EXCITON AND PERCOLATION PROCESSES IN TWO-PHASE CORE-SHELL SiO_2/ZnO STRUCTURES WITH A LARGE DENSITY OF SURFACE NANOCLUSTERS

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S u m m a r y

We report the results of studies of two-phase core-shell (SiO_2/ZnO) structures with a large density of ZnO nanoclusters on the surface of spherical SiO_2 nanoparticles. It is proved that, due to the large surface energy of the latter, nanoclusters grow in the form of quantum disks with diameter exceeding 10 nm and with height of the order of the Bohr radius of an exciton in ZnO. The height was estimated in the effective mass approximation and agrees well with experimental data. It is first shown that the photoluminescence spectra of these structures can be caused by the phase percolation transition of excitons on the spherical surface of nanoparticles which is realized due to a large density of ZnO nanoclusters. This results in the interaction of the latter, but the space effect of excitons does not vanish in this case, unlike the 3D one. The exciton wave function acquires macroscopic dimensions resulting in the appearance of an intense band from deep levels related to vacancies and complexes of oxygen and zinc.