon fiber surface treatments have played a major role in advancing composite properties however research into the influence of manufacturing variables on a fiber manufacturing line is lacking. This project investigates the impact of altering carbon fiber manufacturing conditions on a production line (specifically electrochemical oxidization and sizing variables) to assess fiber-matrix adhesion. Pristine virgin fibers were manufactured and interfacial adhesion systematically assessed from a microscale (single fiber) to a mesoscale (12k tow), and ultimately a macroscale (laminate). Correlations between interfacial shear strength (IFSS) at each level is explored as a function of known interfacial bonding mechanisms; namely mechanical interlocking, chemical adhesion and fiber wetting. Impact of these bonding mechanisms is assessed through extensive mechanical, topological and chemical characterisation. They are correlated to performance as a function of IFSS. Ultimately this study provides a bottoms up approach to improving composite laminates. By understanding the scaling effects from a singular fiber to a composite laminate and linking this knowledge to specific bonding mechanisms, material scientists can make an informed decision on the manufacturing conditions most beneficial for interfacial adhesion.

Keywords : carbon fibers, interfacial adhesion, surface treatment, sizing
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