DEVELOPMENT ANTIFOG NANOHYBRID CONSISTING OF POLYESTYRENE RECYCLED MATRIX BY SOL-GEL PROCESS

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ABSTRACT

A hybrid material consisting of SiO_2 nanoparticles embedded in polystyrene recycled matrix has been developed. A polymer of polystyrene recycled functionalized (PSR-F) was used to influence the morphological and antifog properties of sol-gel synthesized silica nanohybrid. Silica nanoparticles are produced from alkoxide precursors in the presence of polystyrene recycled; hence a final material consisting of SiO_2 globules entangled inside a polystyrene recycled matrix is obtained. The functionalization of the polystyrene recycled matrix has the purpose in situ of uniting these carboxyl groups OH of the surface of the silanol groups during the process sol-gel. In this way, opaque or transparent solid substrata can be obtained, each of these optical conditions depends on the amounts of reactants employed to prepare the nanohybrid specimen. The nanohybrid SiO_2/PSR-F sample was used for coatings in glass and evaluated antifog properties.

Keywords: polystyrene recycled, abietic acid, sol-gel process

1 INTRODUCTION

Coatings, are used to indicate the deposition of a material on the surface of another, usually for the purpose of providing the area covered some characteristic that the material has not by itself [1]. Organic Coatings are those applied in liquid form on a surface after drying and result in a continuous solid layer. The drying process involves chemical reactions or simply evaporating the solvent. Examples: paints, lacquers, enamels and varnishes. The effect of coating on the material that is applied is to provide some type of insulation, protection or adding a surface or interfacial property, without altering the properties of the material covered [2].

Inorganic-organic hybrid composites are rapidly emerging as alternatives to traditional anti-fog materials as they combine the chemical and mechanical properties of both inorganic and organic components [3,4]; because such coatings alone do not have sufficient wear protection properties for the density and thickness to provide protection to the glass or acrilica surface. Thus, the performance of wear resistance and stress resistance of lining materials can be improved by the incorporation of the new hybrid composite.

The funcionalized resins are still interesting from both technological and scientific points of view, as demonstrated by the inclusion of nanoparticles to improve properties of a polymers or resins [5], even polymers recycled.

In this work, hybrid SiO_2- recycle polymer matrix materials were prepared by silica nanoparticles and polystyrene recycled. First, the polystyrene recycled was functionalized used abietic acid by means of the reaction of the carboxyl groups and the ring styrene, by means of a reaction of condensation and estherification. The functionalization of the polymeric recycled matrix has the purpose in situ of uniting these groups carboxyl groups OH of the surface of the silanol groups during the process sol-gel. The kinetic one of the reaction is monitored by means of infrared spectroscopy to verify the functionalization of the polystyrene and incorporation to silica particles. The materials prepared were characterized by some spectroscopies techniques.

2 EXPERIMENTAL PROCEDURE

2.1 Materials and methods

All samples were prepared by using TetraEthylOrthorSilicate (TEOS) (Aldrich Chem.), CO_2-free triple distilled water, Toluene (reactive grade) (J.T.Baker), the polymer recycled was polystyrene glass.

2.2 Polystyrene recycled Funcionalized (PSR-F)

The polystyrene recycled was functionalized with carboxyl groups. The PSR was mixed with abietic acid (AA) in toluene solution in weight ratio PSR / AA of 0.1, the mixture is mechanical stirred by 1 h.

2.3 Preparation of SiO_2-PSR and SiO_2-PSR-F Hybrid materials

The hybrid material composed of modified polystyrene recycled (PSR) and silica was prepared from toluene solutions. In this solution one half of the toluene was utilized. Separately TEOS with the other half of toluene was mixed theses two solutions were mixed together rapidly with vigorous stirring. The resulting solution was stirred and refluxed for 1 h.

2.4 Characterizaction Techniques

The characterization of the resulting hybrid materials was carried by FTIR spectroscopy. Infrared analysis (FTIR) was done in a Bruker Vector 33 spectrometer, by using the Attuned Total Reflectance (ATR) technique using a diamond crystal.

The Raman Dispersive analysis (RD) was used a Bruker Senterra spectrometer, with a 10 scan and 100 mW.

The morphology of hybrid materials was observed by Scanning Electron Microscopy (SEM) observations were carried in a Jeol JSM-5200 scanning microscope. The samples were coated with carbon by vacuum evaporation.

3 RESULTS AND DISCUSSION

The PSR-F FT-IR spectrum (figure 1) confirms the functionalization of the polystyrene recycled with carboxylic groups because of the presence of bands at 1730 cm^{-1} (C=O) and 1226 cm^{-1}, this last signal attributed to the C-O-C ester group vibration [6].

TGA thermographs related to SiO_2/PSR-F and SiO_2/PSR hybrid compounds. It is evident from this plot that the rising presence of silica and fubtionalization improves the thermal stability of hybrid materials.

A SEM photographic study of hybrid and non-hybrid materials was performed too. These materials characterized show some important observations about the morphologies as well as with respect to some other optical or interesting properties of these solids. See Figure 2.

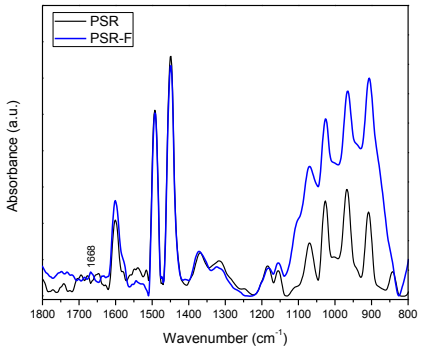

Figure 1: FT-IR Spectrum by PSR and PSR-F

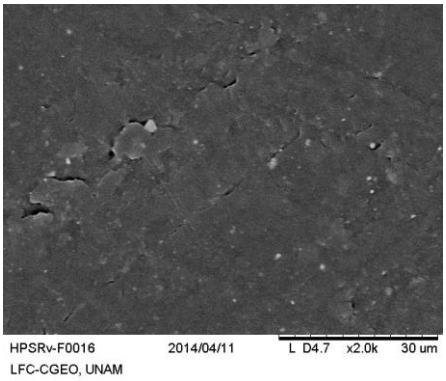

Figure 2: SEM morphology of HPSR-F

5 CONCLUSIONS

The transparency characteristics of these hybrid materials are favored by a more homogeneous repartition of silica particles throughout the polymer matrix as well as by a strong chemical interaction across the PS-Recycled/SiO_2 interface. The choice of gelation catalyst also influences the optical and thermal properties of theses hybrids.

Further applications of these hybrids, PS recycled -F /SiO_2 coatings offer a reliable option against antifog of material glassier or acrilic.

Hybrid materials resulting from the reaction of TEOS and modified PS recycled display chemical bonds at the interface between silica particles and polymer matrix, thus suggesting that the interaction between these two components is due to a hydrogen bonding between silanol and epoxy hydroxyl groups.

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