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Plasma polymerization as an effective tool for surface modification of glass fibers applied in polymer composites

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The fiber coating method is essential for improving the interfacial adhesion in glass fiber reinforced polyester composites. In our study, plasma polymer interlayers of pure tetravinylsilane monomer and monomer in a mixture with oxygen gas (0-71%) were used to surface modify glass fibers at an effective power of 2.5 W. We demonstrate that elemental composition and chemical structure of plasma polymer can be influenced by an amount of oxygen atoms (0-18at.%) partly incorporated into plasma polymer network (Si-O-C, C-O-C) and partly forming side hydroxyl and carbonyl groups eliminating cross-linking of the network. The Young's modulus of the interlayer decreased (19.3-12.2 GPa) with enhanced oxygen concentration as was controlled by the level of polymer cross-linking. The adhesion at the interlayer/glass interface can be maximized at an amount of 33-46% oxygen in the mixture as the result of sufficient concentration of Si-O-C bonding species and adequate cross-linking of the network. The vinyl groups at the interlayer surface are responsible for chemical bonding to the polyester resin at the polymer/interlayer interface. The polar groups (hydroxyl, carbonyl) at the interlayer surface are favorable for wetting the surface by the resin. A fiber bundle (unsized fibers) coated by plasma polymerization was embedded in polyester resin and cured to fabricate composite specimen that was cut and polished using conventional metallographic techniques to form composite cross-sections. The microindentation test was carried out on the individually selected glass fibers on a cross-section of GF/polyester composite to determine the interfacial shear strength. The interfacial strength for plasma coated fibers depended on oxygen amount in the mixture and varied from 0 to 32% above the strength of industrial sizing.

Keywords
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