THE FEATURES OF THE DOPED ZINC OXIDE FILMS AND FORMATION SOLID SOLUTIONS ON ITS BASIS

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Currently quantum wells and heterostructures based on solid solutions $Zn_{1-x}Cd_xO$ and $Zn_{1-y}Mg_yO$ are widely grown and studied as active elements of semiconductor devices (detectors, LEDs, resonant tunneling diode, etc.). The development of these semiconducting materials with the effective band-gap engineering is accompanied by the physical and technological limitations such as spinodal decomposition, phase separation and segregation of cadmium (or magnesium) at the grain boundaries.

Here we have analyzed the formation of the composition fluctuations, phase separation, and their influence on the optical and vibrational properties of $Zn_{1-x}Cd_xO$ and $Zn_{1-y}Mg_yO$ solid solutions. It was studied the effect of nitrogen concentration on the structure, morphology and optical properties of structurally perfect nitrogen doped and nitrogen-aluminum co-doped zinc oxide films grown by layer-by-layer growth for UV detectors with fast response.

It was revealed that the doping by cadmium isoelectronic impurity can lead to a substantial increase of the cathodoluminescence intensity of zinc oxide. An improvement of the performance was also observed in GaN (analogue of ZnO) by doping with indium. It was observed the decrease of dislocations density and point defects, increase of electron mobility, increasing the intensity of luminescence. Cadmium acts as a getter to ZnO. This leads to increased radiation resistance.

$Zn_{1-x}Cd_xO$ solid solutions were studied by the computer modeling. Model of the fullerene-like cluster $Zn_{36-x}Cd_xO_{36}$ with sp^2 – bonding was proposed for study the influence of cadmium on the electronic structure and band gap E_g of solid solutions $Zn_{1-x}Cd_xO$. It was shown that substitution of zinc by cadmium with increasing Cd content reduces the energy gap and the stability of clusters. The obtained values are consistent with experimental data.

During recent years, the role of transparent conductive films becomes more important in solar energetics and other fields. ITO (indium tin oxide) is the most popular material among transparent conductive oxides. However, due to the limited reserves of indium ITO should be replaced by the wide-band gap ZnO semiconductor, which is transparent in the visible and near-ultraviolet regions. High conductivity of ZnO can be provided with donor impurities: Al, Ga, In. The growth of ZnO:Al films and studies of their optical and electrical properties are discussed.