Enhancing the performance of aqueous energy storage systems with redox-active electrolytes

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Research in electrochemical energy storage is converging to target systems with battery-level energy density, and capacitor-level cycling stability and power density. One approach is to utilize redox-active electrolytes that add faradaic charge storage to increase energy density of supercapacitors. Aqueous redox-active electrolytes are simple to prepare and to up-scale; and, can be synergistically optimized to fully utilize the dynamic charge/discharge and storage properties of mesoporous carbon based electrode systems. However, aqueous redox-enhanced electrochemical capacitors (redox ECs) have performed relatively poorly, primarily due to the cross-diffusion of soluble redox couples, reduced cycle life, and low operating voltages.

In this presentation, we provide an overview of the emerging field of redox ECs [1]. Our discussion is primarily focused on operating mechanisms and how they affect performance. We also provide a perspective on the advantage of dual-redox ECs and how to improve them based on fundamental design principles including solubility enhancing approach [2] and self-discharge suppression strategies [3].

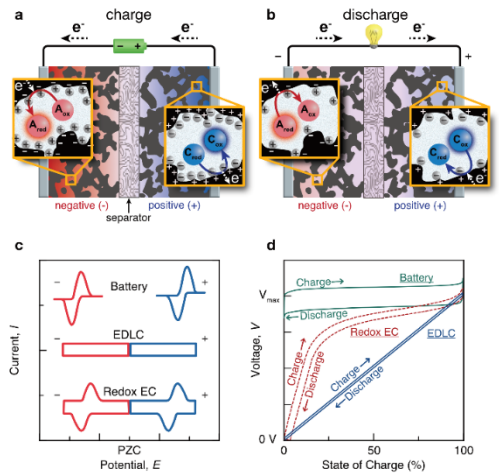

Figure 1. Energy storage mechanisms in a redox EC under (a) charge and (b) discharge conditions. Comparison of the theoretical (c) CVs and (d) two-electrode GCL voltage profiles of a battery, an EDLC, and a redox EC [1].

Reference:

[1] Seung Joon Yoo et al. *ACS Energy Letters* **2017**, *2*, 2581-2590.

[2] Seung Joon Yoo et al. *ACS Energy Letters* **2023**, *8*, 2345-2355.

[3] Seung Joon Yoo et al. *Journal of the American Chemical Society* **2017**, *139*, 9985-9993.