Institut für
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Production and characterization of bi-functional cathodes for secondary zinc-air batteries

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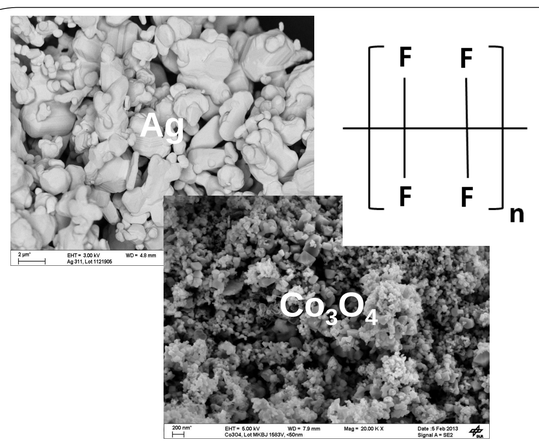
Introduction

Zinc-air batteries have the high energy density of metal-air batteries combined with the features of zinc, which are the safe and easy handling, the environmental acceptability and the abundance of zinc. The only limiting factor for the capacity is the amount of reversible active usable zinc inside the battery. This is due to the high passivation rate and dendritic growth of zinc. Another limiting factor is the high overpotential during charge and discharge and corrosion of cathode materials. In this work an Ag/Co_3O_4 electrode was used and stable performance over 170 cycles in a full cell were achieved. This electrode was investigated under various conditions to improve the performance and cycle life.

