Importance of in-situ techniques in the investigation of rechargeable lithium-sulfur batteries

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The lithium-sulfur (Li-S) battery promises with its high theoretical capacity (1675 mA h^{-1}) and energy density (2600 Wh kg^{-1}) to be one of the energy storage systems of the future. However, the electrochemical processes and degradation mechanisms of the cells need further investigation to improve their capacity and safety.

In this work, in-situ characterization methods were applied for the characterization of reaction products and changes in the electrode properties. By means of XRD, the formation of reaction products during charge and discharge were monitored in operando [1]. The formation of dilithium sulfide and the recrystallization of sulfur were semi-quantitatively determined. The electrochemical behavior of the cell was also investigated using electrochemical impedance spectroscopy (EIS) at different depths of discharge and charge; and up to 50 cycles [2]. An electrical circuit is proposed to quantify the impedance contribution of the cell. Changes in the electrolyte resistance and charge transfer resistance due layer formation on the electrode are amongst others the analyzed processes in this research. Furthermore, atomic force microscopy (AFM) measurements provide information about changes in the electrical conductivity of the cathode surface. UV-spectroscopy is presented as a significant technique for analyzing the polysulfides intermediates products.

This work highlights the importance of in-situ studies and the combination of different spectroscopic and microscopic techniques to reveal new insights into the Li-S battery.

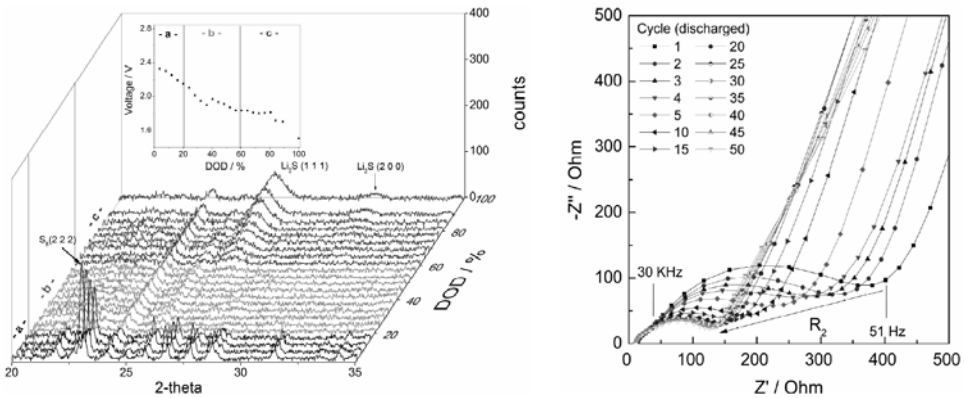

Fig. 1: In-situ X-ray diffraction data collected during discharge of Li-S battery (left). EIS spectra of cell at different cycle number (right).

References:

[1] N.A. Cañas, S. Wolf, N. Wagner, K.A. Friedrich, J. of Power Sources 226 (2013) 313-319.

[2] N.A. Cañas, K. Hirose, N. Wagner, B. Pascucci, N. Wagner, K.A Friedrich, R. Hiesgen, Electrochimica Acta 97 (2013) 42–51.