Fraunhofer IWS Dresden

FRAUNHOFER-INSTITUTE FOR MATERIAL AND BEAM TECHNOLOGY IWS

Coating Development of Al^{3+}-Conducting Thin Films by PLD

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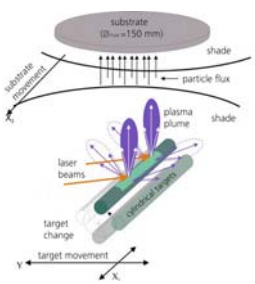
INTRODUCTION AND MOTIVATION

Developing technologies on the market spur the demand for alternative solution in the field of energy supply. All-solid thin-film rechargeble batteries are a promising factor for applications like mobile devices, electronic vehicles and for the storage of renewable energy . Due to the shortage of lithium resources alternative materials have to be concidered. Especially multivalent-ions such as Mg^{2+}, Ca^{2+} and Al^{3+} have become popular canditates as they can transfer more electrons per atom. By taking into account different criteria such as capacity, price, abundance and redox poetential, Al was confirmed to be the most promising choice for the use as electrode material. A challenging task for designing these battery systems is to find functioning cathode materials and solid ion-conducting materials that result in high energy densities.
To find suitable and innovative solutions the Fraunhofer Institute IWS is working within an established research network.

PULSED LASER DEPOSITION – TECHNOLOGY

- stochiometric ablation
- installation of small, sintered targets possible
- adjustable depostion-rate and thin-film-density by controling laser-power
- flexible wavelenght λ
- amorphous structures
- post-heat treatment for crystalisation



BATTERY – MATERIALS

ELECTROLYTE

$(Al_xZr_{1-x})_{4/(4-x)}Nb(PO_4)_3$ 1

- 3D NaSICON-type structure
- partially substituting Zr^{4+} by Nb^{5+} to stabilize structure for Al^{3+} conduction
- 4,5 x 10^{-6} S/cm (600 °C)

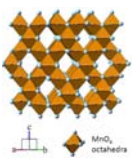
$Al_2(WO_4)_3$ 2

- 2D tunnel structure
- 3,2 x 10^{-6} S/cm (600 °C)
- commercially available target

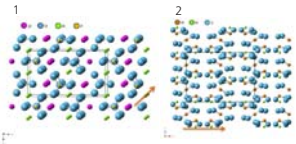
CATHODE

λ-MnO_2

- spinel structure
- 3D tunnel network for intercalation process
- good electric conductivity
- challenge: stabilization of metastable phase



source: Brown et al. U.S. Patent Application 12/895,487, 2010

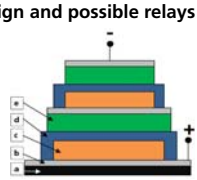


Crystal structures of electrolyte- and cathode materials including indication of ion flux

INNOVATIVE DESIGN FOR BATTERY – LAYOUT

Stack Battery Design and possible relays

series connection



parallel connection