MEGAnanoPOWER: DISRUPTIVE POWER STORAGE TECHNOLOGY APPLYING ELECTROLYTE NANO DISPERSIONS AND MICRO/ NANO STRUCTURED ELECTRODES

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ABSTRACT

The Aigys power storage technology is based on so called redox-flow principle. The patented Aigys Power-Cell® technology uses solid dispersions instead of solved chemical compounds as charge carriers. Currently micro-particulate dispersions are used with the disadvantage of limited stability and insufficient charge density. To overcome these limitations, this project aims to develop stable nano-dispersions as high capacity energy storage media and to apply surface enlarged nano/micro structured electrodes as efficient current collectors.

INTRODUCTION

In redox-flow batteries the energy is stored in solved chemical compounds (electrolytes) which is highly interesting for large scale energy storage (decoupling of storage capacity and power). Mainly vanadium compounds are used in todays, commercially available redox-flow batteries. However, due to the limited solubility of this chemicals, the achievable energy density of such systems is still low.

The goal of this project is to test novel particle based electrolyte dispersion as energy storage media (**fig. 1**) and use surface enlarged nano/micro structured electrodes as efficient current collectors. In a first phase of the project electrolyte dispersion made of well-known lithium-based compounds are used to test the working principle und to understand the basic behavior of particle based electrolyte dispersion. However, in a later stage we will also investigate alternative materials with better availability, lower price and strongly reduced hazardous potential.

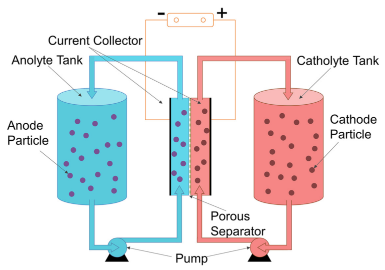

***Fig. 1**: General working principle of a redox-flow battery with solid electrolyte dispersions (source: ref. 1).*

Li-ion dispersion battery based on nano-particulate lithium cobalt oxide (LCO)

Nano-particulate LCO was successfully synthesized using a hydrothermal approach. The obtained plate-like particles have a size of 50-100 nm and showed a typical XRD spectrum (**fig. 2**). These particles were added to an electrolyte/ solvent mixture to obtain a nano-particulate dispersion.

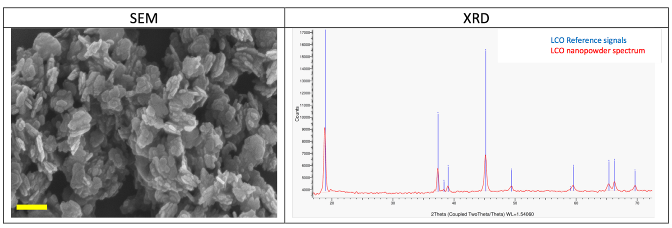

***Fig. 2**: SEM image of LCO nanoparticles (scale bar 200nm) and XRD spectrum of LCO nanopowder (red), showing broad peaks of nano-crystallites, which is compared to LCO reference signals (blue).*

This dispersion was used for first electrochemical measurements (**fig. 3**). The cyclic voltammetry results confirm that reversible redox reactions can be performed with LCO nano-particles at expected potentials. Further, four charge-discharge cycles were successfully conducted and showed a stable coulombic efficiency at around 84 %. Due to the low mass transport in the system (weak magnetic stirring) the battery was not completely charged/discharged. This explains the low capacities in the shown charge/discharge measurements.

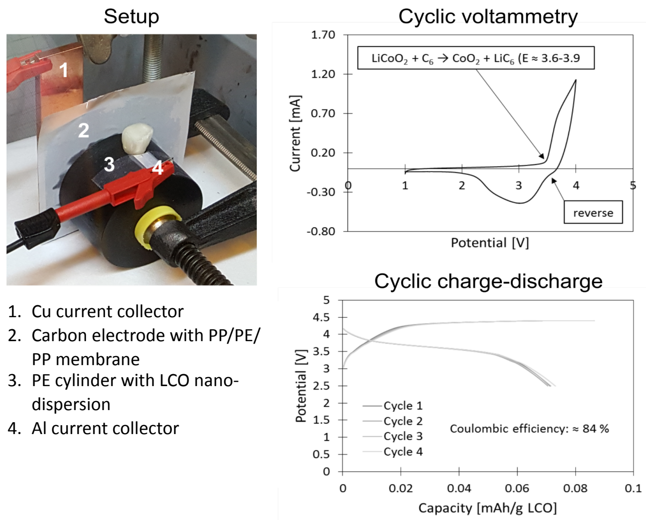

***Fig. 3**: Constructed carbon-LCO nano-dispersion battery (left) and first electrochemical measurements (right).*

Structuring of electrodes – surface enlargement by hot-embossing

The structuring of the current collector surface (**fig. 4**) aims to enlarge the interacting surface area in general and to adapt specific surface topographies which enable rapid charge transfer processes.

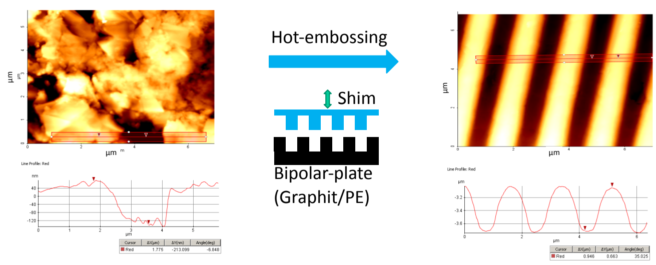

***Fig. 4**: Atomic force microscope (AFM) picture of non-structured and structured graphite/ polyethylene current-collector.*

Outlook

- Study electrolyte dispersions with different particle sizes
- Investigate alternative materials to lithium. Preferably inorganic, low cost compounds which are non-toxic and readily available.
- Optimize battery setup (structured electrode, efficient mass transport concept)

REFERENCES:

[1] *Qi et al.,* Journal of Vacuum Science & Technology B 35, 040801 (2017).

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