

Structural and optical properties of vacuum-deposited ZnS nanostructures

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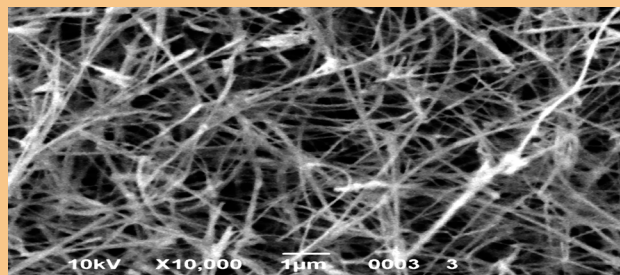
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In this paper some structural, substructural and optical properties of zinc sulfide nanostructures obtained by a CSVS method on bulk ZnSe are investigated. Examination of optical and substructural properties was performed by infrared spectroscopy and X-ray diffraction, respectively. The results of these studies enabled determination of the dependence of the main structural film parameters (texture, lattice parameters, grain and X-ray scattering domain sizes, and microstrain) on the growth conditions. IR-spectral distributions of transmission coefficient $T(\nu)$ for bilayered ZnS/ZnSe nanostructures are obtained.



SEM image of ZnS nanowires obtained on (220) ZnSe substrate.

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1 Introduction Zinc sulfide as a traditional luminescent material that has attracted attention of material scientists due to its properties that make it suitable for designing new low-cost and reliable solar and photovoltaic devices and opto- (acousto-) electronic active elements. Light-emitting diodes (LEDs), photodetectors, sensors, electro-optical modulators, optical cover layers, etc. based on ZnS have successfully functioned for decades [1, 2]. Zinc sulfide doped with Cu or Mn is a good powder phosphor having about 100% quantum efficiency [3].

ZnS films and nanosized particles are now of particular interest as a perspective base for constructing functional devices with unique characteristics. Among them are nanoscaled electronic devices, lasers, sensors, chemical, gas and biological detectors, and so on [4].

Nanodots, nanorods nanobelts, and films based on ZnS had been prepared by various methods: vapor–liquid–solid (VLS) process [5], RF sputtering [6], CVD [7], CBD method [8, 9], and thermal evaporation [10, 11]. Commonly, silicon

wafers with deposited Au (or other metal) nanodots were used as the substrates.

Despite the enormous number of references concerning the preparation of ZnS-based nanostructures the question of producing these structures at low substrate temperatures (<500 °C) without a catalyst was not highlighted until recently.

The aim of our work is to show the effect of deposition temperature, on preparing ZnS films on monocrystalline wafers with large lattice parameter discrepancy, on morphology, structure and substructural features of the layers.

2 Experimental details Films and nanostructures of zinc sulfide were prepared by vacuum evaporation of the material with semiconductor-quality purity in a quasiclosed volume (close-spaced vacuum sublimation (CSVS)) [12]. High-purity monocrystalline cubic ZnSe wafers were used as substrates. The deposition was performed onto the crystallographic (220) plane. The evaporator temperature

axis of the nanostructure in the lattice of the given phase is determined by taking into account the half-width of the diffraction lines ($L(002) = 102.7\text{--}113.1\text{ nm}$) and in the normal direction ($L(110) = 16.0\text{--}18.5\text{ nm}$). Comparing these results and data of microelectronic microscopy enabled us to demonstrate that the nanorods are monocrystalline by thickness, at the same time they contain some SCD by length. EDAX and IR spectrometry show the chemical purity of ZnS films and nanostructures.

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