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Functional coatings for polymer composites

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A helical coupling deposition system was developed for surface modification of fibers using plasma-enhanced chemical vapor deposition (PECVD). Plasma polymer films of controlled chemical, physical, and surface properties can be employed as functional coatings for fiber-reinforced polymer composites. Plasma polymer films were deposited on a bundle of pristine glass fibers from tetravinylsilane monomer at different powers ranging from 0.1 to 10 W using RF (13.56 MHz) pulsed plasma. The coated fibers were observed by scanning electron microscopy (SEM) to investigate film uniformity. The RF power controls the mechanical properties of deposited films via the plasma polymer cross-linking and film wettability changing the concentration of vinyl groups at film surface. The bundle of coated fibers was embedded into polyester resin and cured to form composite samples. The functional coating serves as suitable interlayer to improve compatibility between the glass fiber and the polymer matrix resulting in enhanced composite performance. The composite samples were tested by fiber-bundle pull-out test to determine the interfacial shear strength as a function of RF power and film thickness that was varied form 50 nm to 10 microns. A significant increase of the interfacial shear strength by 67% was found for the increased film thickness and a weak descent by 10% was related to the enhanced power. SEM micrographs of pulled-out (debonded) fiber bundle were used to characterize adhesion at the interlayer/fiber and polymer/interlayer interfaces.

Keywords
thin films
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