Emulsion mixing technique for preparation of poly(buthylacrylate/methylmethacrylate)/graphene electrically conductive composite films

Alejandro Arzac[a], Radmila Tomovska[a,b]

[a] Institute for Polymer Materials, POLYMAT, The University of Basque Country, P.O. Box 1072, 20018 Donostia-San Sebastian, Spain

[b] IKERBASQUE, Basque Foundation for Science, 48011 Bilbao, Spain

radmila_tomovska@ehu.es

The water-borne polymeric dispersions are products with a huge number of applications that include adhesives, paints, paper coatings, additives forconcrete, tires, textile and leather industry, cosmetics and biomedicine[1]. They are usually produced using the polymerization in dispersed media techniques. To enhance the polymer properties, various inorganic nanoparticles with different sizes and aspect ratios have been added (for instance, silica and clay improved mechanical and thermal properties, while carbon nanotubes (CNT) introduced electrical conductivity.[2-5] In this work graphene nanoplatelets (GNP) have been used for preparation of hybrid graphene/polymer dispersions by emulsion mixing technique (blending of stable aqueous dispersions of GNP or modified graphene nanoplatelets (mGNP) with waterborne polymeric dispersion (latex)). The procedure consisted of low-energy sonication of the polymer and GNP aqueous dispersions.

The polymer latex with 40 wt% solids content was produced by seeded semibatch emulsion polymerization of buthylacrylate/methylmethacrylate (BA/MMA) with 50/50 wt/wt. Stable aqueous dispersions of GNP (commercial, Sky Spring Nanomaterials) were prepared by employing ultrasonication to GNP dispersed in water or in 2% water solution of two types of surface active compounds (Sodium Cholate (SC) and Triton x200). It was determined that ultrasonication will additionally exfoliate graphene nanoplatelets and decreased their size, as it could be clearly be seen from TEM images of GNP before and after sonication, shown in Figure 1.

mGNP were prepared by azide photochemistry. Poly(ethylene glycol) methyl ether azide was UV irradiated, that results in fast production of very recative nitrene radicals and their [2+1] cycloaddition to graphene π-electronic system. In this way, poly(ethylene glycol) methyl ether was covalently attached to GNP surface, producing mGNP.

The films were formed from the GNP/polymer or mGNP/polymer water dispersions by evaporation of water under standard atmospheric conditions. The electrical conductivity of the films was investigated as dependence on GNP concentration, varied from 0.1 wt % to 1 wt % related to polymers. The electrical conductivity of these films was determined by a four probe conductivity meter, obtaining conductivity for concentrations above 0.4 wt% of GNP, reaching a maximum conductivity of 0.94 $S.cm^{-1}$ for 0.5wt% GNP stabilized by triton x200.

References

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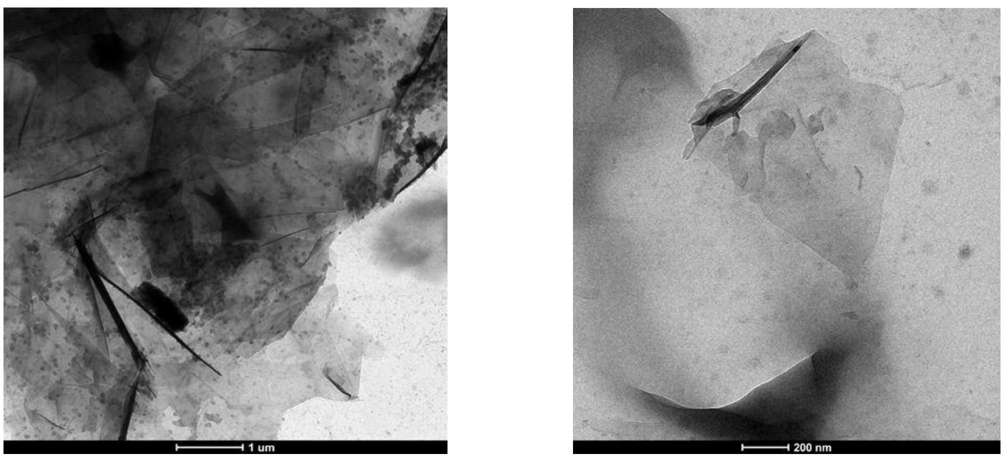
Figures



(a) (b)

Figure 1. TEM images of GNP (a) before and (b) after sonication.