

## Priority Programme

### “Material Synthesis near Room Temperature”



#### Project Description – Project Proposal

#### Preparation of intermetallic phases in ionic liquids

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#### Summary of proposal

The preparation of intermetallic phases at low temperatures continues to be a challenging task. During the past years, redox reactions of reactive intermetallic precursors have been developed to a versatile method providing access particularly to metastable intermetallic phases. The reactions so far have been conducted mostly as heterogeneous gas-solid reactions. Additionally, low-temperature redox reactions on cluster species in ammonia or organic amine solutions of Zintl phases provide access to new metalloids species such as cluster polymers. But, in most cases, phases containing solvent molecules or complex cations have been obtained. In that respect, redox reactions in ionic liquids acting as a solvent for the intermetallic precursors might provide an alternative route to new purely intermetallic phases. However, such attempts so far have suffered from a too high reactivity of the applied ionic liquids towards highly reactive precursors such as Zintl phases, resulting in a fast and difficult to control mostly heterogeneous oxidation to amorphous products. This project, on the one hand, aims to develop inert ionic liquids capable of dissolving intermetallic phases containing Zintl clusters at low temperatures and to systematically study thus possible controlled homogeneous redox reactions to new metastable intermetallic phases by addition of suitable oxidizing agents. The applicability of such redox reactions in ionic liquids on salt-like carbides will be investigated as well, promising the preparation of new carbides or even elemental carbon modifications with polymeric structural motifs. Furthermore, topotactic redox reactions of respective intermetallic precursors will be investigated in purposefully synthesized ionic

liquids of suitable reactivity and sufficient dissolution capability for product species to enable complete conversion of the precursor phase and to provide access to technically interesting yet otherwise hardly accessible product species such as graphene-analogous silicon sheets. For the studies within this project, so called TAAILs (Tunable Alkyl-Aryl Ionic Liquids) will be synthesized, the imidazolium cations of which carry functionalized phenyl substituents enabling electronic tuning and thus modification of the reactivity as proton source. The alkyl side chains will be functionalized by anionic or polyether groups enhancing solubility of salts or salt-like phases by complexation of cations. Furthermore, the protic activity of such ILs will be tuned by selective exchange of the hydrogens on carbon atoms of the imidazole core against inert aryl substituents.