Bundesministerium für Bildung und Forschung

JÜLICH FORSCHUNGSZENTRUM

Development of Corrosion Protection Layers for Current Collectors in Dual-Ion Batteries

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Motivation

In novel dual-ion cells graphite intercalation compounds will be used for both electrodes. The consequent intercalation of both, cations and anions, in the respective electrodes enables potential values above 5 V vs. Li/Li⁺. Established liquid organic electrolytes do not resist these conditions. Therefore those are replaced by ionic liquids having a good electrochemical performance also at higher temperatures. Now the challenge is to overcome the corrosion of the aluminium current collector triggered by fluorinated anions like bis(trifluoromethylsulfonyl)imide (TFSI⁻).

Dual-ion cell concept

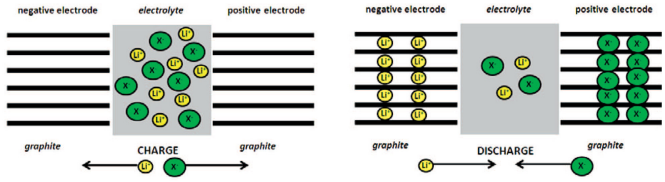
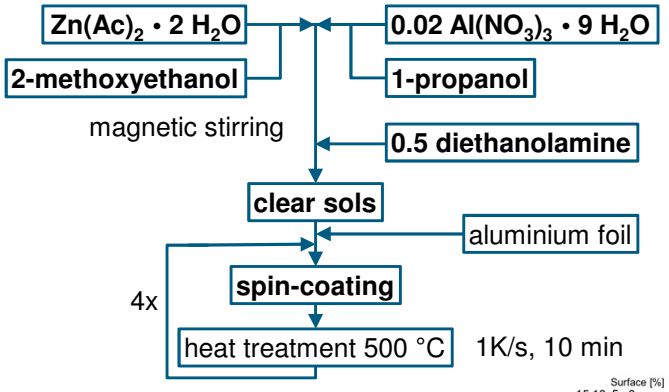


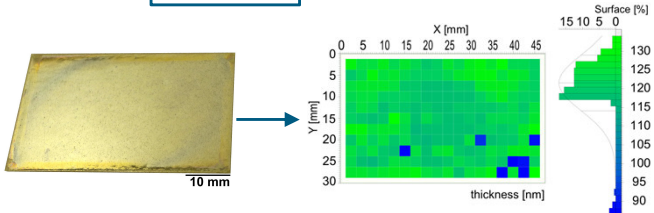
figure from: Placke, T.; et al., *Journal of The Electrochemical Society* 2012, *159* (11), A1755-A1765.

Simultaneous intercalation of cations and anions in graphite based electrodes; release to the electrolyte

Sol-gel approach

- requirements for protection layer: electronically conductive, defect free, mechanically as well as electrochemically stable
- wet chemical deposition of oxidic ceramics, first of all doped semiconductors like ZnO:Al

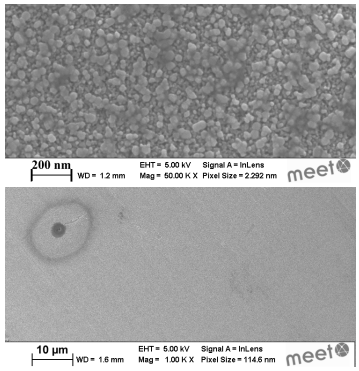




Aluminium foil (130 µm) coated 4x after heat treatment *(left)*. The final thickness distribution by laser ellipsometry *(right)*.

Thin film properties

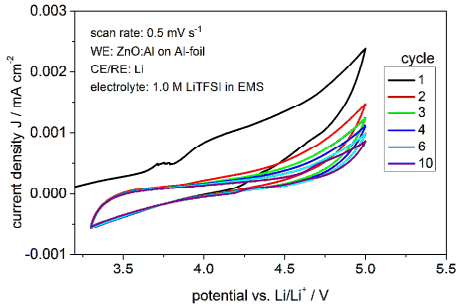
Scanning electron microscopy



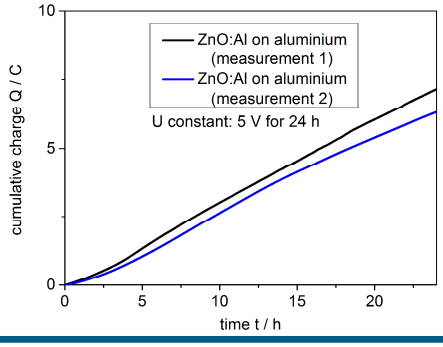
Surface structures of ZnO:Al layers deposited on aluminium foil *(top)*

Surface after electrochemical tests *(left)*, detailed image of this corrosion pit *(right)*.

Electrochemical analyses



Cyclic voltammetry (CV), decreasing current density indicates an electrochemical stability of the layer



Chrono-amperometry (CA), increasing cumulative charge indicates the corrosion of the current collector

Conclusion

Alumina doped zinc oxide was chosen as protective material and synthesized by a sol-gel route for the deposition on different aluminium substrates. Based on the results of the electrochemical tests combined with SEM images it is necessary to improve the structure and density of the ceramic layers to avoid corrosive attacks at defects.

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