

## Advanced Phosphorus-Containing Polymer Materials towards Eco-Friendly Flame Retardant Epoxy Thermosets

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**Abstract :** Nowadays, epoxy materials are extensively used in ever more areas and under ever more demanding environmental conditions due to their remarkable combination of properties, light weight and ease of processing. However, these materials greatly increase the fire risk due to their flammability and possible release of toxic by-products as a result of their chemical composition which consists mainly from carbon and hydrogen atoms. Therefore, improving the fire retardant behaviour to prevent the loss of life and property is of particular concern among government regulatory bodies, consumers and manufacturers alike. Modification of epoxy resins with organophosphorus compounds, as reactive flame retardants or additives, is the key to achieving non-flammable advanced epoxy materials. Herein, a detailed characterization of fire behaviour for a series of phosphorus-containing epoxy thermosets is reported. A carefully designed phosphorus flame retardant additive was simply blended with a bifunctional bisphenol-A based epoxy resin. Further thermal cross-linking in the presence of various aminic hardeners led to eco-friendly flame retardant epoxy resins. The type of hardener, concentration of flame retardant additive, compatibility between the components of the mixture, char formation and morphology, thermal stability, flame retardant mechanisms were investigated. It was found that even a very low content of phosphorus introduced into the epoxy matrix increased the limiting oxygen index value to about 30%. In addition, the peak of the heat release rate value decreased up to 45% as compared to the one of the neat epoxy system. The main flame retardant mechanism was the condensed-phase one as revealed by SEM and XPS measurements.

**Keywords :** condensed-phase mechanism, eco-friendly phosphorus flame retardant, epoxy resin, thermal stability

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