IRON COMPLEXES AS CHARGE CARRIERS IN ALL IRON REDOX FLOW BATTERIES

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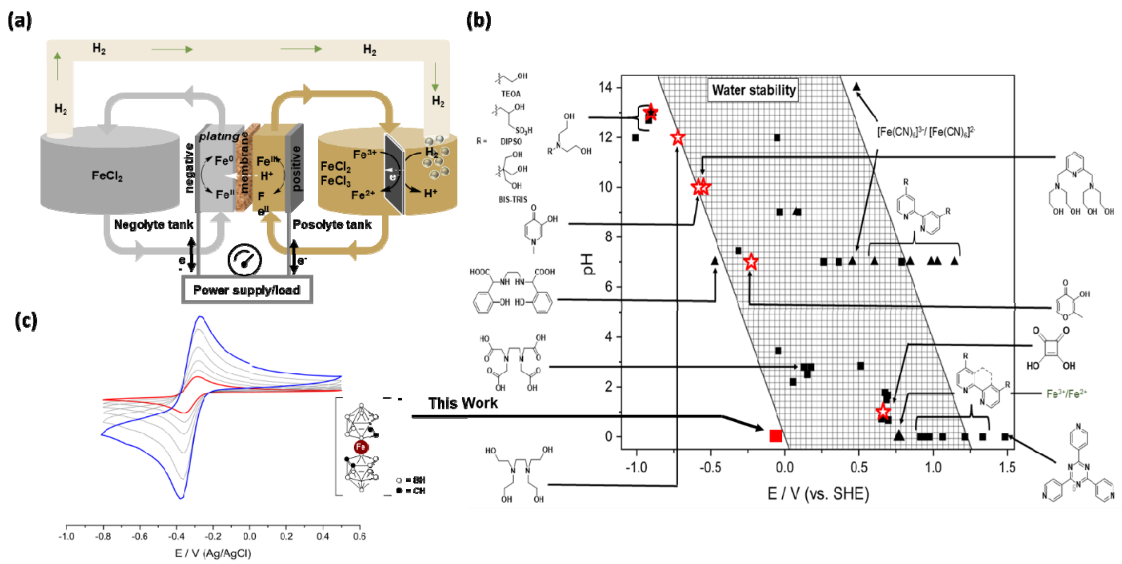
The hybrid all iron redox flow battery (IRFB) developed in 1981[1] and commercialized by ESS Tech, inc. (ESS)[2] has the advantage of using abundant and cheap iron materials. The redox chemistry of the current IRFB technology is based on $FeCl_2$ cycling between the 0/2+ and 2+/3+ oxidation states (Figure 1a). However, this system faces serious challenges: Rust formation on the anodic side and a competing hydrogen evolution reaction (HER) at the cathodic side. A fully decoupled system where high solubility and a fast reversible electrochemical response (Fe^{3+}/Fe^{2+}) within the stability window of water are desired.

We have screened the Fe^{3+}/Fe^{2+} redox couples in water for a library of complexes (Figure 1b) in search for suitable iron complexes for aqueous IRFBs and this has provided us inspiration to investigate the applicability of an anionic iron(III) carborane (Figure 1c) for use in a decoupled all-soluble IRFB. The very stable electrochemistry in acidic medium and its high solubility (C_{max} = 2.14 M at pH 2) makes the iron(III) carborane complex a promising charge carrier in an all-soluble IRFB.



[1] L. W. Hruska and R. F. Savinell, Journal of The Electrochemical Society, 1981, 128, 18.

[2] I. ESS Tech, Iron Flow Chemistry, https://essinc.com/iron-flow-chemistry/, (accessed 17/01, 2025).