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NANO ENHANCED REACTIVE POLYMER SYSTEMS

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When properly functionalized and dispersed, nanoparticles offer an enormous surface area (hundreds of square meters/gram). In the case of reactive systems the interaction with the nanoparticles is even more amenable due to the low molecular weight of the reactants. Based on these fundamentals a wide basic study was carried out using a variety of functionalized nanoparticles and epoxies and polyurethanes reactive systems. Among the nanoparticles studied were: nanoclays (NC), Polyhedral-Oligomeric-Sil-Sesquioxane (POSS) and Inorganic fullerenes based on tungsten sulfide (IF-WS_2). These functionalized nanoparticles were incorporated into the reactive systems and the resulting effect on the mechanical and thermal properties of low temperature curing epoxy systems and elastomeric polyurethanes, was investigated. Experimental results indicated that when properly functionalized (amino silane, epoxy, hydroxyl) NCs increase the shear strength of both high and low temperature curing epoxies with almost no effect on peel strength, while functionalized POSS(amine, epoxy, isocyanate) increased simultaneously the shear and peel properties of epoxies and polyurethanes. When compatibilized with epoxy systems POSS have demonstrated an enhancement of fracture toughness in epoxy systems. In the case of WS_2 a special contribution to fracture toughness was observed at unusual small concentration (<0.5 %).The glass transition temperature (Tg) was increased significantly in both epoxy and polyurethane systems indicating that the incorporation of the functionalized nanoparticles led to interactions and network changes of the reactive systems. The interactions were also followed and verified using FTIR, XPS and SEM techniques.
It should be emphasized that in all the nanoparticles studied the enhancement due to the nano effect was realized at small concentrations and only when properly functionalized surfaces were used. Above the respective optimal concentrations the nano effect diminished and the properties decreased due to agglomeration.