

HIGH-PERFORMANCE POLYMERIC NANOCOMPOSITES THROUGH FUNCTIONALIZED NANOMATERIALS

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Functionalizing nanomaterials is key to achieving homogeneous dispersion within a polymeric matrix. But how many functional groups are truly necessary on the nanomaterial surface to enhance the macroscopic properties of the resulting nanocomposite? In this talk, I will present two examples where mechanical and tribological properties were significantly improved using the same amount of nanomaterial—differing only in the degree of functionalization. Specifically, I will address the critical role of graft density ($G\phi$) in bi-functionalized graphene oxide (GO) with NH_2/NH_2 groups and its impact on the macroscopic properties of SLA 3D-printed nanocomposites. Using a one-step microwave-assisted synthesis, we achieved variable degrees of functionalization—categorized as low, medium, and high—at ultra-low loadings (0.01 wt.-%). Despite the minimal filler content, the resulting nanocomposites exhibited enhanced glass transition temperatures and improved thermal stability. Even at low graft densities, functionalized GO demonstrated superior compatibility with the cured resin, introducing a plasticizing effect. This effect allowed for a more adaptable mechanical response, enabling a transition from brittle to ductile behavior. Additionally, we elucidated how graft density plays a pivotal role in fine-tuning the toughness of the nanocomposite, even at ultra-low loadings. These findings provide valuable insights into SLA 3D printing and highlight the importance of nanofiller surface modification in optimizing material properties for diverse applications.

In a second example, the role of graft density also is studied, but on the functionalized SiO_2 nanoparticles to produce hybrid powder coatings with low friction coefficient. Nanoparticles migration was evidenced promoting a functional polymeric material.

Keywords: Graphene functionalization, graft density, improve properties

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