

USXES and XANES Investigation Of Silicon Nanopowders.

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Silicon nanopowders is an advanced object as for scientific investigations as for the practical applications. In the work Si powders were obtained by evaporation of silicon ingot in electron beam with the energy of electrons 1.4 MeV in Ar or N₂. According to the electron microscopy data Si particles are characterized by a spherical shape with a diameter from several micrometers up to several nanometers. Raman spectra of the particles obtained in Ar correspond to the diameter of about 3 nm. For the powders obtained in N₂ Raman spectrum confirmed the presence of amorphous phase. PL spectrum of silicon nanoparticles corresponds to the energy of recombination transitions of 2.1 eV. To obtain a heterostructure of silicon – nanopowders of silicon the latter ones were dissolved in HF and then were deposited on silicon substrate. Raman spectrum of the heterostructure corresponds to the size of Si nanocrystals 3-4 nm.

Results of the phase analysis by ultrasoft X-ray emission spectroscopy (USXES) for the depth of analysis ~ 60 nm demonstrate predominance of the ordered crystalline phase of Si in the powders. «Nitrogen» nanopowder involves quite a lot of amorphous silicon besides of the c-Si and very little of the oxide while the powder obtained in argon involves much less of amorphous silicon but quite enough amount of SiO₂.

Analysis of the features in composition and structure of the surface layers (< 5 nm) of nanopowder particles by X-ray absorption near-edge structure (XANES) technique demonstrated that the particles of nanopowders are covered with oxide layer with a thickness that is essentially greater than the natural silicon oxide.

The presence of oxide on the surface of nanoclusters allows to observe visible photoluminescence since oxygen is bounded to the dangling bonds of Si.

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