Synthesis and magneto-spectroscopy characterization ZnO core based nanocrystals doped with copper ions.

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Colloidal semiconductor nanocrystals are a class of materials with great potential for applications in low-cost optical, magnetic and electrical signal processing devices (e. g., photovoltaics, light emitting diodes, as well as new advanced devices characterized by, e.g., "zero-threshold" optical gain).

Two types of quantum dots based on ZnO core surrounded by MgO or Oleic Acid doped by copper ions (Cu content up to 2%), were synthesized. The absorption and photoluminescence (PL) at temperatures between 2 K and 300 K was measured. The samples have been characterized by transmission electron microscopy (TEM) and electron paramagnetic resonance (EPR). An attempt was made to observe their magnetooptical response.

To prove the presence of copper ions inside the nanocrystal ZnO core, the EPR technique was used. The EPR spectra were measured for various amounts of Cu dopant. Copper ions incorporated into ZnO lattice are described by the axial spin-Hamiltonian: g_{perp}=2.055, g_{par}=2.42, A_{perp}=0.0025 cm^{-1}, A_{par}=0.0080 cm^{-1}[1]. The obtained parameters of the EPR spectra confirmed that the Cu^{2+} was built into the ZnO without precipitates of copper(II) oxide, even for 10% of dopant concentration. The EPR and TEM measurements do not reveal presence of any copper ions in magnesium oxide shell.

The bandgap is defined by the edge of the absorption band, which in this case strongly depends on the particle size (typically of around ~ 5 nm). The band gap in the resulting material were around 3.53 eV, indicating the bandgap blueshift with resoect to the bulk crystal of ZnO (3.44 eV), which is associated with quantum confinement in such small nanoparticles. Studies failed to confirm unambigously the influence of Cu^{2+} ions on the absorption spectra of ZnO/MgO nanoparticles.

PL spectra of the nanoparticles with various concentration of Cu were examined. The two emission bands characteristic for ZnO were observed, the first narrow one in the UV region corresponding to interband excitonic transition, and a second broad band with a maximum in green spectral range related to defects. Increasing concentration of Cu^{2+} led to luminescence quenching of both the UV and visible PL. In the case of the samples with oleic acid shell, the magnetic field induced a few times increase of emission intensity, what was attributed to blocking of spin-dependent non-radiative recombination channel related to Cu^{2+} ions competing with the excitonic one.

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