Hybrid Nanoparticles Based on Graphene oxide as Active Additives for Polymer Blends

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POLONEZ project number UMO-2016/23/P/ST5/02131. This project is carried out under POLONEZ program which has received funding from the European Unions's Horizon 2020 research and innovation programme under Marie Sklodowska-Curie grant agreement. No 665778.

Research project objectives

The project focuses on the synthesis and application of the polymer brushes based on graphene oxide which could act as compatibilisers for polymer blends. The polymer blending has attracted the wide attention since it enables to gain novel properties that are not possible to be achieved for parent homopolymers. However due to high surface tension between the polymers the coalescence of the polymer domains, large distribution of domain size, as well as phase separation occurs. It manifests namely in loss of mechanical properties, and loss of transparency of final materials. To diminish these drawbacks, the compatibilizers are necessary to be used. The utilization of hybrid particles that would act as compatibilizers is a new challenge. Moreover, the particles bring the additional properties such as electrical, magnetic, mechanical properties according to the particle

nature. In the project we will introduce the concept of using polymer brushes tethered on the graphene oxide. Polymer chains will be grafted from GO surface using atom transfer radical polymerization (SI-ATRP). Graphene provides excellent electrical, mechanical and thermal properties. Oxidized form facilitates its dispersion and enables post-functionalization. Using ATRP for polymer brushes synthesis allows tailoring the molecular architecture of polymer chains, their uniformity, functionality and composition, as well as grafting density. Moreover, as was reported recently in our laboratory, the electrical conductivity of GO can be controlled during SI-ATRP as well. This issue is of high interest since extraordinary properties of ternary polymer blends, i.e. two immiscible polymers and one filler, based on GO have been reported recently. When located at interphase, the small addition of GO polymer hybrids resulted in the extremely low percolation thresholds, extraordinary improvements of mechanical properties, and enhanced stabilization against coalescence.

Aims of the project

The aim is to prepare graphene oxide polymer hybrids with polymer chain architecture that enable the particles preferably locate in minor phase, at the interphase or in the major phase of the blends. The location will be tailored tough the control of molecular parameters of polymer brushes (polymer chain length, grafting density, topology) and nanocomposite processing conditions. At such composites the effects on morphology and final properties will be investigated. We will find the relation between the surface chemistry of graphene oxide polymer hybrids and polymer blend performance. This information could help to understand the origin of the composite blend performance, and tailor the best surface chemistry for any targeted application. Within the project the model systems based on the poly(methyl methacrylate) (PMMA) and poly(styrene-*stat*-acrylonitrile) (PSAN) matrices will be used as polymer matrices. The PMMA and SAN will be grafted from GO surface either as homopolymers or block copolymers. Subsequently they will be blended with PMMA/PSAN.

Research results

Publications in scientific journals

1) Erika Kutalkova, Miroslav Mrlik, Marketa Ilcikova, Josef Osicka, Michal Sedlacik, and Jaroslav Mosnacek. Enhanced and Tunable Electrorheological Capability using Surface Initiated Atom Transfer Radical Polymerization Modification with Simultaneous

Reduction of the Graphene Oxide by Silyl-Based Polymer Grafting. Nanomaterials, 9, 308, 2019. doi:10.3390/nano9020308.
https://www.mdpi.com/2079-4991/9/2/308/pdf

Conferences

1) Monika Zygo, Marketa Ilcikova, Miroslav Mrlik, Josef Osicka, Jaroslav Mosnacek, Milan Kracalik and Joanna Pietrasik. PMMA/SAN blends Compatibilized by Graphene Oxide Polymer Hybrids Eurofillers – Polymerblends, Italy, Palermo. 23. -26.4. 2019. Poster