ANNOTATION

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«Light-controlled functional materials and nanostructures for photonic devices»

This dissertation is devoted to the development of thin films and nanostructures based on transition metal oxides and tellurides for photonic devices. A special device was developed, created and patented that makes it possible to obtain thin films and structures of a stepped or wedge shape. Numerical models have been developed and verified to calculate: dynamics of the temperature field in a thin film during pulsed laser heating and radiation cooling; electric field in the plasmonic structure "metallic nanoparticles/luminescent film"; modulation of optical radiation into a synapse-like structure based on a polymer waveguide coated with an optically active film of phase change material (PCM). The developed memristive structures based on magnetic thin $Zn_{1-x}Co_xO$ films can become elementary cells of neuromorphic information processing systems and spintronic devices. This material is also promising for creating magnetically controlled optical devices. Multiple quantum wells $Mg_{0.27}Zn_{0.73}O/ZnO$ and $Mg_{0.15}Zn_{0.85}O/Cd_{0.2}Zn0$ were obtained and investigated.8O and $Mg_{0.15}Zn_{0.85}O/Cd_{0.05}Zn_{0.95}O$, demonstrating high quantum efficiency in the range of LW well widths from 2.5 nm to 6 nm. When pumped by a pulsed laser source, stimulated radiation was excited in the photoluminescence spectra, the excitation threshold of which does not monotonously depend on the width of the quantum well. At the same time, the minimum lifetime for $Mg_{0.27}Zn_{0.73}O/ZnO$ was τ_r=355 ps at L_W=2.6 nm, and for $Mg_{0.15}Zn_{0.85}O/Cd_{0.05}Zn_{0.95}O$, it reached a record minimum value of τ_r=144 ps at L_W=10 nm. Such low-dimensional heterostructures with high quantum efficiency are promising as active elements of UV-blue spectral laser sources. A method of controlled synthesis of gold and silver nanoparticles with sizes ranging from 2 nm to 120 nm has been developed. The effect of surface plasmon resonance in plasmonic nanoparticle/semiconductor film systems has been studied depending on the size and packing density of metal nanoparticles. In the photoluminescence spectra of thin films and zinc oxide nanorods coated with silver nanoparticles, a nonmonotonic increase in the intensity of the exciton peak was observed with increasing nanoparticle size, which can be used as amplifiers of the UV-blue spectral range in optoelectronic devices. The fundamental possibility of controlling an optical signal in the C-telecommunication band passing through a synaptic interface based on a polymer waveguide coated with an optically active thin film $Ge_2Sb_2Te_5$ by external laser exposure to an optically active region is demonstrated. Based on the principle of optical signal modulation, fully optical storage and computing devices of the next generation can be developed that simulate the operation of biological synapses and neurons.