From heterobimetallic Zinc-tin alkoxide clusters to amorphous tin-containing ZnO and Zn_2SnO_4 nanocrystals suitable for thin film electronic applications

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The reliable synthesis of well defined nano-materials by controlling defects and morphology of the particles, as well as providing a high dispersion of the doping elements in the matrix without other impurities, is one of the primary aims in material chemistry. Zinc oxide (ZnO) can be regarded as a key material in engineering, furthermore nanostructured ZnO is a important material for heterogeneous catalysis [1] and semiconductive devices. [2] ZnO is a direct bandgap semiconductor (E_g = 3.30 eV at room temperature) with a free exciton binding energy of 60 meV. [3] However, in order to prepare nanocrystalline ZnO of high purity while maintaining control over the composition, morphology (particle size and shape), porosity etc., a suitable synthetic method is required. Traditionally ZnO nano-materials have been synthesized by various techniques, such as flame pyrolysis of ZnO precursors [4] and the evaporation and oxidation of elemental zinc. [5] However, these methods give rise to an inhomogeneous particle shape distribution. To overcome this problem we employ the Single Source Precursor (SSP) concept: In the first step a suitable organometallic precursor is synthesized, which is in a second step, thermally decomposed into ZnO. This precursor already contains all the information necessary for the inorganic functional material. [6]

Currently we are focusing on the synthesis of defined heterobimetallic organozinc alkoxides as potential molecular SSP for the preparation of heterometallic (doped) ZnO materials. Interestingly doping ZnO with certain elements presents an effective method to modify its electrical, optical and magnetic properties. In particular tin doped zinc oxide (Sn@ZnO) are promising semiconductive materials. [7]

We present a novel technique for the successful synthesis of Sn/Zn-alkoxides with different sterically demanding organic groups. Their thermal degradation leads to, depending on the variation of the decomposition parameters and the organic groups, different ZnO-based materials. We report how one SSP can easily lead, by controlled decomposition, to different final materials with variable properties and applications.

[1] C. N. R. Rao *Rev. Phys.Chem* **1989**, *40*, 291;[2] A. P. Alivisatos, *Science* **1996**, *271*, 933; [3] S. Polarz, A. Roy, M. Merz, M. Driess, *Small* **2005**, *1*, 5, 540; [4] K. Hara, T. Sato, R. Katoh, H. Sugihara, H. Arakawa, *J. Phys. Chem. B* **2003**, *107*, 12, 597; [5] H. Lin, S. Tzeng, P. Hsiau, W. Tsai , *Nanostruct. Mater.* **1998**, *10*, 465; [6] V. Ischenko, S. Polarz, D. Grote, V. Stavarache, K. Fink, M. Driess, *Adv. Funct.Mater*. **2005**, 15, 1945; [7] Deng, R. Zhang, X.T. *The Journal of Physical Chemistry C,* **2007**, *111*, 13013