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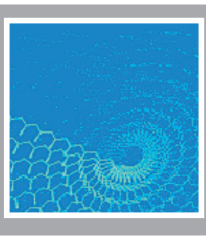

Polymer and Colloid Highlights

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Microwave Chemistry: Towards Predictable Nanoparticle Synthesis

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Nonaqueous sol-gel approaches, involving the chemical transformation of metal oxide precursors in an organic solvent under exclusion of water, have widely been applied to the synthesis of metal oxide nanoparticles with a broad range of sizes, shapes and compositions.[1]

A special feature of these routes is that organic reactions provide the 'monomers' for the nucleation of the inorganic nanoparticles, and they can be controlled by applying microwave irradiation. Additionally, microwave irradiation leads to a high heating rate with minimized thermal gradients. As a matter of fact, various highly crystalline metal oxide nanoparticles[2] in good yields were prepared within just a few minutes (Fig. 1) and lithium metal phosphates.[3]

Subtle control of the irradiation time, the temperature and the out-put power makes microwave-assisted nonaqueous sol-gel chemistry a perfect model system for the study of nanoparticle formation. In the case of ZnO, prepared from zinc acetate and benzyl alcohol, nanoparticle formation and growth can be well described by combining kinetic analysis of the precursor consumption with the crystal growth (Fig. 2).[4] As a result, it is possible to precisely control the crystal size.

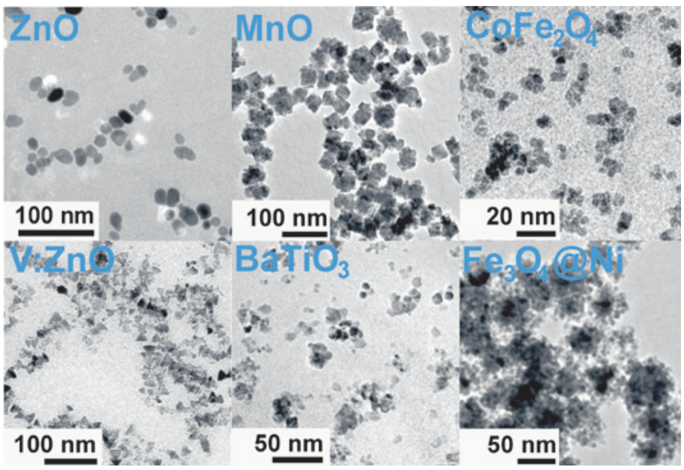

Fig. 1. TEM images of selected oxide nanoparticles.

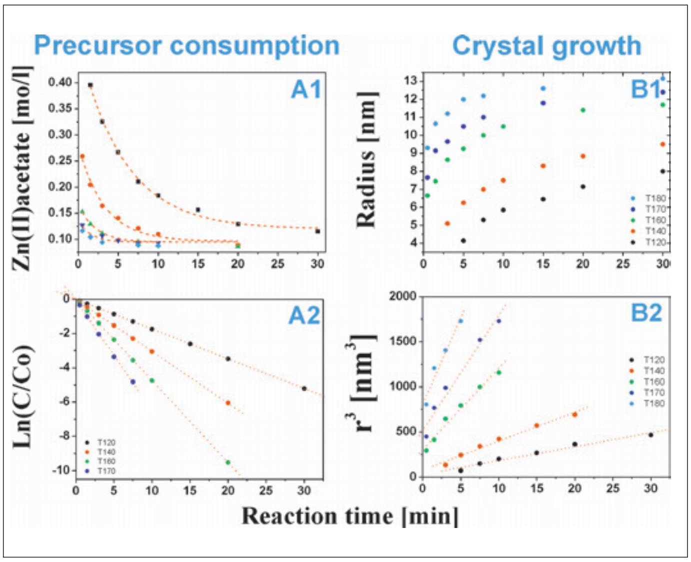

Fig. 2. Change of precursor concentration (panels A) and crystal size (panels B) for different temperatures (120–180 °C) vs. reaction time.

The correlation of the organic reactions with the crystal growth is fundamental for the elaboration of predictable synthesis strategies. This knowledge can not only be applied to the development of new synthesis methods in general, but also to the control of the final stoichiometry in particular, making the nonaqueous sol-gel reaction a promising route for the preparation of doped and multi metal oxides.

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