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Impact of biomass-based multifunctional binders on Li-S battery chemistry - analysis of polysulfide phases by in operando XAS

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Li-S batteries are promising candidates for the next generation energy storage systems due to their extremely high theoretical capacity and energy density and their low cost as well. However, Li-S batteries suffer from limited cycle stability due to the formation of different side-products during the cycling. The use of suitable binder material in the production of cathodes for Li-S batteries can be a possible approach to improving the overall electrochemical performance of the battery. Biomass-originated materials, like carrageenan, can suppress the shuttle effect of soluble polysulfides [1]. Carrageenan contains sulfate groups which facilitate a chemical reaction with the polysulfides and reduce their diffusion throughout the separator, leading to improved cycling stability and increased capacity retention. Additionally, the water-solubility of carrageenan eliminates the need for expensive and hazardous solvents in battery manufacturing processes, thus reducing costs and environmental risks. The literature was controversial regarding the functionality of the carrageenan binder [2], [3], however, it is important to understand its role in designing even better batteries. Therefore, X-ray Absorption Spectroscopy measurements have been done at sulfur K-edge to reveal the carrageenan effect on the polysulfide formation during the discharge and charge of the battery, and a comparison with the industrial standard PVDF has been done. The XANES region of the spectra allowed the determination of the different polysulfide species inside the electrochemical in operando cell and the effect of the binder material on the electrochemical reaction was identified.

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