



Synergy between single-walled carbon nanotubes and ionic liquid in epoxy resin nanocomposites



J. Sanes, N. Saurín, F.J. Carrión, G. Ojados, M.D. Bermúdez*

Grupo de Ciencia de Materiales e Ingeniería Metalúrgica, Departamento de Ingeniería de Materiales y Fabricación, Universidad Politécnica de Cartagena, Campus de la Muralla del Mar, C/ Doctor Fleming s/n, 30202, Cartagena, Spain

ARTICLE INFO

Article history:

Received 12 May 2016

Received in revised form

6 July 2016

Accepted 4 August 2016

Available online 3 September 2016

Keywords:

Epoxy resin

Single-walled carbon nanotubes

Ionic liquids

Adhesion

Abrasion

ABSTRACT

The present work describes new epoxy matrix (ER) nanocomposite materials obtained by addition of a 0.5 wt% of single-walled carbon nanotubes (ER + SWCNT), a 1.5 wt% of the ionic liquid (IL) 1-octyl-3-methylimidazolium tetrafluoroborate (ER + IL), a mixture of a 0.5 wt% of SWCNT and a 1.5 wt% of IL (ER + SWCNT + IL), or a 0.5 wt% of an hybrid nanophase of SWCNTs modified by IL (ER + SWCNTm), obtained after dispersion of SWCNTs in IL and removal of excess IL. The influence of the additives on the curing process of the epoxy resin on the thermal and dynamic-mechanical properties has been studied by FTIR and DSC. The crosslink density has been calculated from dynamic mechanical properties. To determine the performance of the materials under adhesive and abrasive wear, the tribological behaviour of the new nanocomposites has been compared with that of the neat epoxy resin under pin-on-disc sliding conditions and under microscratching abrasion tests. The main findings are that the best friction reduction and antiwear performances are due to the synergistic effect of the combination of SWCNT and IL additives (ER + SWCNT + IL) and that very similar effects can be achieved with SWCNT previously modified by IL (ER + SWCNTm). The higher thermal stability and crosslink density of (ER + SWCNT + IL) makes it a suitable candidate for tribological applications.

© 2016 Published by Elsevier Ltd.

1. Introduction

Polymer/carbon nanophase hybrid materials are receiving increasing attention [1–14] in the expectation of improving the stability and resistance of polymer matrices by the addition of dispersed carbon nanotubes or graphene as neat, modified or functionalized nanomaterials.

One of the scientific and technological fields of research which has attracted more interest during the last years is the development of new polymer nanocomposites for tribological applications [15–23]. The addition of nanotubes to polymer matrices [24–28], has given rise to new nanocomposites with enhanced tribological performance.

Ionic liquids (ILs) are molten salts [29,30] formed by bulk organic cations and organic or inorganic anions which are in the liquid state at room temperature, and show a unique combination of properties such as their low volatility, non-flammability, and

their high thermal stability which are most relevant for tribological applications.

ILs have shown an excellent performance as lubricants and lubricant additives in lubrication of metallic and ceramic materials under severe sliding conditions [31–42], and also in the reduction of friction coefficients and wear rates of thermoplastic polymers and epoxy resins, both as external lubricants and as additives [43–47].

The discovery of the lubricating ability of ILs in 2001 [31] was closely followed by the description of the interactions between ILs and single-walled carbon nanotubes (SWCNT) by Fukushima et al. [48,49].

The ability of ILs to modify, disperse and functionalize [49–51] carbon nanotubes gave rise to a new family of nanofluids [52].

Non-functionalized single-walled carbon nanotubes (SWCNT) and multiwalled carbon nanotubes (MWCNT) modified by ionic liquids have been used as lubricants and as friction-reducing and antiwear additives of thermoplastic polymer matrices [53–58]. Although MWCNTs, have also been combined with ionic liquids to improve the tribological performance of some thermoplastic

* Corresponding author.

E-mail address: mdolores.bermudez@upct.es (M.D. Bermúdez).

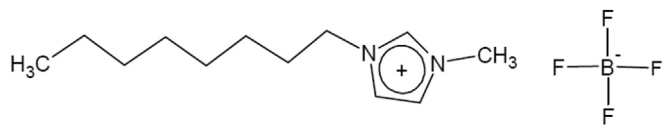


Fig. 1. Ionic liquid 1-octyl-3-methylimidazolium tetrafluoroborate (IL).

Ionic liquids have also made a considerable impact on the development of new epoxy networks and composite materials by acting as curing agents and as dispersants of carbon nanotubes in the epoxy matrix [59–65].

