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Electrocatalysts for Lithium-Sulfur Energy Storage Systems

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Abstract : Li-S- (Lithium-Sulfur-) battery systems provide very high specific gravimetric energy (2600 Wh/kg) and volumetric energy density (2800Wh/l). Hence, Li-S batteries are one of the key technologies for both the upcoming electromobility and stationary applications. Furthermore, the Li-S battery system is potentially cheap and environmentally benign. However, the technical implementation suffers from cycling stability, low charge and discharge rates and incomplete understanding of the complex polysulfide reaction mechanism. The aim of this work is to develop an effective electrocatalyst for the polysulfide reactions so that the electrode kinetics of the sulfur half-cell will be improved. Accordingly, the overvoltage will be decreased, and the efficiency of the cell will be increased. An enhanced electroactive surface additionally improves the charge and discharge rates. To reach this goal, functionalized electrocatalytic coatings are investigated to accelerate the kinetics of the polysulfide reactions. In order to determine a suitable electrocatalyst, apparent exchange current densities of a variety of materials (Ni, Co, Pt, Cr, Al, Cu, ITO, stainless steel) have been evaluated in a polysulfide containing electrolyte by potentiodynamic measurements and a Butler-Volmer fit including diffusion limitation. The samples have been examined by Scanning Electron Microscopy (SEM) after the potentiodynamic measurements. Up to now, our work shows that cobalt is a promising material with good electrocatalytic properties for the polysulfide reactions and good chemical stability in the system. Furthermore, an electrodeposition from a modified Watt’s nickel electrolyte with a sulfur source seems to provide an autocatalytic effect, but the electrocatalytic behavior decreases after several cycles of the current-potential-curve.

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