Transparent flame retardant epoxy nanocomposites based on Novolac resin, in-situ sol-gel amorphous silica, and a liquid DOPO derivative

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Sol-gel chemistry offers a powerful route for the design of multifunctional epoxy nanocomposites; however, achieving high optical clarity together with fire safety remains challenging. In this work, fully transparent and self-extinguishing silica-epoxy nanocomposites were developed via an in-situ sol-gel process using a Novolac epoxy resin [1, 2]. Unlike systems based on bisphenol A diglycidyl ether, which form crystalline silica particles and exhibit opalescence at high filler loadings [1], the Novolac matrix promotes the formation of well-dispersed amorphous silica nanoparticles (SNPs), yielding transparent materials with transmittance values of approximately 80%. To impart flame retardancy while preserving transparency, a liquid phosphorus-based additive was incorporated into the in-situ modified Novolac resin containing 2 wt.% of SNPs [2]. The resulting nanocomposites exhibit non-dripping, self-extinguishing behaviour and achieve UL94-V0 classification with only 3 wt.% of phosphorus. Cone calorimetry tests revealed a significant enhancement in fire performance, with reductions of 34% in total heat release and 56% in peak heat release rate compared to pristine Novolac resin [2]. These results demonstrate a promising strategy for producing sustainable transparent, fire-safe epoxy nanocomposites suitable for electronics, coatings, and advanced composites.

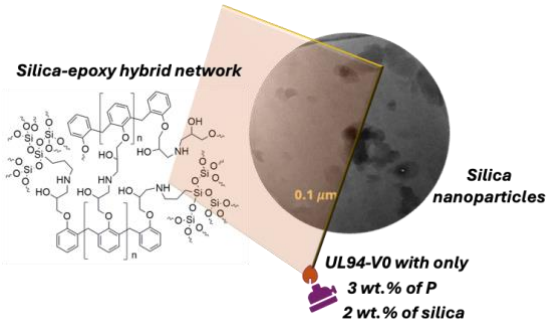

Figure 1. Self-extinguishing epoxy nanocomposites based on a sol-gel modified Novolac resin.

Keywords: Sol-gel, hybrid nanocomposites, transparency, Novolac epoxy resin, silica, fire behaviour.

References

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