Characterization of environmentally sustainable resole phenolic resins synthesized with plant-based bio-resources

ABSTRACT

"Green" resole phenolic resins for laminating applications were synthesized, and their properties and thermal stability were determined. The plant-based cardanol and condensed tannin were used as the partial substitutes of up to 40% of the phenol in the synthesis of the phenolic resins. The resins were synthesized with different proportions of phenol (P) to cardanol (C) and with different total molar ratio to the formaldehyde (F) in the resins (1.25 to 2.0). An increased cardanol content resulted in a proportional increase in the flexibility and fracture toughness of the cured cardanol-phenol-formaldehyde (CPF) resins. Also, a direct proportionality was found between increasing cardanol content and decreased crosslink density of the CPF resins. The best results were obtained with the formulation with a P:F molar ratio equal to 1:1.25. Tannin was incorporated into the CPF resins and the fracture toughness and flexibility values of the cured Tannin-CPF resins were found to be proportional to and increasing with the tannin content. However, glass transition temperature (Tg), flexural stress, and flexural modulus values of the CPF resins decreased with the tannin content. TGA-FTIR study of the resins was carried out and the emitted gas species during the pyrolysis of the samples were identified. The thermal stability and the temperature of degradation of the cured CPF resins decreased with increasing cardanol content.

Keyword: Phenolic PF; Flexural; Fracture toughness; Cardanol; Tannin; SEM; DMA; TGA-FTIR