



Mechanical and thermal characteristics of high density polyethylene–fly ash Cenospheres composites

M.V. Deepthi^a, Madan Sharma^b, R.R.N. Sailaja^{a,*}, P. Anantha^b, P. Sampathkumaran^c, S. Seetharamu^c

^aThe Energy and Resources Institute (TERI), Southern Regional Centre, Bangalore 560 071, India

^bSri Jayachamarajendra College of Engineering, Mysore 570 006, India

^cCentral Power Research Institute, Bangalore 560 080, India

ARTICLE INFO

Article history:

Received 7 April 2009

Accepted 8 October 2009

Available online 12 October 2009

Keywords:

High density polyethylene

Cenospheres

Thermal and mechanical properties

Compatibilizer

ABSTRACT

Fly ash Cenospheres was used as reinforcing filler in High density polyethylene (HDPE) to develop lightweight composites. Cenospheres are inert hollow silicate spheres. Cenospheres are a naturally occurring by-product of the burning process at coal-fired power plants, and they have most of the same properties as manufactured hollow-sphere products. Cenospheres are primarily used to reduce the weight of plastics, rubbers, resins, cements, etc. used extensively as filler lubricants in oil drilling operations under high heat and high stress conditions down the hole. Also used as oil well cementing, mud putty and similar applications. Cenospheres were first used in the United States as an extender for plastic compounds, as they are compatible with plastisols thermoplastics, Latex, Polyesters, Epoxies, Phenolic resins and urethanes. The compatibility of Cenospheres with special cements and adhesives coating and composites have been well identified. Cenospheres are widely used in a variety of products, including sports equipments, insulation, automobile bodies, marine craft bodies, paints, and fire and heat protection devices. Typically applied in gypsum board jointing compounds, veneering plasters, stuccos, sealants, coating and cast resins. Providing the advantages of reduces weight, increased filler loadings, better flow characteristics, less shrinkage and warping and reduces water absorption. In order to improve the interaction between the inorganic filler and the organic matrix, the Cenospheres were surface treated with silane coupling agent and HDPE-g-dibutyl maleate was used as compatibilizer. The tensile and thermal properties of the composites were measured according to ASTM methods. The results reveal that, both surface modification of Cenospheres accompanied by compatibilization led to the substantial improvement to mechanical properties and thermal stability of the composites.

© 2009 Elsevier Ltd. All rights reserved.

1. Introduction

Development of lightweight fire retardant fly ash based polymer composites is essential for a number of applications such as Cables, Railways etc., Fly ash is an aluminosilicate rich waste obtained from coal-fired power plants and their disposal is a cause of major environmental concern. Fly ash is disposed to ash ponds through slurry media. Here, the floating material that is seen is nothing but Cenospheres. Cenospheres of different sizes are obtained from fly ash by advanced grading techniques. These are low density hollow microsphere particles and efforts are being made to develop value added products from Cenospheres [1–5]. A potential application of fly ash Cenospheres is as lightweight filler in polymer matrices so that they are good from techno-economic perspective [6]. The gelation behavior of fly ash–polyethylene composites have been studied by Alkan et al. [7,8]. The change in gelling and bonding behavior of the flyash

has been observed after commencing SO₂ injection. It is also observed that the polymeric material can be attributed to the presence of a negatively charged sulphur-rich species present on the surface of the flyash. It is generally observed that apart from Cenospheres volume fraction and size, the Cenospheres–matrix interaction plays a major role in determining the mechanical properties of the polymer composites. The mechanical properties of polymer–Cenospheres composites are inferior owing to poor interfacial interactions between the hydrophilic Cenospheres surface and the hydrophobic polymer [9]. Thus, tetrasulfane modified Cenospheres were used as reinforcing filler by Thongsang and Sombatsompap [10]. Silane coupling agents are commonly used as adhesion promoters between inorganic filler and an organic matrix. In this study, fly ash Cenospheres have been surface grafted with a silane coupling agent to get silanated Cenospheres (SC). The treated Cenospheres were then used as reinforcing filler in high density polyethylene (HDPE). The blends were then prepared by reactive blending using a dibutyl ester grafted HDPE as compatibilizer to enhance interfacial adhesion. The composites developed have been characterized for mechanical and thermal

* Corresponding author. Tel.: +91 080 25356590.

E-mail address: rnsb19@rediffmail.com (R.R.N. Sailaja).

properties. No such literature could be cited on such Cenospheres based compatibilized polymeric composites.

2. Experimental

2.1. Materials

HDPE (grade 24FS040 with melt flow index of 10 g/10 min from Reliance Petrochemical Ltd, India) was used for blending with Cenospheres. The Cenospheres were obtained from thermal power plant. 3-Amino propyl tri ethoxy silane (APTS) was obtained from Sigma Aldrich (USA). Dibutyl maleate (DBM) and all other solvents were obtained from S.d. Fine Chemicals, Mumbai, India.

