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Structural Property and Mechanical Behavior of Polypropylene–Elemental Sulfur (S8) Composites: Effect of Sulfur Loading

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Abstract : Elemental sulfur is currently produced on the level of 70 million tons annually by petroleum refining, majority of which is used in the production of sulfuric acid, fertilizer and other chemicals. Still, over 6 million tons of elemental sulfur is generated in excess, which creates exciting opportunities to develop new chemistry to utilize sulfur as a feedstock for polymers. Development of new polymer composite materials using sulfur is not widely explored and remains an important challenge in the field. Polymer nanocomposites prepared by carbon nanotube, graphene, silica and other nanomaterials were well established. However, utilization of sulfur as filler in the polymer matrix could be an interesting study. This work is to presents the possibility of utilizing elemental sulfur as reinforcing fillers in the polymer matrix. In this study we attempted to prepare polypropylene/sulfur nanocomposite. The physical, mechanical and morphological properties of the newly developed composites were studied according to the sulfur loading. In the sample preparation, four levels of elemental sulfur loading (5, 10, 20 and 30 wt. %) were designed. Composites were prepared by the melt mixing process by using laboratory scale mini twin screw extruder at 180°C for 15 min. The reaction time and temperature were maintained constant for all prepared composites. The structure and crystallization behavior of composites was investigated by Raman, FTIR, XRD and DSC analysis. It was observed that sulfur interfere with the crystalline arrangement of polypropylene and depresses the crystallization, which affects the melting point, mechanical and thermal stability. In the tensile test, one level of test temperature (room temperature) and crosshead speed (10 mm/min) was designed. Tensile strengths and tensile modulus of the composites were slightly decreased with increasing in filler loading, however, percentage of elongation improved by more than 350% compared to neat polypropylene. The effect of sulfur on the morphology of polypropylene was studied with TEM and SEM techniques. Microscope analysis revels that sulfur is homogeneously dispersed in polymer matrix and behaves as single phase arrangement in the polymer. The maximum elongation for the polypropylene can be achieved by adjusting the sulfur loading in the polymer. This study reviles the possibility of using elemental sulfur as a solid plasticizer in the polypropylene matrix.

Keywords : crystallization, elemental sulfur, morphology, thermo-mechanical properties, polypropylene, polymer nanocomposites
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