Electrical and magnetic properties of thin films of cross-linked fullerene C60 polymers in micro- and nano-scale

V. Kazachenko[1], I. Razanau[1], E. Skopcov[2], G. Zhavnerko[2]
[1] Belarusian State University of Transport, Belarus;
[2] The Institute of Chemistry of New Materials, Belarus

Thin (100-200 nm) films of fullerene C60 polymers were formed using the method of electron-beam dispersion of pristine fullerite in high vacuum with fullerene ions assistance. Material of the synthesized films represents a highly cross-linked random 3D network of covalently bonded fullerene molecules. Electrical properties of the films deposited onto the substrates with a thin-film interdigital electrode system have been measured in-situ in the vacuum chamber immediately after the deposition and after atmosphere exposure. It was shown that original conductance of the film is relatively high (about 50 Ohm cm). Upon atmosphere exposure, it decreases by approximately 3 orders of magnitude. However, even after the air exposure, the film conductance is still several orders of magnitude higher than that of the nonpolymerized C60 films. Electrical properties of the films in the micro- and nano-scale have been measured via the conductive atomic-force microscopy (C-AFM) technique. The measurement showed that the film conductance is enabled by a conducting network in a significantly less conductive matrix. The behavior and physical chemical processes in the film material upon C-AFM measurement is discussed. Magnetic properties of the synthesized films have been studied using magnetic force microscopy (MFM) technique. The films exhibit stable magnetic contrast highly correlated with the film topography, whereas the content of the ferromagnetic contaminants in the films is insignificant (less than 1 ppm as estimated by matrix-assisted laser desorption ionization mass spectrometry). Origin of the MFM signals and magnetic structure of the cross-linked C60 polymer films is being speculated about.

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Optical characterisation of nanostructured composite formed by Ag+ implantation into polyethyleneterephthalate

V.Volobuev [1], Y. Bumai [3], N. Dolgikh[1], M. Lukashevich[1], V.Valeev [2], R. Khaibullin [2], V.Odzhaev[1]
[1]Belarusian State University, Belarus;
[2]Kazan Physical-Technical Institute, Russia;
[3] Belarusian National Technical University, Belarus

Thin (40 μm) polyethylenterephthalat ($C_{10}H_8O_4$)n films were implanted with 30 keV Ag+ ions to fluencies of (0,25–1,5)10^17 cm^-2 at ion current density of 4 μA/cm^2. The maximum silver atomic concentration occurs at the projected range of 35 nm and the penetration depth (modified layer) extends to about 60 nm. Reflectance and transmittance spectra were measured for two opposite sides of the film (implanted and non-implanted) by Proscan MC-122 at the wave length range 200–1100 nm. Transmittance spectra show sharp increasing of penetration at λ=310 nm. The absorption increases with fluence increasing. Such behaviour indicates growing concentration of carbon clusters and metallic inclusions. Reflectance spectrum of virgin sample shows two weak peaks in UV region at λ1=205, λ2=260 nm which vanish on implanted and increase on non-implanted side because of carbonization of the irradiated surface and thermal modification of the film beyond the projected range. Independently of exposed side reflection increases with fluence increasing and shows maxima at λ≈620 nm due to surface plasmon resonance in silver nanoparticles. This maxima shifts continiously towards longer wavelength with fluence increasing because of growing of silver nanoparticles. Supposing two-layer structure of the implanted film numerous fitting reflection and extinction coefficients was made for refractive index determination. Refractive index for modified layer obtained in the range 1,4–2,8 depending on the fluence. The numerical estimation of the mean silver cluster size with «MiePlot v.4.2» computer program for obtained refractive index was made. The mean cluster sizes are in the range 5-20 nm. Validity of the two-layers structure for optical properties describing in a whole fluence interval is discussed.

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