

Influence of hygrothermal aging on carbon nanofiber enhanced polyester material systems

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Four polyester composites (neat polyester, polyester reinforced with glass fibers, polyester reinforced with carbon nanofibers, and polyester reinforced with both glass fibers and carbon nanofibers) were prepared with the Vacuum Assisted Resin Transfer Molding (VARTM) process. These material systems were exposed to 60 °C/60% RH for 3600 h. Diffusivity was determined using moisture uptake curves. And, it was discovered that the addition of glass fibers (GFs) increased diffusivity, while the addition of carbon nanofibers (CNF) decreased diffusivity. Optical analysis was performed on the manually delaminated glass fiber reinforced polymer (GFRP) and nano-enhanced GFRP. This analysis indicated that the addition of CNF retarded the degradation of the matrix after exposure to elevated heat and humidity. Thermo-mechanical analysis was performed across material systems during various stages of the environmental preconditioning to determine alterations in properties such as storage modulus (SM) and glass transition temperature (T_g). The addition of GF to the system initially increased the maximum storage modulus, it also increased degradation from elevated heat and humidity exposure. In contrast with GF, the addition of CNF retarded SM degradation and increased thermal stability. Upon re-drying, the nano-enhanced material systems recouped more than 90% of the maximum SM and maintained a T_g between the baseline and saturated hygrothermal treatments. This indicated both a reversible plasticization and an irreversible retarded degradation which could be potentially attributed to the addition of CNF.