Nanoobjects microscopy

Electron microscopy studies of the metal sulfide nanocrystals formed in Langmuir-Blodgett films

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Semiconductor nanocrystals arouse interest both in terms of basic research and practical application. The metal sulfides nanocrystals are perspective material for optoelectronic and photovoltaic devices. In the Institute of Semiconductor Physics SB RAS original method for producing semiconductor metal sulfides nanocrystals by reacting gaseous hydrogen sulfide with the metals behenates Langmuir-Blodgett films was designed.

The frequency of the fluorescent radiation depends directly on the atomic structure and particle size determining by the nanocrystals formation conditions. The most direct method for the nanocrystals structural and morphological features examination is a high-resolution transmission electron microscopy. Investigations were carried out using electron microscopes JEM-4000EX and TITAN 80-300.

The average size of CdS nanocrystals after sulfidation depends on the film thickness and varies in the range from 3 to 6 nm by changing the film thickness from 10 to 16 monolayers. The average size of CdZnS and CuS nanocrystals after sulfidation and ZnS nanocrystals after annealing is 3 nm. Annealing the nanocrystals in vacuum at the residual gas pressure of 10^{-3} Torr and 200º C temperature during 100 minutes results in increasing CdS and CdZnS nanocrystals average size in 1.5 times. Annealing the CuS nanocrystals in argon atmosphere at temperatures of 150-350º C results in increasing the average size of the nanocrystals in 2.2 times. From the interplanar distances analysis of CdS and CdZnS solid solutions nanocrystals with different compositions are found forming with the hexagonal lattice type $P6_{3/mmc}$ or with the cubic lattice type $F\underline{4}3m$. CuS nanocrystals annealing in the temperature range 150-200º C are found having a hexagonal crystal lattice type $P6_{3/mmc}$. At annealing temperature range 250-350º C Cu_2S crystalline phase formation occurs. Cu_2S nanocrystals have the hexagonal crystal lattice type $P6_{3/mmc}$. The proportion of this Cu_2S crystalline phase increases with increasing annealing temperature. Annealing at 200º C temperature leads to the formation of ZnS nanocrystals having a hexagonal crystal lattice type $P6_{3/mmc}$ or cubic crystal lattice type $F\underline{4}3m$. After annealing at 300º C temperature ZnS nanocrystals are oxidized forming ZnO having a hexagonal crystal lattice type $P6_{3/mmc}$.