Inorganic nanofillers, the new way of designing thermoplastic materials with enhanced properties

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Since the emerging of nanotechnology over the last decades, this area of knowledge has rapidly grown, attracting a great interest from the scientific community as a consequence of the novel applications and improved properties of this new type of materials.

In order to take advantage of the potential use of nanomaterials, it is important to provide them with good processability. In this context, plastics loaded with nanomaterials will present the existing qualities of the polymers, mixed with the unique properties of nanofillers. This family of materials denoted as polymer nanocomposites are prepared using a conventional polymer as host matrix which incorporates a low amount of fillers in order to obtain new materials suitable for novel applications.
Polymer nanocomposites are the key of future advances in the defense area. Among the capabilities offered by these nanocomposites are included the production of harder/lighter platforms, materials with higher resilience and robustness, special properties such electronic/opto-electronic/magnetic for sensoring applications, improvement in properties such as UV, toxic environments and fire resistance, and novel smart materials as well as new fuel sources and storage.

In this work, different commercial polymers such as: PVC and PC for thermal uses; PP and P6 for mechanical and wear resistance applications; and SEBS with remarkable magnetic properties, have been produced by loading them with a variety of inorganic fillers (from 1.5 to 7 wt% content) including hydrotalcites, inorganic molecular wires/ fullerenes nanotubes or cobalt nanoparticles.

The processing methods presented here can be potentially extrapolated to an industrial level and can be used in the defense fields for applications such as microwave absorbers, electromagnetic shielding, fire retardation and flammability reduction, in addition to reduce the maintenance costs (e.g., wear reduction, fatigue resistance increase).

The results obtained have shown that the fire risk, measured in terms of fire performance index (FPI) of PVC nanocomposites; consisting of 5 wt% nanoparticles surface-modified with non-halogenated fire retardant compounds, is about 70% lower with respect to pristine PVC polymer. (see Figure 1)

The composites containing nanowires show a significant increase of the E-module of up to 38% at a nanowire concentration of 4 wt% in the glassy state of PA6. Likewise, for a concentration of only 2 wt% of inorganic molecular wires based in molybdenum ($Mo_6S_2I_8$), a reduction of the friction coefficient by 35% compared to the neat polymer was observed. Meanwhile when the concentration was increased up to 4 wt% this reduction improved to ca. 40% together with reduction of the wear rate by ca. 57%.

Finally, in composites prepared with a thermoplastic elastomer matrix of SEBS and ferromagnetic cobalt nanoparticles (in 7wt% concentration), a ferromagnetic behaviour was observed with a magnetization saturation of ~10 emu/g and 280 Oe of coercivity field, at the same time the E-module increased up to 70%, in comparison with neat TPE matrix.

References

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Figures

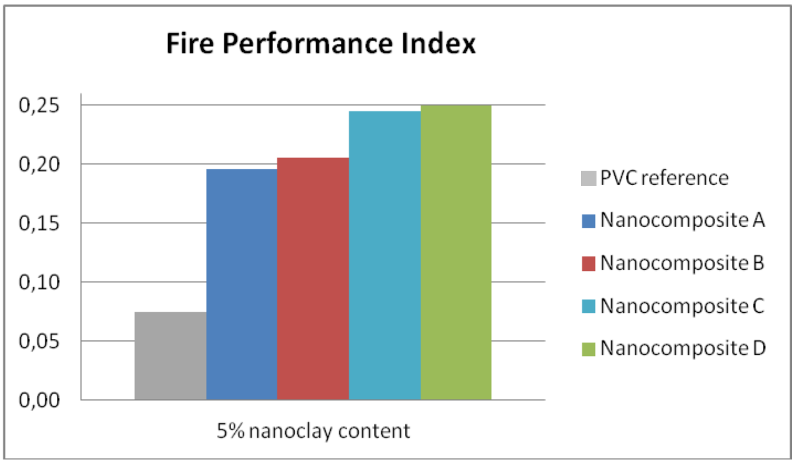

Figure 1. Fire performance index of different PVC nanocomposites with 5% of nanoclay content in comparison with the pristine PVC polymer.