2.2. Silane grafting

Silane grafted Cenospheres was synthesized grafting APTS onto Cenospheres. The grafting reaction was carried out in a mixture of water/ethanol (20:80 wt.%). A quantity of 50 g of Cenospheres was

first introduced into the mixture of water/ethanol and the temperature was kept at 80 °C. Further, 2% by volume of APTS was added into the above mentioned solution and continuously stirred for 5 h at 80 °C. The resultant product was filtered and washed many times using mix of water/ethanol and oven dried. The product was characterized by Fourier transform infrared spectroscopy (FTIR), as shown in Fig. 1a and b. Fig 1a shows the FTIR spectra of untreated and silane treated Cenospheres. The –C–H– stretching vibration of propyl group at 2920 cm^{-1} and –NH₂ deformation mode [11,12] is observed at 1553 cm^{-1} is shown. A magnified FTIR spectrum in the range of 900–1480 cm^{-1} is shown in Fig 1b. The methylene deformation modes of propylamine are observed at 1345 and 1434 cm^{-1} as similarly reported by Taghvaei et al. [11].

2.3. Synthesis of the compatibilizer

HDPE-g-DBM was synthesized (as done earlier by Girija and Sailaja [13]) by the dissolution of HDPE in O-dichlorobenzene at 120 °C, 0.2% of the dicumyl peroxide initiator was then added

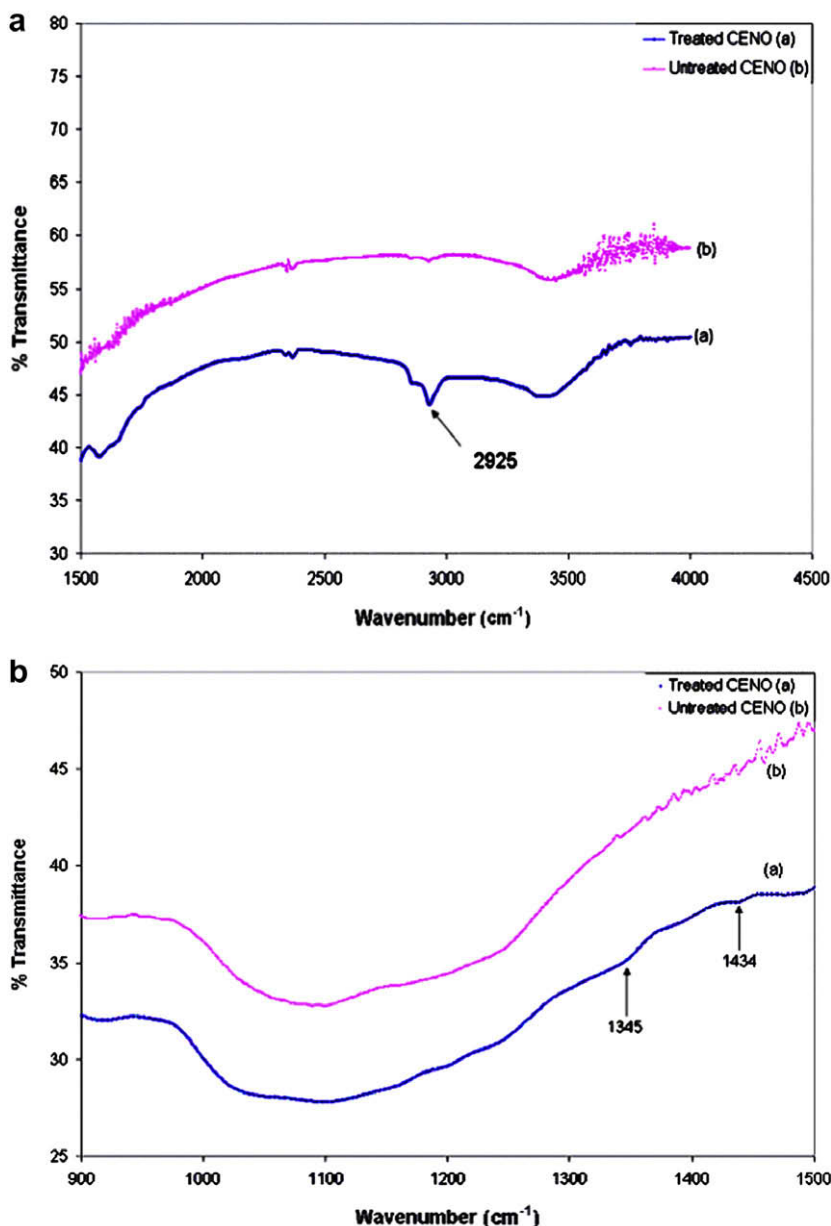


Fig. 1. (a) and (b) FTIR spectrograph of the silane treated Cenospheres and untreated Cenospheres.

Download English Version:

<https://daneshyari.com/en/article/832227>

Download Persian Version:

<https://daneshyari.com/article/832227>

[Daneshyari.com](https://daneshyari.com)