The effect of surface modification of silica nanoparticles on the morphological and mechanical properties of bismaleimide/diamine matrices

Abstract

Silica and surface-modified silica nanoparticles were successfully incorporated into bismaleimide/diamine (BMI/DDM) matrices using a combinatory procedure that involved pretreatment of filler, mechanical mixing, ageing in BMI melt, and melt mixing. Fillers with different sizes and surface modification (of expoxide and BMI groups) showed to some extent the catalytic effect of the cure reaction on the matrix, without any negative effects. Nonmodified nanoparticles were found to interact with the BMI/DDM matrix through hydrogen bonding, whereas the surface-modified nanoparticles exhibited strong adherence to the polymer matrix through covalent bonding. Morphological analysis revealed that surface-modified nanoparticles were homogenously distributed within the polymer matrix, whereas the pure silica filler formed large aggregates due to strong filler–filler interactions. Nanocomposites reinforced with surface-modified silica nanoparticles showed significant improvements over pure silica, and improvements were also noted in the thermo mechanical properties and thermal stability of the neat BMI/DDM, such as the storage tensile modulus and glass transition temperature. A reduction in the coefficient of thermal expansion was also noted.