

In-situ thermal reduction of graphene oxide/alkylamine for reinforced polybutylene succinate nanocomposite

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Biodegradable polybutylene succinate (PBS) was incorporated with graphene oxide/octadecylamine (GOODA) via simultaneous in-situ reduction and functionalization of GOODA in PBS matrix. Functionalization of graphene oxide with octadecylamine prevented aggregation and resulted in homogeneous dispersion of GOODA in PBS nanocomposite as shown in FESEM result. GOODA did not profoundly affect the crystallinity of the thermally treated PBS/GOODA nanocomposite but interestingly improved the mechanical and thermal properties. With the addition of low loading GOODA content, a sharp increase in tensile strength and Young's modulus were observed exhibiting an increment of up to 78% and 96% from pristine PBS at 0.3wt% GOODA loading. The improvement in strength could be attributed to the successful interfacial interaction between amine group from GOODA and carboxylic group of PBS chain tail via nucleophilic substitution reaction. This improved interphase structure through in-situ reduction technique enhanced the reinforcement effect of GOODA in PBS matrix without utilizing any hazardous reducing agent.

Keywords: Polybutylene succinate, in-situ reduction, alkylamine graphene oxide, mechanical properties.

1. INTRODUCTION

Biodegradable aliphatic polyester such as polybutylene succinate has been a great substitute for synthetic polymers due to its prominent assets of biodegradability and biocompatibility¹. Nonetheless, to widen the applications of PBS in more sophisticated and top-notch areas such as engineering fields, pristine PBS needs to be modified as the mechanical and thermal properties are insufficient². Modification of pristine polymer matrix to nanocomposite is one of the most effective ways to overcome these deficiencies^{3,4}. Moreover, appropriate choice of combination for nanofiller and polymer matrix does not only improve the properties but also increase the filler dispersion and interfacial adhesion. Reinforcement efficiency from both polymer matrix and nanofiller will develop a novel material that widens its practical

applications⁵. Various carbon nanofillers such as carbon nanotube⁶, carbon black⁷, graphene oxide⁸, and reduced graphene oxide⁹ have been incorporated into PBS as a reinforcement material. Nanofiller such as graphene is attracting a widespread interest in polymer nanocomposite area due to its striking mechanical, thermal, and electrical features. Graphene has been prepared by mechanical^{10,11,12} and chemical¹³ approaches. However, pristine graphene that lacks functional group makes the interaction between graphene and required polymeric material challenging as the physicochemical properties of nanocomposite is greatly influenced by the distribution of graphene nanofiller in the polymer matrix. Hence, covalent functionalization of graphene is preferable to obtain homogeneous graphene/polymer composites.

In-situ thermal reduction of graphene nanofiller in