Irradiation and doping induced changes in properties of C_{60} fullerite films

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C_{60} fullerenes in the condensed state at the room temperature are semiconducting molecular crystals. It was shown that under influence of high pressure, UV-irradiation, doping with alkali metals and electron-beam irradiation the fullerites can be polymerized and change their properties dramatically. Due to that C_{60} have high potential of application in the nanoelectronics, medicine. But the mentioned polymerization methods have limitations. Therefore in the given work we have performed study of C_{60} films under irradiation with different types of bombardment particles and doping with metal atoms.

Thin C_{60} films (thickness 1000 nm) were prepared by vacuum sublimation of C_{60} powder on Si substrates. Irradiation was performed with electrons (E=1.8 meV), doses varied from 1 to 25 MGy, with carbide forming Ti and Fe ions (E=140 keV), doses varied from 10^{10} to 10^{14} ions/cm^2, and Ar ions (E=350 eV), doses varied from 10^{10} to 10^{14} ions/cm^2. After each step of irradiation changes in the crystal structure, vibration and electron properties were studied by methods of X-ray's diffraction, Raman spectroscopy, photoluminescence and spectral ellipsometry, STM. In order to study interaction mechanisms of implanted atoms with C_{60} molecules were prepared C_{60} films with Sn, In, Bi metal atoms and investigated with the same methods. Model chemistry calculations in the Gaussian program (Hartree-Fock approximation) were done for systems: C_{60}Ti, C_{60}Fe, C_{60}C, C_{60}Sn, C_{60}In, C_{60}Bi.

Results have shown that irradiation of fullerites with mentioned particles and doping with metal atoms leads to polymerization of molecules that is confirmed by appearance of new diffraction reflections, shifting and splitting of Raman modes, complicate change of electron spectra. Theoretically was shown that complexes C_{60}Ti, C_{60}Fe, C_{60}C, C_{60}Sn exist. Doses at which effects of destruction of C_{60} molecules begin to prevail were determined.