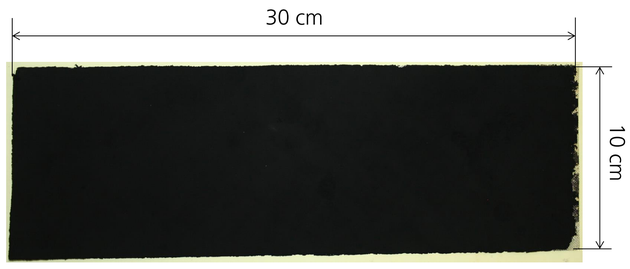
Production Technique



Conductive additive + catalyst + PTFE

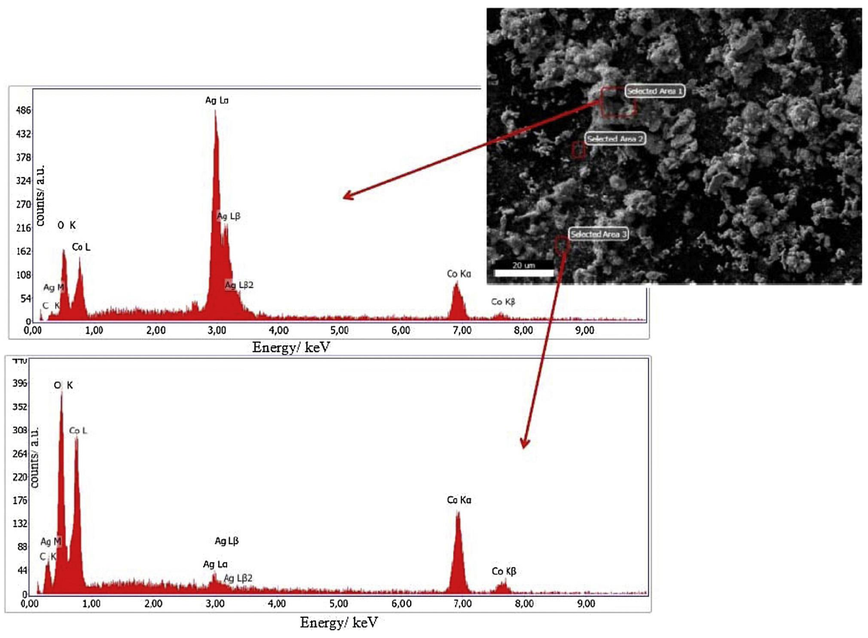
Mixing

Hydraulic pressing

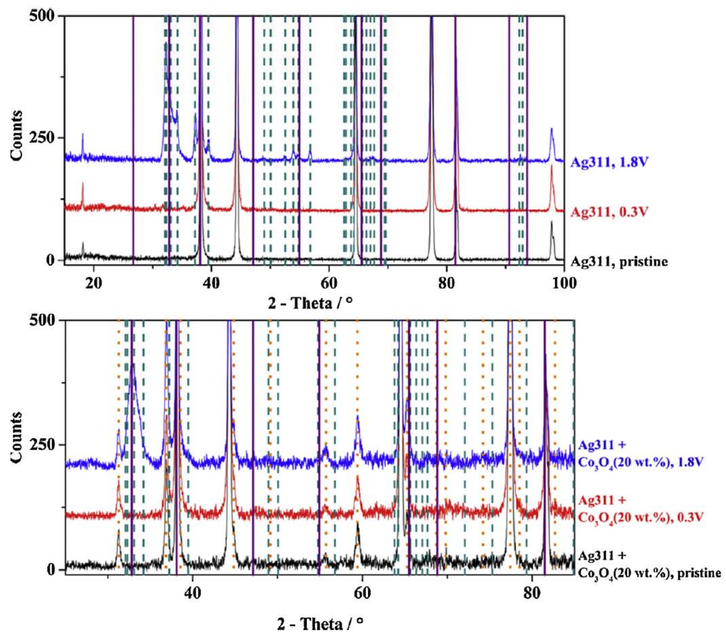


Gas diffusion electrode (GDE)

Surface characterization



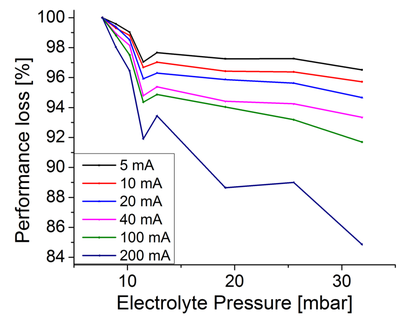
- Co_3O_4 particles cover the surface of Ag particles almost completely, as shown in the EDX measurement on the left
- XRD-measurement shows presence of $Ag^{I}Ag^{III}O_2$ and $Ag_2{}^{I}O$ at 1.8 V vs. RHE. For longer dwell times at 1.8 V, the $Ag_2{}^{I}O$ will also be transformed to $Ag^{I}Ag^{III}O_2$
- XRD-measurements at 0.3 V vs. RHE show the presence of metallic Ag

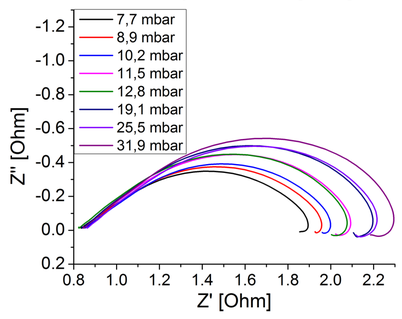


H.M.A. Hatem, H. Baltruschat, D. Wittmaier, K.A. Friedrich, *Electrochimica Acta* **151** (2015) 332–339

Hydrostatic Pressure

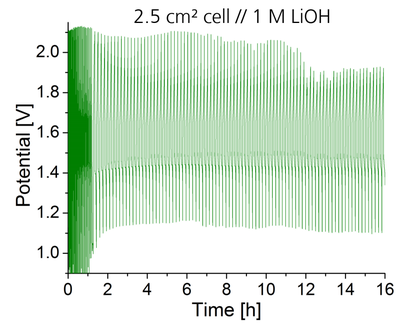
- Ag/Co_3O_4 electrode measured in 7.5 M KOH at RT with a O_2 pressure of 3 mbar
- Increase of pressure leads to electrochemical performance loss
- Impedance spectra shows increase in diffusion impedance
- Inductive loop for small frequencies shows electrochemical activity of backing GDL → electrode is completely flooded above 11.5 mbar

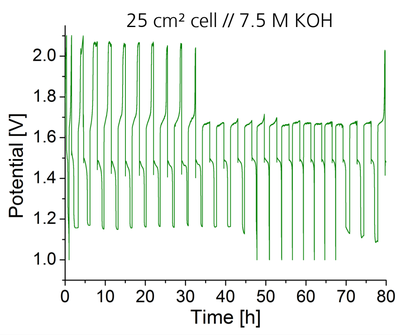


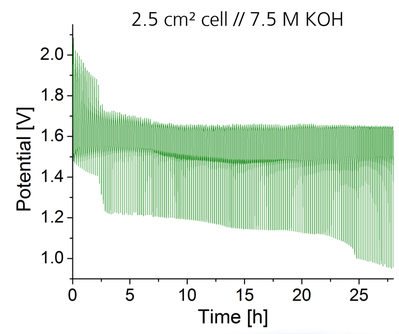


Full Cell Testing/Scalability

- Over 170 cycles were achieved for KOH based systems
- Potential window for 2.5 cm² and 25 cm² cell are in good agreement







Conclusion

- A stable and active catalyst combination for Zn-air batteries was developed and over 170 cycles in a full cell Zinc-air battery was shown
- Only around 11.5 mbar are needed to flood the electrode
- The change of oxidation states from pristine Ag to $Ag_2{}^{I}O$ and $Ag^{I}Ag^{III}O_2$ and back to pure metallic silver were measured with XRD

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DLR Deutsches Zentrum für Luft- und Raumfahrt