

# Nernstian-Potential-Driven Redox-Targeting Reactions of Battery Materials

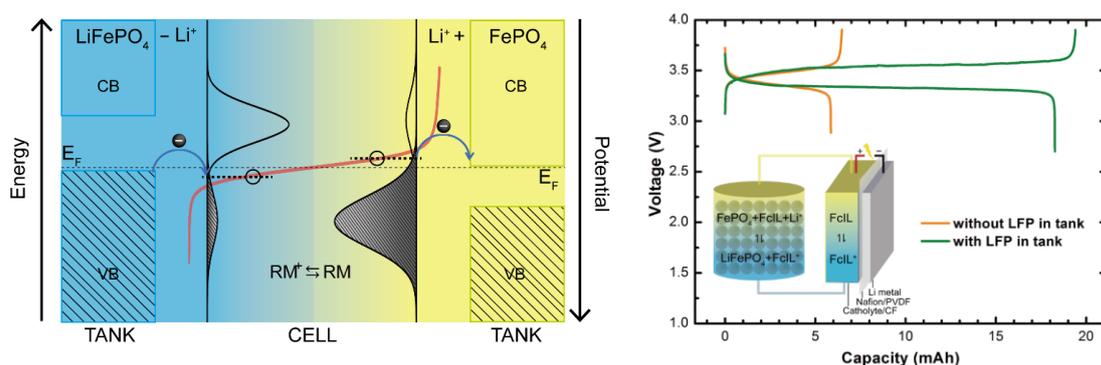
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Large-scale energy storage serves as an important means to enhance the quality and efficiency of the power grid. It also buffers the energy generated by the wavering and intermittent renewable energy sources such as solar and wind when they are connected to grid. Among various electrochemical energy storage technologies, both redox flow batteries and lithium-ion batteries have received considerable attention. However, one main obstruct of conventional redox flow battery is the relatively low energy density (<40Wh/L) due to the limited solubility of redox species. Whereas for the lithium-ion battery with higher energy density, it suffers from safety issue and high life cycle cost when taking maintenance and battery management system into consideration. By virtue of redox-targeting reactions, the recently developed redox targeting-based flow battery breaks the boundary between solid phase and liquid phase energy storage, combining the advantages of those two technologies to achieve a high energy density redox flow battery. While promising, redox-targeting generally involves multiple redox reactions between the molecules and materials, which inevitably brings about additional complexity in electrolyte composition and more critically low voltage efficiency (<85%). The Nernstian potential-driven redox targeting reaction reported here elegantly eliminates the voltage loss of a LiFePO<sub>4</sub>-based redox flow lithium battery. The bi-functional redox molecule, a ferrocene-grafted ionic liquid with identical standard potential to that of LiFePO<sub>4</sub>, reacts with the solid material both anodically and cathodically driven by Nernstian potential difference, exhibiting nearly unity material utilization, unprecedented voltage efficiency of 95%, and an energy density of 315 Wh/L (max. 942 Wh/L). This study paves a general pathway applicable to other battery chemistries, showing great promise to the development of next generation flow battery technologies for large-scale deployment.



Left: Energy diagram and charge transfer of the SMRT reactions of RM<sup>+</sup> with LiFePO<sub>4</sub> upon charging, and RM with FePO<sub>4</sub> upon discharging.

Right: Voltage profiles of flow cells with 0.20 M FcIL in the catholyte and 0.37 M equivalent LiFePO<sub>4</sub> granules in the tank. The inset is schematic of a RFLB half-cell with LiFePO<sub>4</sub> granules filled in the energy storage tank.

## References:

- [1] Zhou Mingyue, Qizhao Huang, Thuan Nguyen Pham Truong, Jalal Ghilane, Yun Guang Zhu, Chuankun Jia, Ruiting Yan, Li Fan, Hyacinthe Randriamahazaka, and Qing Wang. "Nernstian-Potential-Driven Redox-Targeting Reactions of Battery Materials." *Chem* (2017). <https://doi.org/10.1016/j.chempr.2017.10.003>