Effect of noble metal nanoparticles on the glass transition temperature of poly(*t*-butylacrylate) composites

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Abstract
In the last years the understanding of the effect of nanofillers on the behavior of polymer based nanocomposites became essential for the development of new materials with innovative properties [1,2]. However, few studies have been reported on the impact of metal nanoparticles (NPs) used as fillers on the thermal behavior of polymers [3,4].

The aims of the research reported here was the study of the effect of organically capped colloidal metal nanoparticles (NPs), prepared by a modification of the polyol method [5], on the glass transition temperature (T_g) of the polymer poly(*tert*-butyl acrylate) (P*t*BA). This polymer matrix was selected due to our interest on the optical properties of P*t*BA nanocomposites namely as new platforms for sensing devices [6, 7].
The nanocomposites were prepared by two distinct methods: i) cast films of blends of metal NPs and P*t*BA obtained from tetrahydrofuran (THF) mixtures and further evaporation of the solvent; ii) polymerization using miniemulsions (*in situ method*) in the presence of the metal NPs. The presence of the metal NPs in all the nanocomposites was confirmed by visible spectroscopy performed on the samples, namely by monitoring the surface plasmon resonance (SPR) of the nanometal. Microscopy analysis of the nanocomposites prepared by the *in situ* method shows that the polymer is coating the metal nanoparticles (Figure 1).

The influence of the inorganic fillers on the glass transition temperature of the polymer (T_g) by varying the chemical nature of the filler, average particle size, and metal content, were investigated by differential scanning calorimetry (DSC). This study showed slightly differences on the T_g of the polymer depending on the method employed in the composite preparation. On the other hand, the incorporation of metal (Au or Ag) nanoparticles in the P*t*BA matrix had a marked effect on the T_g due to the presence of metal/polymer interfaces which can promote polymer chains mobility. The chemical nature of the nanofillers used seemed to have similar effects on the T_g of the P*t*BA. On the other hand, the average particle size and amount of metal NPs strongly influenced the T_g of the polymer. These results have been interpreted in terms of effects on the polymer chains mobility, namely by considering the influence of the metal NPs on the intermolecular forces between the P*t*BA segments.

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Figure 1

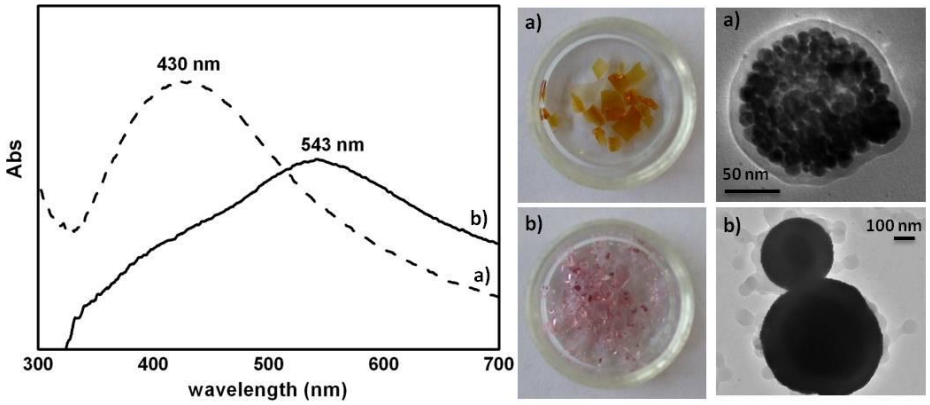

Figure 1: Optical spectra of nanocomposites prepared by miniemulsion polymerization: a) Ag/P*t*BA (11nm, 0.8 wt% Ag); b) Au/P*t*BA(11nm, 0.8 wt% Au), photographs and TEM images of the respective nanocomposites.