Research topic:
Materials

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The research activity is carried out in collaboration with the PEG, Polymer Engineering Group.

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Polymer Engineering Group

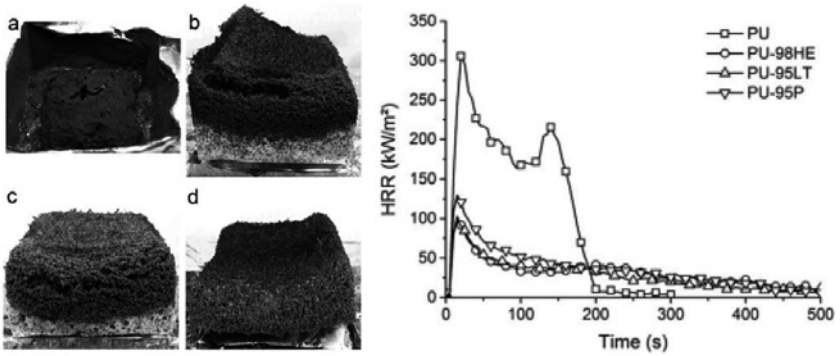
Main research topics:
- Nanostructured membranes based on nanofibers
- High performance polymeric nanocomposites
- Thermal stability and fire behavior of polymeric materials
- Design and processing of polymeric materials
- Physical and chemical recycling of plastic materials

Expandable graphite in polyurethane foams: the effect of expansion volume and intercalants on flame retardancy

Expandable graphite (EG) belongs to the class of graphite intercalation compounds. These materials are formed by inserting atomic or molecular layers of a different chemical species as an intercalant between the layers of a graphite host material. Since 2002 EG is being widespread used as flame retardant in polyurethane (PUR) and polyisocyanurate (PIR) due to its capability to act as char that covers the burning surface, slowing the spread of the flame. Despite this, just few studies have dealt with the effect of EG properties on fire behavior but only in terms of the combined effect of expansion volume and EG size. In order to have a better understanding of EG role we have avoided this "coupling effect" by analyzing the fire behavior of different EGs with the same particle size. Specifically we have analyzed their retardancy effectiveness in PUR foams in terms of type of intercalant compound (sulfur- or phosphorus-based) and expansion volume (Table 1).

Table 1. Main properties of EGs used

Sample	Minimum expansion volume (cm^3/g)	Particle size
98HE	300	min 70% > 50 mesh
95LT	200	min 70% > 50 mesh
95P	200	min 70% > 50 mesh



The results have shown that both the two type of intercalants enhance the residue yield, induce a protective layer, and thus efficiently flame-retard PUR foams (Figure 1). However the expansion volume of the EGs had a surprisingly limited influence on the performance of the foams, at least in the range tested. The most important feature controlling the effectiveness of EG in terms of flame retardancy of PUR foams was the type of intercalant, with better performance of sulfur over phosphorus. The presence of EG affected the physical–mechanical properties of the foams; however, no significant effect of the expansion volume or intercalant type has been revealed on the physical–mechanical properties of the foams (Figure 2).

Figure 2. Compression strength (left) and thermal conductivity (right) of unfilled and filled PU foams