Thin C_{60} polymer films formed with C_{60} ions assistance, their optical, electric and magnetic properties

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100-200-nm-thick films of polymerized C_{60} have been formed via electron-beam dispersion of pristine fullerite C_{60} target in vacuum. It has been shown that the active gas phase produced by the electron-beam dispersion contains neutral, excited C_{60} molecules as well as few mass per cent of positive fullerene ions. The coatings are being deposited onto the substrates under the bombardment of true secondary and backscattered primary electrons from the target holder resulting in deposition of films containing about 83% of polymerized phase (dimers, linear chains and 2D polymers). However, application of the negative electrostatic potential of 100-300 eV to the substrate during the deposition leads to bombardment of the growing coating by the accelerated fullerene ions and formation of randomly cross-linked 3D polymer network of covalently bonded C_{60} molecules.

UV-Vis absorption spectra of the deposited 3D C_{60} polymer films exhibit a broad continuum with a maximum at around 5 eV and increased absorption at low photon energies of 1-3 eV. The band gap of 3D C60 polymer films estimated using absorption edge in the UV-Vis spectra is about 2.14-2.15 eV, whereas the band gap of non-polymerized C_{60} films estimated using the same technique is about 2.34 eV.

Conductivity of the films has been measured by depositing them onto the quartz substrates with a system of 2 interdigital thin-film Ni electrodes. 3D C_{60} polymer films exhibit formation of the Schottky barrier to Ni electrods. Intrinsic resistivity of the films is about 50 Ω·cm in-situ and about 10^4 Ω·cm after the air exposure and storage under atmospheric conditions for several days. That is still considerably lower in comparison with nonpolymerized C_{60} films (10^7-10^{14} Ω·cm).

Conductive AFM studies of the 3D C_{60} polymer films have shown bimodal distribution of the surface electric properties with a low-conductive phase emerging upon storing under atmospheric conditions and day light. The films have also shown magnetic contrast, stable across the surface, in magnetic force microscopy. The content of the possible ferromagnetic contaminants in the samples is analysed and intrinsic magnetic properties of the deposited 3D C_{60} polymer films are discussed.