

Studies on the thermal and morphological properties of blends of thermosetting phenolic resin and nonfiller

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Nanocomposites generally exhibit improvements in properties of polymeric materials even at very low volume fraction loading (1-5%). Phenolic resins have a 3-D structure even prior to cure, which makes exfoliation of the clay with the polymers difficult. The blends of epoxy and resole offer a versatile spectrum of superior properties such as outstanding strength and adhesion, good solvent and chemical resistance, high heat and thermal resistance, etc. [1, 2]. The resoles from various phenols viz. phenol, *o*-cresol, *p*-cresol, and *m*-cresol were synthesized by reacting respective phenols, separately, with formaldehyde in a molar ratio of 1:2 in basic medium at 70 °C (Knop and Schieb method). The DGEBA-epoxy resin was mixed with various resoles, separately, in different weight ratios ranging between 0-100 wt% in the interval of 25 wt%. Prior to curing, nano clay was incorporated in epoxy/resole blends through ultrasonication technique at 70°C for several hours. A stoichiometric amount of the curing agent corresponding to 40 wt% of total weight of blend of epoxy/resole content was added. All samples, poured in a steel mould, were cured for 3 h at 75 °C and post-cured 12 h at 110 °C. Compositions are tabulated in Table 1. The resole prepared from phenol, *o*-cresol, *p*-cresol, and *m*-cresol have been designated as R₁, R₂, R₃, and R₄, respectively. The blend sample containing 50 wt% epoxy with 1, 2, 3 wt% nano clay loading and cured with 40 wt% polyamide have been discussed in our presentation.

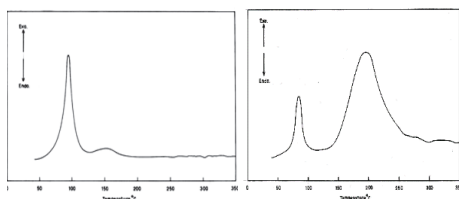


Figure 1: DSC scans of (a) pure resole-type phenolic resin and (b) DGEBA epoxy/resole-type phenolic resin blend

Figure 1a and 1b show the dynamic DSC scans of resole (R₁) and its blend with epoxy resin. Two exotherms appeared and extrapolated at 98° and 148 °C. Figure 1b clearly indicated that the exotherm of the lower temperature scale of sample R₁ shifted to 85 °C whereas the exotherm of the higher temperature scale appeared at 198 °C for blend sample.

The XRD pattern of blend sample (Figure 2) where the peak of the clay at 2θ = 3.2° has been vanished which indicated that exfoliation has occurred. Figure 3 shows the TEM micrograph, which show the complete exfoliation of nano particles in epoxy/resole-type phenolic resin matrix system with 2 wt% loading of nano clay.

Type of resole	Table 1 DGEBA epoxy (wt%)														
	0			25			50			75			100		
	Nano Clay loading (wt%)														
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
R ₁	ER ₁₀₁	ER ₁₀₂	ER ₁₀₃	ER ₂₀₁	ER ₂₀₂	ER ₂₀₃	ER ₃₀₁	ER ₃₀₂	ER ₃₀₃	ER ₄₀₁	ER ₄₀₂	ER ₄₀₃	ER ₅₀₁	ER ₅₀₂	ER ₅₀₃
R ₂	ER ₂₀₁	ER ₂₀₂	ER ₂₀₃	ER ₃₀₁	ER ₃₀₂	ER ₃₀₃	ER ₄₀₁	ER ₄₀₂	ER ₄₀₃	ER ₅₀₁	ER ₅₀₂	ER ₅₀₃	ER ₆₀₁	ER ₆₀₂	ER ₆₀₃
R ₃	ER ₃₀₁	ER ₃₀₂	ER ₃₀₃	ER ₄₀₁	ER ₄₀₂	ER ₄₀₃	ER ₅₀₁	ER ₅₀₂	ER ₅₀₃	ER ₆₀₁	ER ₆₀₂	ER ₆₀₃	ER ₇₀₁	ER ₇₀₂	ER ₇₀₃
R ₄	ER ₄₀₁	ER ₄₀₂	ER ₄₀₃	ER ₅₀₁	ER ₅₀₂	ER ₅₀₃	ER ₆₀₁	ER ₆₀₂	ER ₆₀₃	ER ₇₀₁	ER ₇₀₂	ER ₇₀₃	ER ₈₀₁	ER ₈₀₂	ER ₈₀₃

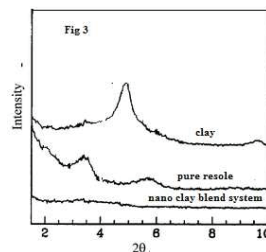


Figure 2: XRD patterns of clay, pure sample and blend

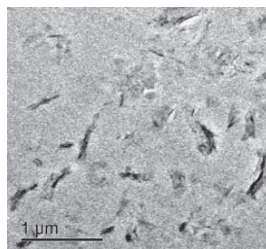


Figure 3: Tem micrograph of the blend

References

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