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Facile synergetic dispersion approach for magnetic Fe_3O_4@graphene oxide/polystyrene tri-component nanocomposite via radical bulk polymerization

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HIGHLIGHTS

- A synergetic dispersion strategy was developed for tri-component nanocomposite.
- Fe_3O_4@GO/PS tri-component nanocomposite was prepared by bulk polymerization.
- Fe_3O_4@GO/PS showed excellent mechanical, thermal, and semi-conductive properties.

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ABSTRACT

A synergetic dispersion strategy was developed for the preparation of the well-defined magnetic Fe_3O_4 @graphene oxide/polystyrene (Fe_3O_4@GO/PS) tri-component nanocomposite by the facile one-pot in situ radical bulk polymerization of styrene in the presence of the Fe_3O_4 nanoparticles modified graphene oxide (Fe_3O_4@GO) magnetic hybrid with oleic acid (OA) as surface modifier. Compared with the tri-component nanocomposite prepared with the graphene oxide (GO) and Fe_3O_4 nanoparticles added separately, the synergetic dispersion effect via the immobilization of Fe_3O_4 nanoparticles on GO sheets could avoid the magnetic aggregation of the Fe_3O_4 nanoparticles in polymer matrices. Furthermore, OA molecules adsorb onto the surfaces of the Fe_3O_4 nanoparticles on the GO nanosheets, improving efficiently the dispersibility of the GO nanosheets in styrene, which resulted to the well-dispersed Fe_3O_4@GO/PS tri-component nanocomposite consequently.

1. Introduction

Graphene sheets, one-atom-thick two-dimensional layers of sp^2-bonded carbon, are predicted to have a range of unusual properties, such as exceptional electron transport, mechanical properties, and high surface area [1]. One possible route to harness these properties for practical applications might be to incorporate graphene sheets in a composite materials in which these atomically thin carbon sheets can significantly improve physical properties of the host polymer matrices at extremely small loading [2,3]. The manufacturing of such composites requires that the graphene sheets could be produced on a sufficient scale and be homogeneously dispersed into various matrices.

By now, many successfully strategies have been developed for the preparation of the graphene/polymer nanocomposites, such as solution phase mixing of the exfoliated phenyl isocyanate-treated graphite oxide sheets with polystyrene followed with their chemical reduction [4], self-assembly [5], in situ reduction-extractive dispersion [6], covalent polymer fictionalizations [7], in situ radical polymerization technique [8], and so on. In most of the graphene based polymer composites prepared, the graphene oxide (GO) was needed to be reduced into graphene before being used or the chemical reduction was conducted to the resulting composites. The GO nanosheets could not be dispersed homogeneously into the common weak polar or nonpolar polymer matrices. However, the reduction procedure could be avoided by using of the GO nanosheets directly, and the production efficiency for the graphene based polymer composites could be greatly enhanced.

Multicomponent nanocomposites that contain two or more nanometer-scale components have attracted much attention recently owing to the two or more functions introduced by the different nanometer-scale objects [9,10]. Recently, the tri-component nanocomposites with two nanometer-scale components in

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