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Fire Retardancy of Polymeric Systems

Motivation

The majority of polymers used in technical applications naturally exhibit poor flame retardancy properties and, thus, require either molecular or additive modification to lower the probability of a fire hazard. Since intrinsically flame retardant polymers available today mostly exceed the cost of conventional polymers many times over, modification of conventional grades with flame-retardant additives is the most widely used alternative in order to fulfill stringent flame retardancy standards. Particularly intumescing systems represent a promising group of flame retardant additives, providing long protection in a fire hazard. New developments in material science now enable expandable graphit (EG) (Fig. 1) to be used as flame-retardent additive system in technical polymers

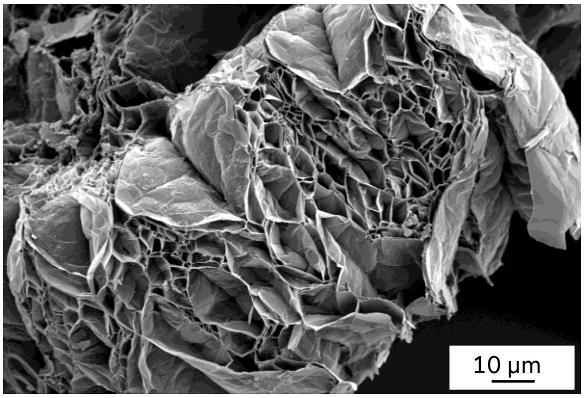

Fig. 1: Scanning electron microscope (SEM) images of an expended graphite platelet

Application

Today, EG is successfully used as flame retardant additives predominantly in polyurethane (PU) foams, gaskets and flame retardant coatings. EG provides excellent long term, low cost fire protection, structural stability and is characterized by a low smoke generation (Fig. 2).

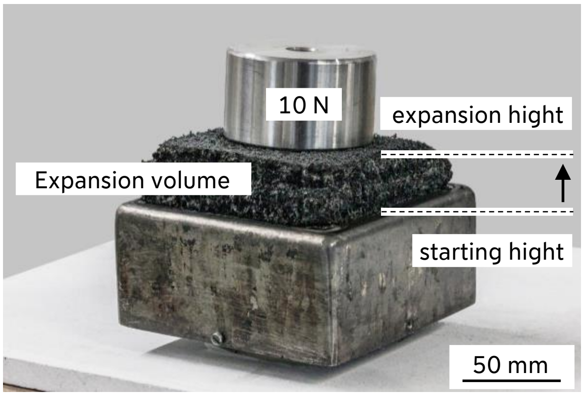

Fig. 2: Expanded graphite residue after cone calorimeter testing

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Research focus

Most commercially available EG types exhibit a temperature stability up to 230 °C, which exceeds processing temperatures used for technical or high performance thermoplastics. A newly developed, higher temperature-stable EG grade has been fundamentally characterized for usage in engineering thermoplastics, allowing processing temperatures up to 270 °C [1]. The study has been focused on the investigation and characterization of fire protection properties of this new EG type as additive for glasfiber reinforced polyamide 6 (PA6). Fundamental mechanical testing provided further information about performance properties.

Main research results

Results revealed excellent fire protection properties of EG and EG mixtures in cone calorimeter tests due to an enormous char formation (Fig. 3). Recipes containing EG/ AlPi/ MPP/ MMT performed particularly well, exhibiting a peak heat release rates (pHRR) under 100 kW/m². A very low total heat release (THE) was measured due to the highly effective thermal isolation layer, leaving a substantial amount of non-combusted polymer in the residual layer. A low total smoke production was found and attributed to a very low burning rate as well as a low gas phase activity. Good LOI and a UL-94 V0 classification could be achieved for the synergistic flame retardant recipe based on EG/ AlPi/ MPP/ MMT. Additionally, mechanical properties of the synergistic mixture performed well achieving 77 MPa tensile strength and 10.000 MPa E-module (Fig. 4).

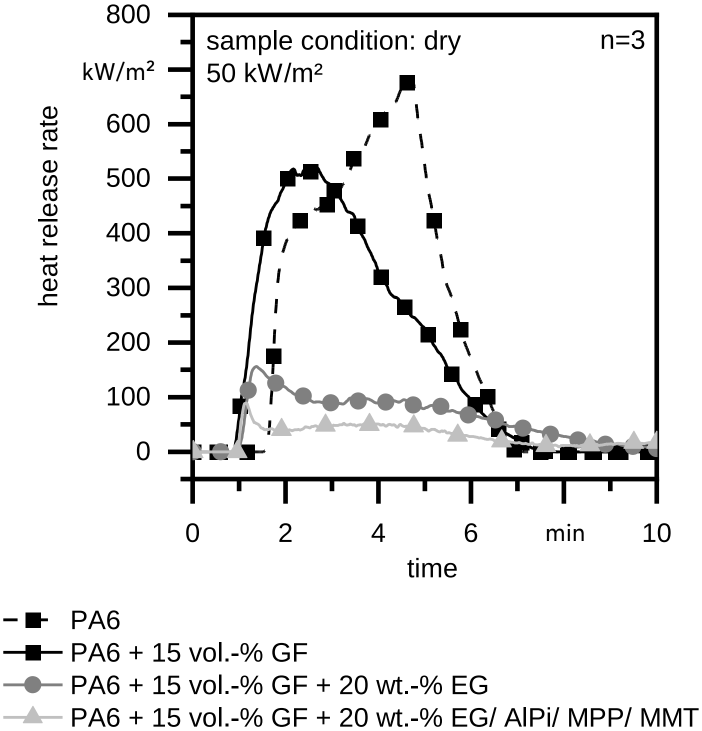

Fig. 3: *Cone calorimeter results of glass fiber (GF) reinforced recipes based on PA6, expandable graphite (EG), Aluminum diethylphosphinat (AlPi), Melaminpoly-*

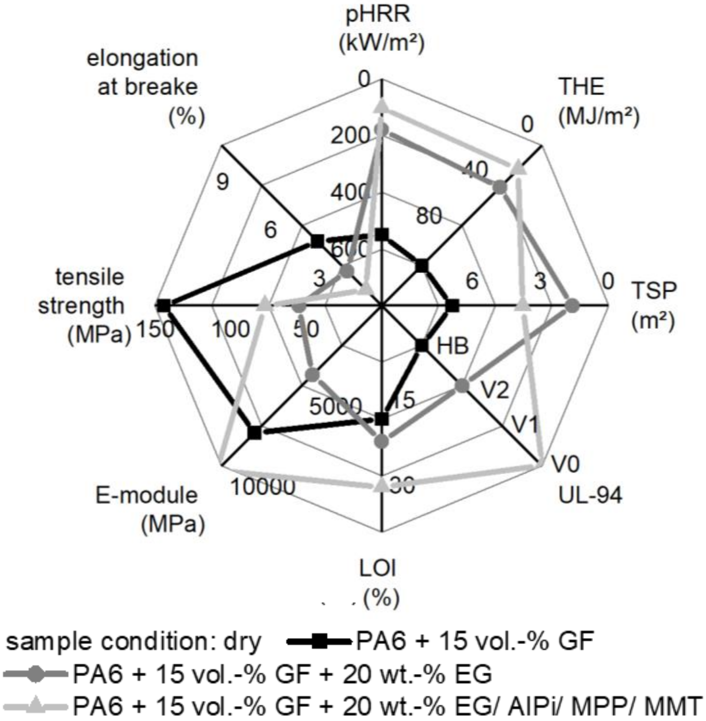

Fig. 4: *Fire and mechanical performance – a summary*

[1]: LUH GmbH

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