

Polystyrene-based composites and nanocomposites with reduced brominated-flame retardant

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Abstract Polystyrene was melt blended with a halogen-based flame retardant (FR), hexabromocyclododecane, and a non-halogenated FR, triphenyl phosphate (TPP), in a twin-screw extruder. An organically modified montmorillonite (Cloisite 15A) was used to prepare FR polystyrene nanocomposites. The flammability properties and thermal stability of FR polystyrene composites and nanocomposites were investigated. X-ray diffraction analysis showed that the exfoliation structure of organically modified montmorillonite in polystyrene nanocomposites may be achieved by melt-compounding in a twin-screw extruder. Furthermore, a good dispersion of FRs and nanoparticles of organically modified montmorillonite was observed by energy dispersive X-ray analysis. Thermogravimetric analysis demonstrated that the thermal stability of FR nanocomposites enhanced in the presence of clay nanoparticles and antioxidant. The aim of this study was to reduce the FR level, especially in the brominated FRs. The good results obtained by the limiting oxygen index test showed high-performance flammability properties in the composites containing hexabromocyclododecane and TPP, resulted from the synergy effects between these two FRs. However, in spite of producing high thermal performance polystyrene nanocomposites and dispersing clay nanoparticles efficiently into the polystyrene matrix, the flame retardancy properties were deteriorated in the presence of clay nanoparticles. Therefore, the organically modified clay (Cloisite

15A) was not a good synergic compound to improve the flame retardancy of polystyrene nanocomposites.

Keywords Polystyrene · Flame retardant · Hexabromocyclododecane · Triphenyl phosphate · Nanocomposite

Abbreviations

AO	Antioxidant
ASTM	American Society for Testing and Materials
DTGA	Differential thermogravimetric analysis
EDXA	Energy dispersive X-ray analysis
FR	Flame retardant
GPPS	General purpose polystyrene
HB	Horizontal burning
OMMT	Organo-modified montmorillonite
HBCD	Hexabromocyclododecane
LOI	Limiting oxygen index
PS	Polystyrene
SEM	Scanning electron microscopy
TEM	Transmission electron microscopy
TGA	Thermogravimetric analysis
TPP	Triphenyl phosphate
UL-94	Underwriters Laboratories
XPS	Extruded polystyrene
XRD	X-ray diffraction

Introduction

Polymeric materials play an important role in modern communities through the creation of alternative materials which have the potential to be applied in various industries. Polystyrene is one of the widely used polymers, which has a broad range of applications in construction

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