Poster Presentations

[MS26-P02] Characterization of composite materials based on graphene and ZnO nanoparticles.

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New perspective materials based on graphene (G) and its derivatives are actively explored nowadays. It is the urgent task to study coordination possibilities of G, which is electron-rich easy polarized ligand with respect to both metal ions and particularly nanoparticles (NPs). Mutual influence of G and metal-containing NPs can give rise to the materials with unique properties. It is known that the ligands determine not only the stability of NPs, but their basic characteristics as well. This is due to the fact that most of the physical effects (spectral, magnetic, etc.) develop on the surface of NPs, where the influence of ligands is crucial. The aim of this work was to obtain composite materials based on ZnO NPs and G. ZnO was selected as it is a multifunctional semiconductor having a wide band gap (3.37 eV), a large exciton binding energy (60 meV) at room temperature and effective UV luminescence. Such nanocomposites are of interest for using both G in itself and ZnO in nanoelectronics, nanophotonics, and other applications. Synthesis of the samples was carried out in several stages. At first, the dispersion of graphene oxide (GO) in isopropanol was prepared by the modified Hamers's method. Then, GO surface was precipitated with ZnO NPs by alkaline hydrolysis of a Zn salt in an anhydrous medium, where dihydrate zinc acetate was the precursor and isopropanol was the medium. The GO/ZnO system was further reduced to the G/ZnO one in a supercritical fluid (SCF), where isopropanol was used as a SCF. Literature data and our research show that ZnO is not reduced in the SCF, but ZnO NPs enlarge only due to high temperature processing.

A complex of structural and spectral techniques including scanning and transmission electron microscopy, X-ray powder diffraction, small-angle X-ray scattering, and photoluminescence was used for samples characterization. Scanning microscopy has shown that the size of graphene sheets, which were precipitated with ZnO, was up to 40 microns. High resolution transmission electron microscope and small angle X-ray scattering have revealed that ZnO NPs are of spherical shape. The average size of ZnO NPs in the GO/ZnO dispersion was ≈ 6 nm, while ZnO NPs in the G/ ZnO dispersion enlarged to the size of ≈ 17 nm. X-ray and electron diffraction analysis has revealed the presence of two phases in the fabricated nanocomposites: GO and ZnO after the deposition stage, G and ZnO after the reduction one.

The photoluminescence spectrum of the GO/ZnO sample contains a wide peak at the wavelength of ≈ 560±50 nm (visible green) corresponding to the recombination luminescence caused by surface defects of ZnO nanocrystals. This peak is not observed in the spectrum of the G/ZnO sample, which is presumably due to the fact that after high temperature processing, resulted in reduction of GO to G, ZnO NPs enlarged significantly, their glow faded, and reduced G additionally screens glow from ZnO NPs.

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