11th International Conference
on Advanced Materials

Rio de Janeiro Brazil
September 20 - 25

ICAM2009

Nanocomposites of Polypropylene based on halogen free flame retardants for fire protection and safety

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Abstract – To obtain the best flame retardancy performance with polypropylene nanocomposites, an inorganic synergistic agent, a nanoporous filler, was incorporated to act in synergist with a phosphorus based flame retardant. The enhancement of performance on flammability properties was investigated by limiting oxygen index (LOI), UL-94, TGA, EDS/SEM, heating microscopy and cone calorimetry test. We observed that this additive has a synergistic effect in the intumescent system, allowing low levels of flame retardant, leading to better mechanical properties, LOI results of at least 30%, V-0 in UL-94 and significant decrease in the heat release rate compared with that of virgin PP.

The modern concept of flame retardancy implies that flame retardants should effectively reduce the probability of fire development and also its consequences, both on humans and on structures. In recent years, concern has been widely expressed about the toxicity of the versatile and highly efficient halogenated flame retardants. In the quest for halogen-free flame retardants much research is being centered on intumescent additives and nanotechnology will play the key role in improving fire-retardant performance and reducing production costs. Nanostructured particles, can act as synergistic agents in intumescent systems [1-3], for example, and have achieved some very promising results. In this work, it was employed the association of an intumescent formulation and an inorganic synergistic additive, a nanoporous filler, to obtain flame resistant polypropylene nanocomposites (NAPP), that could be used in a variety of household and industrial appliances.

Nanocomposites of polypropylene were prepared by melt-mixing the inorganic additive with lower levels of the phosphorus based flame retardant, in order to obtain better mechanical properties. The effects of the flame retardant on the flammability and thermally decomposing behaviors of NAPP were investigated using limiting oxygen index LOI, UL-94 rating standard, thermogravimetric analysis (TGA), heating microscopy, scanning electron microscopy (SEM) with EDS (Energy Dispersive X-ray Spectroscopy) and cone calorimeter measurements. The obtained NAPP have shown LOI values of at least 30% and were attained V-0 ratings according to the UL-94 standard. Additionally, the NAPP produced a relatively large residue percentage at 600ºC, in an air atmosphere, when submitted to TGA studies. The “swell up” and the thermal resistance of the char formed were observed through high temperature microscopy (figure 1). Flame retardancy was due to the formation of a heat resistant char layer at the surface of the material with chemical elements (X1 and X2) from the synergistic agent (EDS/SEM - figure 2) in this carbonaceous residue structure. Cone calorimetry shows strong decreases in the rate of heat release values compared to those of the virgin polymer, as well as decrease in the smoke density and CO release. All of these results show the increase in the efficiency of intumescent system for NAPP using nanoporous filler as synergists while also making it possible to reduce the amount of flame retardant necessary to deliver efficient flame retardancy performance within the stringent regulations imposed as well as enhancing mechanical properties.

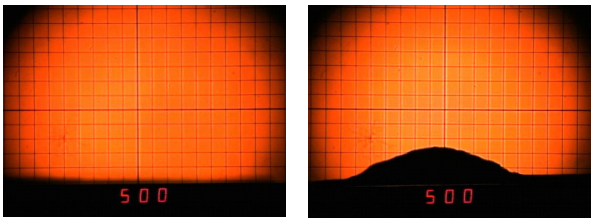

Figure 1 – Heating microscopy images of samples PP virgin (left) and PP Nanocomposite at 500°C

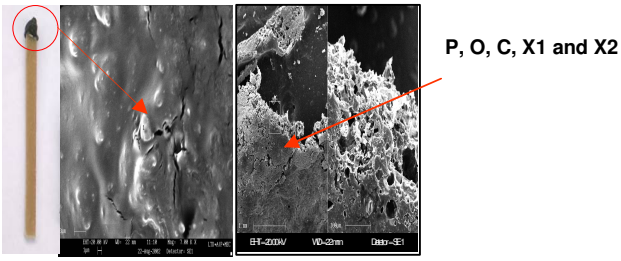

Figure 2 – EDS/SEM images of the carbonaceous residue obtained in UL-94 test specimen

References

[1] A.B. Morgan and C.A. Wilkie, Flame retardant polymer nanocomposites, 2007, John Wiley and Sons, Inc.
[2] S. Bourbigot, M. Le Bras, P. Breant, J. M.Tremillon, R. Delobel, Fire Materials, 1996, 20, 145.
[3] M.Jimenez, S.Duquesne, S. Bourbigot, Surface & Coatings Technology, v.201, n.10, p. 979–987, 2006.