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Structural and Optical Characterization of Rice-Husk-Derived SiO_2 Crystals-reinforced PVA Composites

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Abstract : The objective of this study was to investigate the optical properties of polyvinyl alcohol (PVA) and its prospective applications by adding crystalline silica which is usually used as a reinforcing agent. To do this, we synthesized and evaluated PVA-based composites reinforced with silica crystals, namely cristobalite, derived from rice husk. The experimental procedure involved the production of SiO2 particles using rice husk precursors, which were subsequently subjected to calcination at a rate of 10 °C/min for a duration of 3 hours. This process primarily resulted in the formation of SiO2 crystals in the cristobalite phase, according to X-ray diffraction (XRD). Following this, the crystals were incorporated into polyvinyl alcohol (PVA) via a casting technique, resulting in the formation of composite sheets. The SiO2 contents in the composites were 0, 2.5, 5.0, and 10.%. XRD and Fourier-transform infrared spectroscopy (FTIR) techniques provided confirmation of the composites' successful synthesis, i.e., it did not yield any indications of chemical bonding between polyvinyl alcohol (PVA) and silicon dioxide (SiO2), indicating that the interaction was limited to interfacial reactions. The incorporation of SiO2 crystals resulted in a notable enhancement in UV-vis light absorption and a decrease in the optical band gap. Addition of 2.5, 5.0, and 10.% SiO2, for example, decreases the direct optical band gap of the composites form 5.37, 5.19, and 5.02 eV respectively, while the indirect band gaps of the samples were 4.44, 4.84, and 4.48 eV, correspondingly. These findings emphasize the efficacy of rice husk-derived SiO2 crystals as both reinforcement agents and modifiers of optical properties in the polymer composites, showcasing their significant potential to modify the composite's structural and optical characteristics.

Keywords : rice husk, cristaline SiO_2, PVA-based composites, structural characteristics, optical properties.
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