The unique characteristics of carbon nanostructures may considerably enhance the performance of the composite materials with respect to polymer matrices. However, the increase in mechanical resistance not always corresponds to a better tribological behaviour [66]. The synergy of ionic liquid and nanophases has previously shown its efficacy in lubrication [67–69] and in improving the tribological performance of new epoxy resin

materials [58], the main reason for using SWCNTs was the good tribological performance obtained in previous studies for different thermoplastics when they were modified by ionic liquids [53–55].

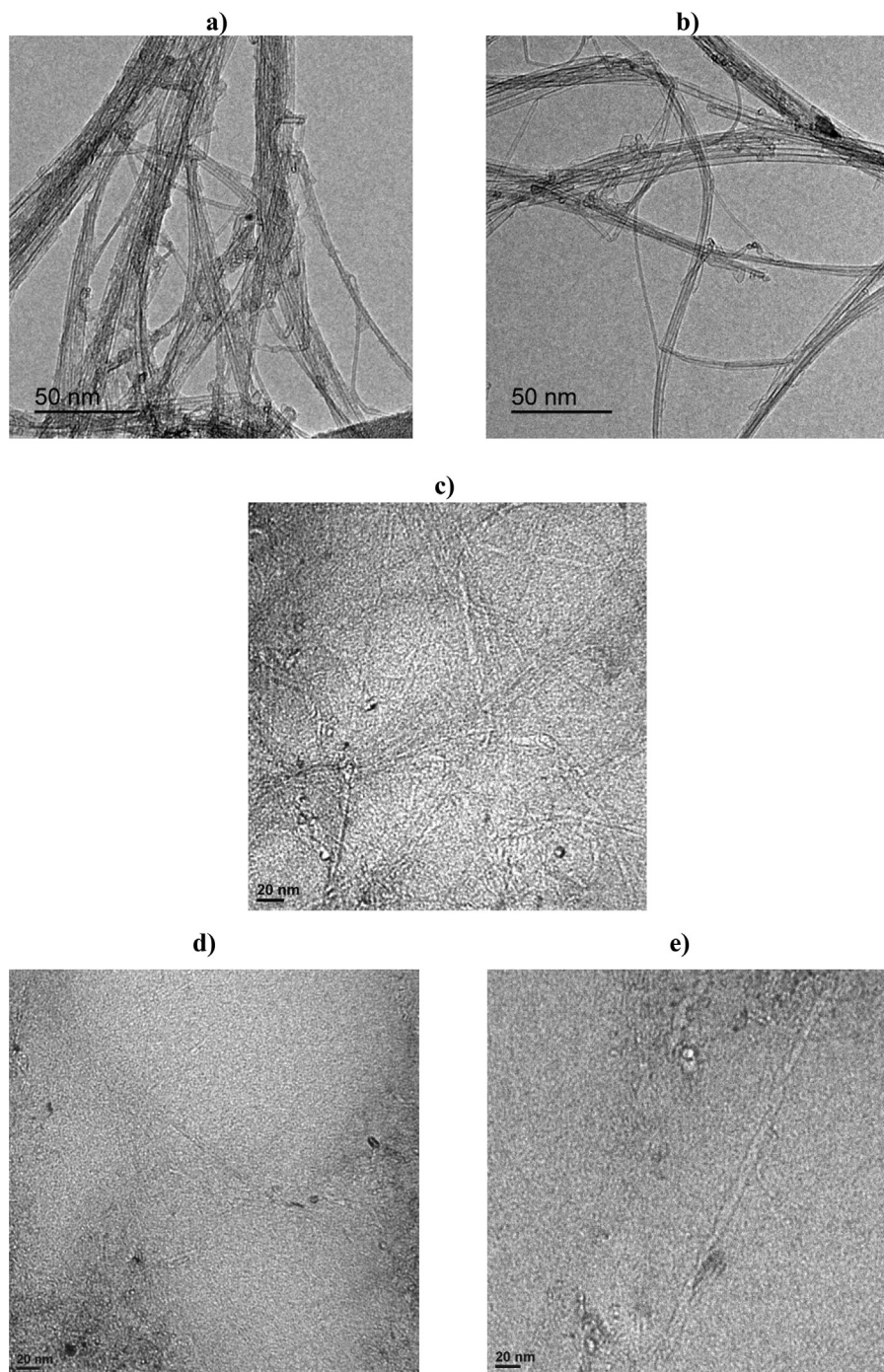


Fig. 2. TEM micrographs of: a) as received SWCNT; b) SWCNT modified by IL (SWCNTm); c) (ER+SWCNT); d) (ER+SWCNTm); e) (ER+S).

Download English Version:

<https://daneshyari.com/en/article/5021726>

Download Persian Version:

<https://daneshyari.com/article/5021726>

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