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ORIGINAL PAPER

Polyphenylene sulphide/carbon fiber composites: study on their thermal, mechanical and microscopic properties

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Abstract The present study investigates the thermal, mechanical and microscopic properties of polyphenylene sulphide/carbon fiber (PPS/CF) composites by incremental number of fiber layers. The composites were prepared by hand lay-up technique followed by compression molding. A superior matrix-reinforcement adhesion was attained without the use of coupling agent and mechanical stability of the composites improved with increasing fiber layers. Transverse rupture strength and bending modulus were improved by 59.84 and 125.21 %, respectively, without loss in toughness. Impact strength and hardness values were enhanced while storage modulus, loss modulus and damping factor were dropped by increases in fiber layers. Thermogravimetric analysis (TGA) indicated a gradual rise in thermal stability (16.84 %) of the composite as compared to pure matrix. Surface morphology and crack propagation were studied by optical microscopy. It was found that crack was propagated in a linear plane by applying load. In addition, scanning electron microscopy (SEM) illustrated steady alignment of fibers and uniform distribution of the matrix around reinforcement. Based on the obtained results, fiber layers showed great potential for enhancement of thermal and mechanical properties of the composites.

Keywords Carbon fiber · Mechanical characterization · Thermal stability · Optical microscopy · Surface analysis

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Introduction

Polymer composites are considered as one of the most expanded engineering materials currently in use. Properties of polymer composites such as cost efficiency, ease of manufacture, excellent performance and light weight cannot be attained by ceramics, metals or even non-reinforced polymers [1–4]. Extensive use of fiber reinforced polymer composite (FRPC) in fundamental applications such as civil structures, mechanical parts of machines and vehicles has caused an increase in demand, thereby increasing the need for new improved experimental techniques for the synthesis of composite materials to enhance mechanical strength and thermal stability of these materials [5–8].

Over the past few decades, the research trend of thermoplastic-based composites has been transformed from "high-performance" advanced composites to evolution of "cost-performance" engineering composites [9]. Fiber reinforced thermoplastic composites (FRTPC) are multiphase systems and have gained great attention as compared to composites based on thermoset polymers due to the various advantages [10–12], including enhanced intrinsic properties of thermoplastic polymers such as damage tolerance, fracture toughness, ease of processing before consolidation, rapid and economical manufacturing [13, 14], raw materials with a larger shelf life and the ability to be recycled and reshaped [15]. The synthesis of these composites does not involve complex chemical reactions and therefore, can be processed without time-consuming curing reactions hence, allowing storage at normal environmental conditions [16]. Owing to this, there is arising demand for light weight and high strength composite structures which can be attained by proper inclusion of fibers as reinforcement [17, 18].