

Effect of surface functionalization of SiO₂ particles on the interfacial and mechanical properties of PEN composite films

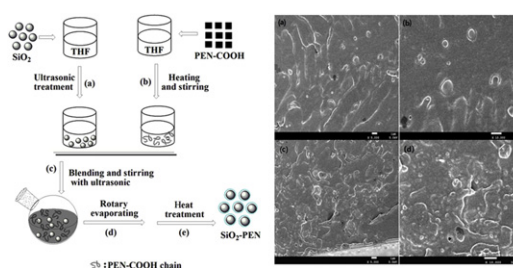
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HIGHLIGHTS

- ▶ SiO₂ particles were surface functionalized by grafting polyarylene ether nitrile containing carboxyl groups.
- ▶ The effect on the morphologies, mechanical and interfacial properties were investigated.
- ▶ The interfacial compatibility was characterized using parallel-plate rheometry.
- ▶ The inherent mechanism of interfacial compatibility was clarified.

GRAPHICAL ABSTRACT



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ABSTRACT

In this paper, we have introduced a new effective approach to graft polyarylene ether nitrile containing carboxyl groups (PEN-COOH) on the surface of silica (SiO₂) particles which were further confirmed by Fourier transform infrared spectra and transmission electron microscopy analyses. Polyarylene ether nitrile (PEN) composite films with SiO₂-PEN particles were prepared through solution-casting method, which were characterized using parallel-plate rheometry, thermogravimetric and mechanical analysis, aimed at investigating the effect of surface functionalization of SiO₂ particles on the thermal, mechanical and interfacial properties of PEN/SiO₂ composite films. The rheological test indicated that SiO₂-PEN particles presented better dispersibility and interfacial compatibility in the PEN matrix, which was further confirmed from scanning electron microscopy and Cole–Cole plots. The thermogravimetric analysis results revealed that the PEN/SiO₂ composite films showed a slightly increase in 5% weight loss temperature (increased by 1–12 °C) and maximum decomposition rate temperature (increased by 2–5 °C) compared with purified PEN film. DSC curves showed that the glass transition temperatures were in the range of 168–172 °C. In addition, the mechanical properties of composite films were higher than that of pure PEN film even the SiO₂-PEN particles loading reached 6 wt%. In sum, the surface functionalization of SiO₂ particles was confirmed to be an effective method to improve the interfacial and mechanical properties of PEN/SiO₂ composite films.

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1. Introduction

In recent years, many laboratories have launched projects on composites containing particles on the nanometer and micron

scale with varying success. This is because these composite films exhibit excellent performances such as mechanical [1–3], optical [4–7], optoelectronic [8], magnetic [9] and electrical [3,10] properties. For example, inorganic particles have successively been added to polymers to improve their toughness, thermal and mechanical properties [11]. In polymer composites, surface functionalization of the particles has already been proved to be a wide applicable technique to minimize particle/particle interaction and enhance

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