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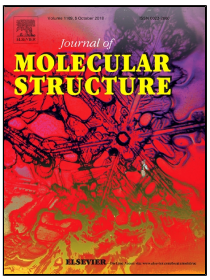

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Influence of Heating on spectroscopic, mechanical, and thermal properties of reduced graphene oxide-poly(vinyl alcohol) composite films

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ABSTRACT

The spectroscopic, uniaxial tensile, and thermal properties of reduced graphene oxide (rGO)-poly(vinyl) alcohol (PVA) composite films produced by using rGO synthesized using modified Hummer's method with varying weight ratio of rGO up to 10% were investigated by using an uniaxial tensile tester, Fourier Transform Infrared (Ft-IR)/Attenuated Total Reflectance (ATR) spectroscopy, and Differential Scanning Calorimeter (DSC) methods after heating process at different temperatures from room temperature to 200 ^{o}C. For unheated composite films, with increasing rGO weight ratio up to 10%, the Young's modulus of rGO-PVA films increased by approximately 2-3 times, conversely the strain at break values decreased greatly by about 40-50%. The heating process led to the significant improvement in the tensile strength and the Young's modulus, and great decrease in extensibility with respect to the unheated samples, e.g., the tensile strength and Young's modulus increased by 3-4 times and 8-10 times, respectively, for the heating temperatures up to 150 °C. With increasing heating temperature, the stress-strain curve of rGO-PVA composite films turned from that of ductile and amorphous polymer to that of more brittle and rigid polymers. With increasing rGO content, the glass transition, the crystallization, and the melting temperatures increased and heating process generally shifted these temperatures to higher values. The great contribution of rGO content and the heating to the improvement of especially mechanical properties of rGO-PVA composite films thanks to the strong intermolecular interactions of rGO nanosheets with the PVA matrix molecules through hydrogen bonding and to the changes in the crystallinity ratio of PVA was shown in detail in the analysis of the spectral results. The relationship between the changes in the mechanical, structural, and thermal properties of the studied composite films was determined by using tensile testing, Ft-IR/ATR, and DSC methods.