



Coating Development of Al³⁺-Conducting Thin Films by PLD

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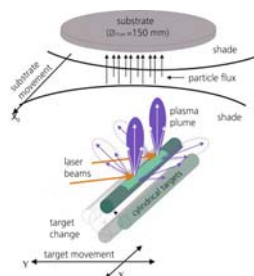
INTRODUCTION AND MOTIVATION

Developing technologies on the market spur the demand for alternative solution in the field of energy supply. All-solid thin-film rechargeable 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 considered. Especially multivalent-ions such as Mg²⁺, Ca²⁺ and Al³⁺ have become popular candidates as they can transfer more electrons per atom. By taking into account different criteria such as capacity, price, abundance and redox potential, 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.

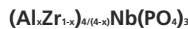


PULSED LASER DEPOSITION – TECHNOLOGY

- stoichiometric ablation
- installation of small, sintered targets possible
- adjustable deposition-rate and thin-film-density by controlling laser-power
- flexible wavelength λ
- amorphous structures
- post-heat treatment for crystallisation



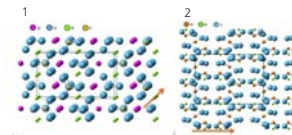
BATTERY – MATERIALS ELECTROLYTE



- 3D NaSiCON-type structure
- partially substituting Zr⁴⁺ by Nb⁵⁺ to stabilize structure for Al³⁺ conduction
- 4,5 x 10⁻⁶ S/cm (600 °C)



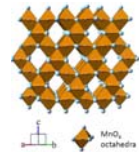
- 2D tunnel structure
- 3,2 x 10⁻⁶ S/cm (600 °C)
- commercially available target



CATHODE



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



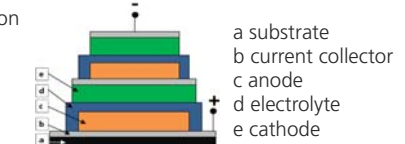
source: Brown et al. U.S. Patent Application 12/895,487, 2010

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

