Nanostructured thermosetting systems based on block copolymers as templates for inorganic nanoparticles

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Block copolymers can self-assemble to form nanoscale structures with domain spacing that depends on molecular weight, segment size, and the strength of the interaction between the blocks, represented by the Flory-Huggins interaction parameter. In selective solvents, diblock copolymers are able to form micelles of various morphologies such as spheres, cylinders, vesicles, etc. In the bulk, microphase separation occurs, leading to various microstructures such as spheres, hexagonally packed cylinders, lamellae and discontinuous phases, among others. The ability to control both the length scale and the spatial organization of block copolymer morphologies makes these materials particularly attractive candidates for use as templates in the preparation of functional nano/mesostructured materials, which can act as templates for hybrid inorganic/organic materials.

On the other hand, block copolymers are widely used as templates for generating nanostructured epoxy or phenolic matrices with long range order in both uncured and cured states. One feasible pathway for generating self-assembled thermosetting nanostructures is the use of amphiphilic block copolymers consisting of thermoset-miscible and thermoset-immiscible blocks. As it is well known, nanostructured materials based on thermosetting matrices can find application in many different fields of nanotechnology, such as nanostructured functional surfaces, nanolithography, or building of nanostructured inorganic/organic materials.

In this study, nanostructured thermosetting systems modified with an amphiphilic block copolymer were used as templates for TiO_2 nanoparticles (both commercial and synthetized via sol-gel). In order to reach better dispersion of TiO_2 nanoparticles, in case of the commercial nanoparticles, low molecular weight 4'-(hexyl)-4-biphenyl-carbonitrile (HBC) was used as surfactant. The addition of nematic low molecular weight liquid crystals to the system allows for the achievement of thermo-responsive materials and simultaneously as dispersing agent for TiO_2 nanoparticles. On the other hand, titanium dioxide nanoparticles were employed taking into account their conductive and optical properties, which were measured using tunnelling atomic force microscopy (TUNA) at nanoscale and Keithley at macroscopic scale.

Acknowledgments

Financial support from Basque Country Governments in the frame of ETORTEK iNANOGUNE (IE09-243), Grupos Consolidados (IT-365-07) and SAIOTEK2010 (S-PE10UN40) is gratefully acknowledged. The authors wish to also thank the Ministry of Education and Innovation for the project MAT-2009-06331. Additionally, J.G. thanks Eusko Jaurlaritza/Gobierno Vasco (Programas de becas para formación y perfeccionamiento de personal investigador) and A.T. acknowledges MICINN for Ramón y Cajal program. Moreover, we are grateful to SGIker units of the UPV/EHU.

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