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ABSTRACT BOOK

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Structural, optical and EPR studies of ZnO thin films doped with 3d-elements prepared by rf – sputtering

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Zinc oxide (ZnO) is a multifunctional inorganic semiconductor material with industrial applications in many fields. Doping in ZnO transition metal elements offers an effective method to adjust its electrical, optical, and magnetic properties, which is crucial for its practical applications. The present work is devoted to preparing of $Zn_{1-x}TM_xO$ (TM: Co, Ni) thin films and study of their structural, optical and magnetic properties depending on content of 3d- transition metals (TM) elements as cobalt and nikel. $Zn_{1-x}TM_xO$ (TM: Co, Ni) thin films were deposited onto glass and quartz substrates by RF-plasma sputtering technique. Content of TM elements in the deposited films has varied in range of $0<x<0.1$. The composite targets were formed by mixing and pressing of ZnO and CoO (NiO) powders with appropriate rations of components. The structures of samples have been studied by using X-ray diffraction (XRD), transmission electron microscopy (TEM) and scanning electron microscopy (SEM). The structure and surface morphology of the deposited layers show strong dependence on doping transition element and deposition conditions. The EPR spectra of ZnCoO films show a broad asymmetrical line of Dysonian shape and satisfactory ascribed by the single Lorenz type curve with Dysonian term. Near the ferromagnetic ordering temperature distortion of the EPR spectra and its following splitting on two Dysonian lines were found.

Optical and magneto-optical studies of layered diluted magnetic semiconductor nanoparticles PbI_2:TM (TM: Mn, Fe, Co)

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In the last two decade, after the discovery of unique properties of graphene [1], was increasing interest in the study of materials with layered structures. Among them, lead iodide (PbI_2) is an intrinsic wide band gap semiconductor (about 2.5 eV) having high molecular weight and high resistivity. As a high-anisotropic semiconductor, PbI2 has a type of layered structure, with repeat unit of hexagonally closed packed layer of Pb^{2+} sandwiched between two layers of I− in the crystal. Doping of PbI_2 single crystals by transition metal (TM) elements (Mn, Fe, Co) with unfilled 3d-shell is of interest for the development of new materials – layered diluted magnetic semiconductors (DMS). The main characteristics of this materials are associated with exhibition of an exchange interaction between the hosting electronic subsystem and electrons originating in the partially-filled d – levels of the introduced magnetic atoms.

In this paper we present results of experimental studies of the absorption spectra, photoluminescence and magneto-optical Faraday effect of colloidal solutions of PbI_2: TM (TM: Mn, Fe, Co) nanocrystals as well as nanoparticles dispersed in PVA and gelatin polymer matrices. In the exciton structure of the absorption spectra of colloidal solutions of nanoparticles, in addition to the short-wavelength shift caused by the quantum-size effect, a dependence of the position of the maximum of the exciton absorption band on the direction of the light beam was also found. Studies of the photoluminescence spectra of $Pb_{1-x}Co_xI_2$ nanocrystals with $x < 3\%$ at room temperature allowed us to observe an intense line, which can be interpreted with the presence of Co^{2+} ions in the PbI_2 matrix.

The magneto-optical spectra of nanocomposites exhibit peculiarities typical for bulk DMSs due to the strong spin-exchange interaction between band carriers and magnetic ions and simultaneously manifest some features because of confinement effects in low dimensional structures.

*1. Geim A.K., Novoselov K. S., The rise of graphene // Nat. Materials. - 2007. – **6**. - P.183-191.*

Investigation of nonlinear effects in A^2B^6 semiconductors exposed to pulsed laser irradiation for biomedical applications

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Group A^2B^6 semiconductors, particularly ZnO, CdTe, and ZnS, are promising materials for the creation of functional nanostructures with tunable physical properties. Pulsed laser irradiation of such materials induces nonlinear thermal, electronic, and deformation effects that lead to the generation of point defects, phase transitions, and self-organization of nanoparticles. The study of these processes is important both for fundamental science and for applied tasks, especially in the biomedical field. Laser-synthesized A^2B^6-based nanoparticles exhibit antimicrobial, photocatalytic, and optical properties suitable for applications in therapy, biosensors, and drug delivery systems. Investigating the nonlinear mechanisms of nanostructure formation enables controlled tuning of their characteristics for optimization in biomedical technologies.

The ZnO has a complex system of dot defects: interstitial atoms of zinc (Zn_i) and oxygen (O_i), vacancies of zinc) and oxygen, as well as antistructural defects). Under the influence of laser irradiation, pairs of defects are generated in both the oxygen and zinc sublattices. The defects are the centers of deformation: the interstitial atoms are the centers of deformation of stretching, and the vacancies are the centers of deformation of compression. The large values of elastic constants indicate that the deformation effects can play an important role in the modification of the near-surface layers. As a result of self-consistent deformation-diffusion redistribution of the concentration of point defects in the crystal, there is a noniniform deformation and, under certain conditions, their self-organization (the formation of nanoparticles) takes place. The presence of such deformation in the semiconductor with point defects due to self-consistent electron-deformation coupling leads to the local change in the band spectrum and, accordingly, to the spatial redistribution of conduction electrons and the emergence of electrostatic potential Depending on the relationship between the individual components of the flux of defects, it is possible their localization in different areas of the crystal, or, conversely, "blurring" throughout the volume. ZnO nanoparticles created under the influence of laser irradiation can be used as photocatalytic materials to kill bacteria or treat wounds using UV radiation.