Nanocomposites and nanomaterials

Chemically-controlled nanostructured thermostable hybrid polymer networks with organic (triazine) and inorganic (POSS) junctions

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A few series' of nanostructured thermostable hybrid polymer networks of several cyanate esters of Bisphenols were prepared *in situ* in the presence of reactive silicon-based nanoparticles (NPs), viz., with epoxy cyclohexyl-functionalized polyhedral oligomeric silsesquioxane (POSS) molecule introduced in the amounts varying from 0.01 to 10 wt.%. The nanocomposites' structure, dynamics and properties were characterized in detail by FTIR, SAXS, TEM, DSC, DMA, TGA, Far-IR spectroscopy, laser-interferometric creep rate spectroscopy (CRS), and energy-dispersive X-ray spectroscopy (EDXS). FTIR spectra confirmed chemical embedding of NPs in these densely cross-linked networks. It was revealed that, even ultra-low additives of NPs (starting from 0.025 wt.%) exerted the substantial impact on their nanostructure, molecular dynamics and improving thermal/mechanical properties due to enhanced long-range action of the "constrained dynamics" effect. Thus, introducing 0.025% NPs already generated structural nanoheterogeneity suggesting a quasi-periodic type of spatial distribution of NPs in the amorphous matrix (SAXS), and POSS molecular dispersion within the nanocomposite matrix (TEM, EDXS). Ultra-low NP additives resulted in a substantial increasing $T_{g\ onset}$ (by $40\text{-}50^0$) and moduli by 1.5-3.0 times over the temperature range of $20\text{-}200^0$C, enhancing high temperature creep resistance and thermal stability at the earlier stages of their degradation (at $T < 400^0$C).

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