The Effect of Phosphorus on Flame Retardancy of Plastics

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ABSTRACT

Halogen-free flame retardant (FR) material, specifically the phosphorous FR material, has an increasing application in polymer industry. The phosphorous FR mechanism in burning polymeric solids is still controversial primarily owing to the coupled gas phase and condensed phase reaction. In order to better understand this mechanism, triphenylphosphine oxide (TPPO) was mixed with polystyrene (PS) at different concentrations; and the samples were examined with multiple flammability test standards. Other flame retardants, including polymeric FR, hexabromocyclododecane (HBCD), and decabromodiphenyl oxide (DBDPO) were also mixed with PS and their flammability was also examined. We attribute the significant reduction in combustion efficiency to the heterogeneous mechanism of promoting soot formation in flames. Detailed characterizations of the soot collected from the fire calorimetry test were performed. It is found that phosphorus only slightly increases the soot particle size. About 75% of phosphorus in the virgin sample is incorporated into soot particles. The nascent soot with P contains more aromatic structures and does not undergo sufficient dehydrogenation to form the more matured aliphatic soot. It is therefore speculated that phosphorus increases direct condensation of aromatic structure; and the cooler flame temperature as a result of more radioactive heat loss inhibits the soot dehydrogenation process.