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Flexural Properties of Carbon/Polypropylene Composites: Influence of Matrix Forming Polypropylene in Fiber, Powder, and Film States

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Abstract : Thermoplastic composites render new opportunities as effective processing technology while crafting newer complications into processing. One of the notable challenges is in achieving thorough wettability that is significantly deterred by the high viscosity of the long molecular chains of the thermoplastics. As a result of high viscosity, it is very difficult to impregnate the resin into a tightly interlaced textile structure to fill the voids present in the structure. One potential solution to the above problem, is to pre-deposit resin on the fiber, prior to consolidation. The current study compares DREF spinning, powder coating and film stacking methods of predeposition of resin onto fibers. An investigation into the flexural properties of unidirectional composites (UDC) produced from blending of carbon fiber and polypropylene (PP) matrix in varying forms of fiber, powder and film are reported. Dr. Ernst Fehrer (DREF) yarns or friction spun hybrid yarns were manufactured from PP fibers and carbon tows. The DREF yarns were consolidated to yield unidirectional composites (UDCs) referred to as UDC-D. PP in the form of powder was coated on carbon tows by electrostatic spray coating. The powder-coated towpregs were consolidated to form UDC-P. For the sake of comparison, a third UDC referred as UDC-F was manufactured by the consolidation of PP films stacked between carbon tows. The experiments were designed to yield a matching fiber volume fraction of about 50 % in all the three UDCs. A comparison of mechanical properties of the three composites was studied to understand the efficiency of matrix wetting and impregnation. Approximately 19% and 68% higher flexural strength were obtained for UDC-P than UDC-D and UDC-F respectively. Similarly, 25% and 81% higher modulus were observed in UDC-P than UDC-D and UDC-F respectively. Results from micro-computed tomography, scanning electron microscopy, and short beam tests indicate better impregnation of PP matrix in UDC-P obtained through electrostatic spray coating process and thereby higher flexural strength and modulus.

Keywords : DREF spinning, film stacking, flexural strength, powder coating, thermoplastic composite
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