Polymer Powder Prepregging - Scoping Study

by

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There are several ways of interacting thermoplastic resins and carbon fiber tow to produce prepreg unitape. To some degree, nearly all compromise composite fabrication operations that follow. The ideal process is one in which an average 1 micron thick film of polymer is applied to individual unsized 5 to 7 micron diameter carbon fibers, without residual adducts such as binders, solvents, vehicles, carriers, surfactants or dopants. Most high-performance thermoplastic resins are available as fine reactor powders. LARC-TPI thermoplastic polyimide powder has squared-egg shape and is 1 to 10 micron in dimension. These powder characteristics are similar to those of DuPont Vespel PI and Amoco Torlon PAI. LARC-TPI is the candidate powder used here.

Early on, it was found that NEAT LARC-TPI behaved elastoplastically at pressures to 20 ksi and temperatures to 260°C (below MP). At high resin assay, resin powder could be continuously "cold-flowed" around individual carbon fibers in a metal rolling mill. At low resin assay (2:1, C:TPI), fiber breakage was prohibitive. Thus, although processing of TPI below MP would be quite unique, it appears that the polymer must be melted and flowed to produce low resin assay prepreg.

Fiber tow was spread to 75 mm using a venturi slot tunnel. This allowed intimate powder/fiber interaction. Two techniques have been examined for getting room temperature powder onto the room temperature fiber surface. Electrostatic powder coating allows the charged powder to cling tenaciously to the fiber, even while heated with a hot air gun to above its melt temperature. Figure 1 is a schematic of the proposed continuous prototype prepregging line. A variant of the wet slurry coating process has also been explored. The carbon fibers are first wetted with water. Then dry powder is sprinkled onto the wet tow and doctor-rolled between the fibers. The wet structure is then taken onto a heated roll, with hot air guns drying and sinter-melting the powder onto the fiber surfaces. In both cases, SEM shows individual fibers coated with powder particles that have melted in place and flowed along the fiber surface via surface tension. It is recommended that the electrostatic powder coating technique be developed here and the wet slurry process be developed under the NASA-VPI program.

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