SYNTHESIS OF NANOCOMPOSITE POLYURETHANE FOAMS BASED ON ORGANIC AND INORGANIC PHOSPHINATES

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Introduction The main aim of this work is to study the synergy between phosphinated flame retardants and layered silicates in polyurethane foams. Novel results on the synergism between organic phosphinates and ammonium modified clay on flame retardancy of PU foams will be reported and compared to the combined use of inorganic phosphinate and clays; moreover, also the effect of different clay amounts on the fire behavior and thermal stability will be considered.

Methods Polyurethane foams were prepared using a two steps procedure. A fixed amount of clays (3 or 5wt% on total foam mass) was dispersed in polyols mixture; clay dispersion was promoted using a microwave treatment[1]. After that, the catalysts, surface active agent, flame retardant (fixed amount, 10wt% on total foam mass) and blowing agent were added to the polyols mixture and stirred with a high speed mechanical stirrer. The isocyanate was added to this mixture; the components were mixed for 15 seconds and then poured into an open mould for free rise polymerization.

Characterization The thermal stability was studied by thermogravimetric analyzer, under air atmosphere with heating rate of 20°C min-1 from 25 to 800°C. Fire behavior was characterized by means of limiting oxygen index (LOI), according to ISO 4589, and cone calorimeter (CC) test according to ISO 5660.

Results: Fire behavior The use of both organic or inorganic phosphinate is very effective in enhancing LOI; however, inorganic phosphinate showed better performance. No significant effect of the nitrogen-based synergic compound can be seen. Moreover, further addition of layered silicate to phosphinates led to no significant variation, as already reported by other authors for analogous systems[2]. The cone calorimeter results shows very low ignition time (1s) for all samples tested because of the cellular structure of the material and the high radiant heat flux (50 kW/m2). After ignition, all materials exhibited a sharp increase in the heat release rate (HRR) until a first maximum was reached (peak of heat release rate, PHRR). The first PHRR was followed by a second peak, with lower intensity. The second peak was ascribed to the combustion process of an intermediary decomposition product or intermediary char. The use of phosphinates, both organic and inorganic, led to a decrease of the first PHRR more or less marked: the better results were obtained for IPA filled foams (Figure 1).

Conclusions For all analysed nanocomposite foams, the use of ammonium modified nanoclays seemed to depress gas phase activity, enhance the development of partly combusted products and increase the smoke released (TSR), thus showing no synergistic effect.

1. Lorenzetti, A.; Hrelja, D.; Besco, S.; Roso, M.; Modesti, M. J Appl Polym Sci 2010, 115, 3667-3674

2. Zammarano, M; Krämer, R.H.; Harris, R.; Ohlemiller, T.J.; Shields, J.R.; Rahatekar, S.S.; Lacerda, S.; Gilman, J.W. Polym Adv. Technol., 2008, 19, 588-595

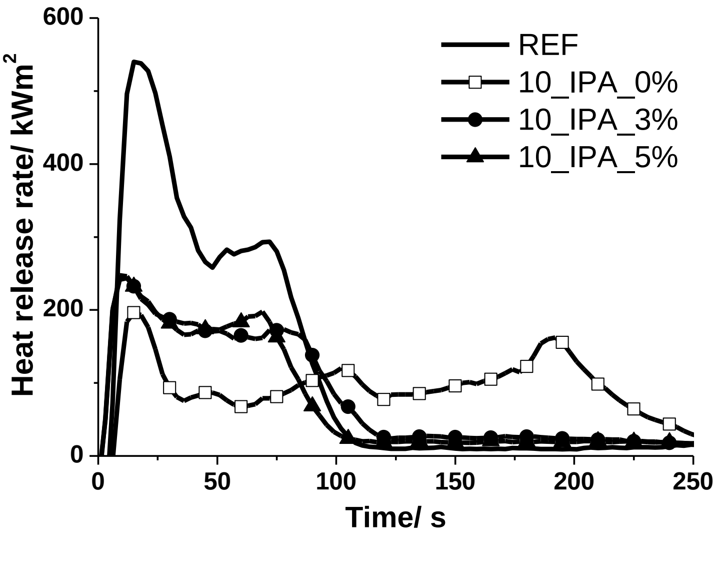

Figure 1 Heat release rate (HRR) for unfilled (REF) and IPA filled PU foams.