Magnetooptical properties of nanoporous ZnO thin films covered with a metallic Fe layer

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Doping of semiconductors with magnetic ions results in a number magnetic, transport and optical and magnetooptical properties valuable from the point of view of spintronics and optoelectronics. Typically, the magnetic ions are introduced during the sample fabrication, e. g., in epitaxial or spray pyrolysis growth.

In the present work we study magnetooptical properties of thin nonporous ZnO film covered with a semitransparent layer of Fe by sputtering. Thanks to a high surface to volume ratio, the nanoporous film is expected to incorporate Fe ions into its crystal lattice ions due to diffusion during the sample production process. ZnO films thick for 100 nm are deposited onto fused silica substrates by means of DC reactive sputter deposition from a Zn target in an argon–oxygen mixture. Next, 25 nm of iron is sputtered on the film. Photoluminescence is measured at T = 1.8 K, in magnetic field of up to 10 T applied in Faraday configuration.

Two emission maxima observed in the near band-gap spectral region are related to bound exciton at around 3.36 eV and to donor acceptor pairs (DAP) at around 3.32 eV (see Figure 1). In the case of Fe covered ZnO the DAP maximum dominates, while in the case of a reference, as grown ZnO sample the excitonic one is stronger. Upon application of external magnetic field the emission of the Fe covered layers increases in both polarizations and shows a tendency to saturation. In σ+ polarization the increase is much stronger (up to two-fold) than in σ- polarization. For reference ZnO layers, the emission gets weaker in σ- and stronger in σ+ polarization, with a linear dependence on the field and no saturation.

The above observations are in agreement with what was observed previously for semimagnetic (Zn,Fe)O layers produced by spray pyrolysis. This indicates that doping of the nanoporous ZnO by diffusion effects is feasible. The presented doping method is likely to work also with other magnetic ions than Fe and provides an alternative for well established, previously used ones.

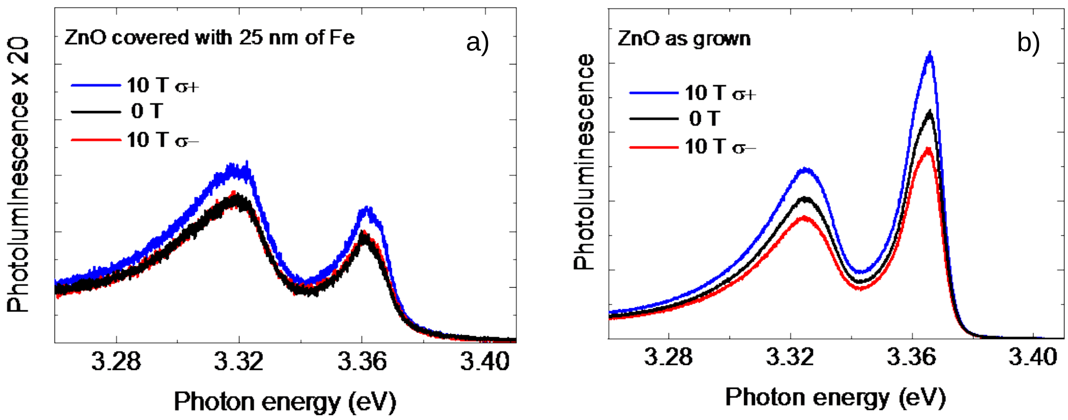

Figure 1. Photoluminescence of nanoporous ZnO film a) covered with 25 nm of iron and b) as grown for two polarizations of the light at magnetic field of 0 T and of 10 T.

[1] J. Papierska *et al.*, Physical Review B 94, 224414 (2016).