Laboratory-based XANES to study vanadium in vanadium redox flow batteries

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Vanadium redox flow batteries (VRFB) are currently one of the most promising candidates for stationary energy storage. For large-scale applications, the ion conducting membranes currently in use need to be improved. Ideally, they need to become more cost efficient and selective regarding the vanadium crossover. To obtain a better understanding of the transport of the different vanadium species through the separator polymer electrolyte membranes (PEM) it is necessary to be able to determine concentration and species of the vanadium ions inside the nanoscopic water body of the membranes [1].

The speciation of vanadium in the electrolyte of vanadium redox flow batteries is important to determine the state of charge (SOC) of the battery. Speciation of V in the electrolyte of VRFBs have been performed by others at the synchrotron by X-ray absorption near edge structure analysis (XANES) [2]. However, the concentrations are quite high and not necessarily justify the use of a large-scale facility. Here we show on the basis of vanadium electrolyte and membranes hydrated with vanadium electrolyte challenges and possibilities of laboratory-based XANES.

We were able to determine vanadium species in the 1.6 M electrolyte with a measurement time of 2.3 h and vanadium species having a concentration of 9.8 $g \cdot kg^{-1}$ inside the membranes (thickness (unhydrated): 178 µm) with a measurement time of 5 h. Our results show that laboratory-based XANES is an appropriate tool to study these kind of samples.

Literature:

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