Chemical modification of polystyrene in order to reduce its flammability

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Abstract:

There has been a big interest in an issue associated with an enhancement of polymers fire resistance. It is because of safety considerations and requirements related to flammability. Polystyrene is one of the most flammable polymers. Nowadays, a physical modification based on an application of additive flame retardants is commonly applied in order to reduce a polystyrene flammability. Despite this method, which is quite easy to conduct, it has cons such as: during combustion large quantities of toxic gases are emitted, moreover, high concentrations of additive flame retardants leading to deterioration of mechanical and physical properties of polymers. For these reasons, the chemical modification based on an utilization of reactive flame retardants, which constitute integral part of polymer backbone and contain atoms responsible for reduction flammability may be an alternative method. The aim of the study was the chemical modification of polystyrene by means of a copolymerization of styrene with comonomer acting as reactive flame retardant. Various concentrations of styrenic comonomers with covalently bonded halogen, phosphorus, boron atoms and vinyl derivatives containing bromine atoms were used. The obtained (co)polymers were analyzed in terms of their thermal properties by thermogravimetric analysis (TGA) and differential scanning calorimetry (DSC). Additionally, the flammability of synthesized (co)polymers was evaluated on the basis of results from pyrolysis combustion flow calorimeter (PCFC). Furthermore, the combination of two techniques, that is gas chromatography and mass spectrometry (GC-MS) allowed to identify a composition of the thermal degradation products. Moreover thermal degradation kinetics was studied for selected (co)polymers. The best results (the lowest values of heat release (HR), the highest amount of char residue after heating polymer to 800°C) indicating good flame retardant properties of applied comonomer exhibited polymers with covalently bonded bromine, fluorine, boron and phosphorus atoms.