Towards Totally Aqueous Membrane-free Flow Batteries: Fundamentals and Challenges

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The implementation of renewable energies (solar, wind, etc) is driven the development of new energy storage systems that can mitigate their inherent intermittency solving the mismatch between the energy demand and production. Among different systems, electrochemical energy storage devices stand out due to their efficiency, flexibility and modularity. Specifically, Redox Flow Batteries (RFB) are an unique technology able to decouple energy and power which makes them versatile and adaptable to different applications. Nevertheless, although they are commercially available, their implementation is limited by the high cost and issues associated with some components such as the vanadium-based electrolytes and Nafion ion-exchange membranes.

In this regard, our approach to overcome these limitations is the development of membrane-free flow batteries based on immiscible/biphasic electrolytes containing organic active species[1,2]. The selective thermodynamic separation of the active species in two immiscible liquid phases made possible to eliminate any membrane or physical barrier in our batteries. In this talk, I will present an overview of the different membrane-free batteries developed in our group, including those based on biphasic aqueous electrolytes. Thanks to a patented flow-cell reactor[3], we were able to develop the first example of aqueous membrane-free battery operating under flow conditions.[4] The results show high coulombic efficiency (94%), capacity utilization (98%), and stable long-term performance over 250 cycles. The fundamental challenges and the last advances in this innovative concept will be discussed with especially attention to the strategies designed to mitigate the inherent self-discharge of this membrane-free battery technology.

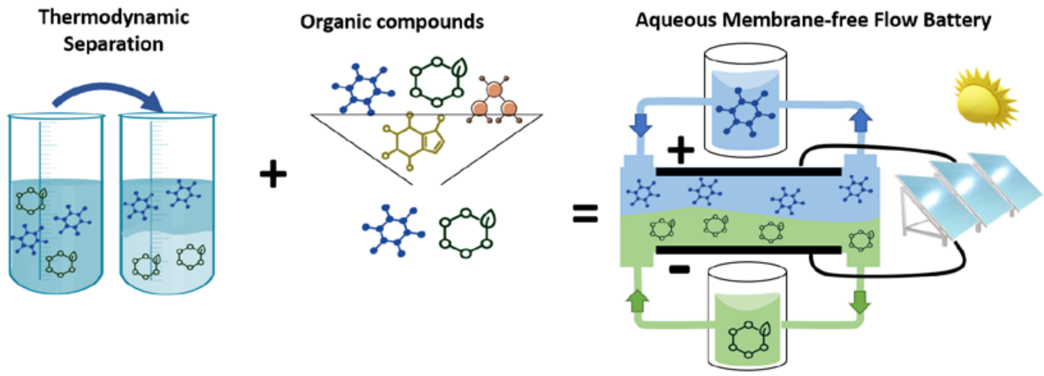

Figure 1 Schematic representation of the development of a membrane-free flow battery based on two aqueous biphasic electrolytes with organic active species.

References:
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