Priority Programme

"Material Synthesis near Room Temperature"

Project Description – Project Proposal

From birth to growth of metastable metal oxides in ionic liquids

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Summary of proposal

It is widely known from chemistry that the energy of transient states may be affected decisively by a surrounding solvent, so is the outcome of a chemical reaction. Also in materials science, one could interpret nanosized seeds as transient states for the generation of shaped particles or of phases with alternative crystal structure. In both cases, one is often interested in thermodynamically less favored (metastable) products, respectively unusual shapes or polymorphs. Besides crystal structure, also shape of a crystal is an important parameter determining its properties. This is, because a particular shape is characterized by a unique set and abundance of surfaces corresponding to different lattice planes. The accession of the mentioned, metastable materials products is linked to the possibility to generate the solid phase under kinetically controlled reaction pathways. The main task of the project is the investigation of the effects in highly polar, non-aqueous solvent environments (ionic liquids) with regards to the formation of metastable products. We will focus on the preparation of anisotropic particles deviating from the most stable shape (Wulff morphology). Furthermore, we are also interested in the role of the solvent concerning accession of metastable crystal structures. We will achieve such kinetically controlled conditions by interfacing molecular routes with materials synthesis, combined with refined in-situ investigations. Highly reactive, organometallic precursors will be used by us for the preparation of important metal oxide semiconductor materials like zinc oxide (ZnO) or manganese oxide (MnxOy). A particular challenge is the generation of novel precursors

comprising reluctant groups (e.g. oxidizing and reducing) joined together in one molecule for the purpose of initiating particle growth either at very low temperatures near ambient or below, or initializing it by a non-conventional trigger such as light. A profound base of knowledge will be acquired by us, not only by a detailed analysis of the final materials, but also by comprehensive X-ray scattering investigations (small and wide angle) conducted in an in-situ mode. The advantage of the proposed transition metal oxides is that the contrast in electron density compared to the organic, ionic liquid environment is sufficient for performing scattering with a high tempospatial resolution. We will spot the very early stages of particle formation, raising the question at which point for instance formation of shape and crystal structure is determined.