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Aleksandra Sut, Elke Metzsch-Zilligen, Michael Großhauser, Rudolf Pfaendner, Bernhard Schartel

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Rapid mass calorimeter as a high-throughput screening method for the development of flame-retarded TPU

Aleksandra Sut[1], Elke Metzsch-Zilligen[2], Michael Großhauser[2], Rudolf Pfaendner[2], Bernhard Schartel[1*]

[1] Bundesanstalt für Materialforschung und –prüfung (BAM), Unter den Eichen 87, 12205 Berlin, Germany

[2] Fraunhofer-Institut für Betriebsfestigkeit und Systemzuverlässigkeit LBF, Schlossgartenstr. 6, 64289 Darmstadt, Germany

*Corresponding author: bernhard.schartel@bam.de

Abstract

The rapid mass calorimeter (RMC) was used as a screening tool based on accelerated fire testing to assess flame-retarded thermoplastic polyurethane (TPU). The reliability of RMC results was proven with the cone calorimeter as reference fire test. The influence of melamine cyanurate (MC) concentration on the fire performance of TPU was investigated, along with some flame-retardant combinations such as MC with aluminium diethylphosphinate (AlPi), aluminium trihydrate (ATH), and melamine polyphosphate (MPP). The two-stage burning behaviour of TPU was investigated in detail; the first stage corresponds mainly to the hard segments' decomposition and has a much lower effective heat of combustion (EHC) than the second stage, in which mainly the soft segments decompose and an intensive liquid pool fire is observed in the cone calorimeter set-up. In addition to fire testing with the cone calorimeter, RMC, and UL 94 flammability tests, the decomposition of the materials was investigated using thermogravimetric analysis coupled with infrared spectrometry (TG–FTIR). TPU/MC/AlPi shows the most promising results, achieving V-0 classification in UL 94 and reducing the extreme peak heat release rate (PHRR) of the liquid pool fire from 3154 kW/m^2 to 635 kW/m^2. Using MC/AlPi/MPP enhances the latter PHRR reduction further. The