Priority Programme

“Material Synthesis near Room Temperature”

Project Description – Project Proposal

Intermetallic Clusters and Nanoparticles

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Summary of proposal

Novel intermetallic clusters and intermetallic nanoparticles offer interesting properties ranging from quantum-confinement effects to cooperate magnetism and highly efficient/specific catalysis. While aiming at metastable intermetallic compounds, several prerequisites have to be considered: (1) Low-temperature synthesis under kinetic reaction control; (2) Use of weakly-coordinating solvents that do not coordinate to metal cations; (3) Use of solvents that do not oxidize less-noble elemental metals. Merging these prerequisites clearly points to ionic liquids (ILs) as highly suitable solvents. By reacting suitable precursors (preferentially carbonyl metals and metal halides), we aim at the formation of novel intermetallic clusters and nanoparticles. The formation of clusters and nanoparticles in the IL will be validated by characterizing of the obtained compounds (e.g. X-ray diffraction with powders/single-crystal diffraction, electron microscopy) and the proceeding nucleation will be studied in-situ (e.g. via DLS, UV-Vis, DSC). From the huge number of potential combinations of metals, we focus on binary and ternary phases of Mn, Fe, Co, Cu, Al, Sn and Pd. For several combinations, and especially if less-noble metals are included (e.g., Mn, Fe, Al, Sn), only a limited number of intermetallics is known as a cluster or nanoparticle so far. Aiming at intermetallics containing less-noble metals, ILs reveal their full potential for chemical synthesis, so that a variety of new compounds and compositions are to be expected. In view of the material properties, intermetallic clusters and nanoparticles are very interesting in view of rare-earth-free magnets (e.g., MnAl- or Heusler-type Cu2MnAl and Cu2MnSn phases) or low-cost environmentally begin catalysts (e.g., FeSn2, CoSn2 or Al13Fe4 for hydrogenation).