NONAQUEOUS SOL-GEL ROUTES TO DILUTED MAGNETIC SEMICONDUCTORS

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Nanostructured oxides play a major role in the development of functional nanoscale materials and devices. Among them, diluted magnetic semiconductors (DMS) represent an important family of materials. In an extremely quoted paper of Dietl et al., ZnO and GaN have been predicted ferromagnetic at room temperature [1]. Since 2000 a lot of controversial works were published on the subject showing that these materials show ferromagnetic behavior in function of the doping but also of the synthetic approach. A recent theoretical work predicts that transition-metal doped zirconia can be also ferromagnetic at room temperature in function of the metal dopant, its oxidation state and concentration [2].

Non-aqueous sol-gel routes are remarkably successful for the synthesis of oxide materials. Solvent assisted synthesis and especially the "benzyl alcohol route" have several advantages such as a low reaction temperature and a high crystallinity and purity of the as synthesized oxides [3,4]. We extended the "benzyl alcohol route" to the synthesis of transition metal doped oxide semiconductors[5,6]. This synthetic method enables the incorporation of several transition metal dopants into oxide matrix.

Here, we present the synthesis, the characterization and the magnetic properties of doped ZnO [5] and ZrO_2[6] nanoparticles. The synthesis involves the reaction of inorganic precursors and benzyl alcohol at moderated temperature and lead to high-quality nanocrystals presenting a homogeneous distribution of the magnetic ion. Manganese doped zinc oxide as well as manganese doped zirconia, exhibit mainly a paramagnetic behavior of the diluted spins. In the case of cobalt doped zinc oxide, the magnetic properties are affected by the synthesis condition, paramagnetic or ferromagnetic behavior was obtained depending on the solvent used. The homogeneity and local environment of the magnetic ions diluted into the matrix were characterised by high resolution TEM, electron energy loss spectrometry and by electron paramagnetic resonance, which is a local probe sensitive to oxidation state, local symmetry and spin-spin interactions. After providing evidence on the homogeneity of doping and the absence of any secondary phase, the magnetic properties of the as-synthesized nanoparticles were studied using SQUID and VSM magnetometer.

References:

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