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Dry coating of binder-free sulfur cathodes for lithium-sulfur batteries

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In research and development, a discussion about the next battery generation has long since been sparked, so that research is already being conducted into other material systems. The lithium-sulfur (Li/S) battery system seems to offers a good alternative for gravimetrically critical applications such as aircraft and trucks. The anode usually consists of metallic lithium and the cathode of a composition of sulfur, carbon and binder. The manufacturing costs of the electrodes take up more than half of the total costs of a battery[1]. Thus, it is important that the sulfur for the Li/S battery can be acquired cheaply, as it is the active material of the cathode components and is elementarily available worldwide and can be recycled from waste products, such as those from oil refineries[2].

Usually, the sulfur cathode consists of a mixture of sulfur, carbon and binder. To ensure the homogeneity of an electrode, all electrode components must be homogeneously distributed (s. picture 1a). This is achieved through various mixing processes. The process applied mechanically inserts the sulfur into the carbon matrix (s. picture 1b). The aim of the research is to reduce the inactive material of the electrode components. In order to reduce the binder content, a dry coating process can be used. The homogeneously distributed sulfur cross-links with the carbon matrix by means of melting and pressure and thus, achieves sufficient adhesion of the particles in the electrode coating. Using a structured aluminium substrate, the adhesion of the coating to the substrate could also be guaranteed (s. picture 1c/d). Structured substrates have the potential to increase the performance of the cathodes while reducing weight and to increase the energy density, which is beneficial for aerospace applications. With this dry coating process and the use of structured substrates, it was even possible to produce binder-free sulfur cathodes. These delivered better electrochemical performance than wet-coated electrodes, which for instance require a binder content of between 5-10 %.

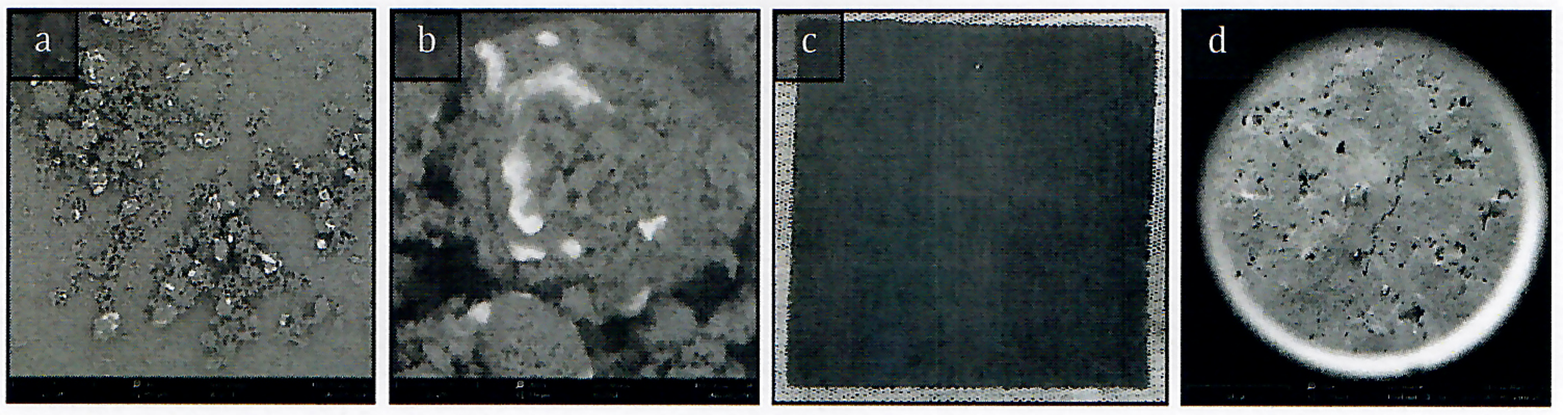

figure 1: (a,b) SEM pictures of S/C-powder, (c) dry coated electrode, (d) SEM picture of dry coated electrode

References:

[1] A. Kwade et al, *nature energy*, 2018, 3, 290-300
[2] McKinsey&Company, *Energy Insights*, https://tinyurl.com/2p94a6sc, 2022

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