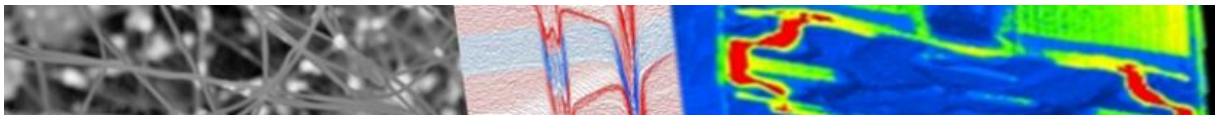
Karlsruher Institut für Technologie Institut für Angewandte Materialien



Internship or bachelor thesis

Layered oxides with honeycomb ordering as cathode materials for Na- ion batteries

Starting date: September

Layered transition metal oxides Na_xMO_2 (*M* = transition metal) become popular sodium-insertion materials due to good mobility of Na^+-ions inside the structure. The honeycomb-ordered phases of general formula $Na_3M_2SbO_6$ (*M* = Ni, Cr, Cu, Co, etc.) [1] are structurally related to the layered Na_xMO_2 with an M^{2+} /Sb^{5+} cationic ordering or a superstructure within each slab, where each SbO_6 octahedron is surrounded by six MO_6 octahedron forming a honeycomb network [2-4]. For $Na_3Ni_2SbO_6$, the theoretical capacity (199 $mAh*g^{-1}$) corresponds to the extraction/insertion of 3 sodium ions per formula unit, which takes place in the high potential range of 3.1-3.8 V vs. Na^+/Na. The total or partial substitution of Sb^{5+} with other M^{5+} cations may result in new high performance battery materials with honeycomb ordering in the transition metal layer. The synthesis of $Na_3Ni_2BiO_6$ has already been reported [5], but the electrochemical characteristics of this compound in sodium-ion cells are still missing. At the same time, it is interesting to explore the possibility of substitution of Sb^{5+} with smaller and lighter V^{5+} in this type of structure. The nominal composition $Na_3Ni_2VO_6$ has not been reported so far.

The aim of this work is to synthesize honeycomb structures of $Na_3Ni_2BiO_6$ and $Na_3Ni_2VO_6$ and to determine their electrochemical performance in sodium-ion cells. The optimization of the synthesis conditions (temperature, annealing protocol, precursors) is required. X-ray powder diffraction and scanning electron microscopy will be used to characterize the crystal structure and morphology of the obtained compounds. The electrochemical potentials and capacities of sodium insertion-extraction will be investigated by galvanostatic cycling and cyclic voltammetry in the electrochemical cell with Na-anode and non-aqueous Na-electrolyte.

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References:

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