Walther-Meißner-Institut, Seminar Room 143, 13:30 h

Date: Friday, 12 December 2008

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Title: Co-doped ZnO epitaxial films: from an ideal Brillouin-like paramagnet to a phase-separated superparamagnetic ensemble

Abstract:

The hope of discovering a dilute magnetic semiconductor (DMS) with ferromagnetic order up to room temperature (RT) still motivates research on suitable material combinations. One candidate is Co-doped ZnO, which has been widely studied in the past years, but with contradicting results. We recently reported the absence of intrinsic ferromagnetic interactions in pulsed laser deposited Co-doped ZnO films with a high structural perfection as measured by x-ray linear dichroism (XLD) [1]. On the other hand, in many cases phase separated dopant clusters were detected if ferromagnetic-like behaviour was present [2]. To study the magnetic properties in dependence of the structural properties, we prepared a series of Co-doped ZnO-films on c-plane sapphire by reactive magnetron sputtering. The structural properties are readily tuned by changing the preparation conditions such as the composition of the sputter gas (Ar:O₂). The structure was characterized using x-ray diffraction and element specific XLD, revealing that the structural quality of the films changes continuously from good crystallinity for oxygen-rich to phase separated material for oxygen-deficient preparation conditions. The structural change is accompanied by an altered magnetic behaviour: SQUID magnetometry and magnetic resonance studies reveal ideal Brillouin-like paramagnetic behaviour for the samples with the highest structural quality in agreement with [1], whereas it changes to superparamagnetic blocking for the clustered samples. A further decrease of the oxygen content shifts the blocking temperature towards RT. Additional element specific analysis of the magnetic properties was performed by means of x-ray magnetic circular dichroism (XMCD) to refine these results. In the entire range we find no sign of intrinsic ferromagnetic interaction for the homogeneous Co-doped ZnO system as well as no long range magnetic order above RT if metallic Co is absent.

M. Venkatesan et al., APL 90, 242508 (2007);  
S. Zhou et al., PRB 77, 035209 (2008);  
T. C. Kaspar et al., PRB 77, 201303(R) (2008).

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