Reversible Intercalation of Metal Cations towards High-Performance Batteries

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Abstract: New types of cation storage materials would show tremendous potential in the development of high-performance rechargeable energy storage devices. Recently, we develop layered double hydroxides (LDHs) as promising cation supercapacitor materials in aqueous and neutral operation, *via* an effective electrochemical activation (ECA) strategy, for a reversible intercalation of a wide range of metal cations.[1] The results show that the ECA process induces the formation of hydrogen vacancies on LDH host layers and extravasation of interlay anions, which provides a 2D open channel with abundant active sites for a reversible intercalation of metal ions. Furthermore, we present 2D $Co(OH)_2$ with different crystal phase structures as models to explore the relationship between cation intercalation and the interlayer structure of layered materials. [2] It is found that α-$Co(OH)_2$ with an intercalated structure is more conducive to phase transition after ECA process than β-$Co(OH)_2$ with a non-intercalation structure. As a result, the activated α-$Co(OH)_2$ delivers four times higher capacity and ultralong cycle life in multi-cation storage than that of activated β-$Co(OH)_2$. Meanwhile, the experimental studies and DFT calculations reveal that the active oxygen on ultrathin LDHs after the ECA process could provide abundant atomic-scale active sites for Li homogeneous nucleation and plating, which effectively suppress the dendrite growth of Li metal anode.[3] Therefore, the controllable synthesis and surface interface regulation of LDHs would provide space and opportunities for the construction of new two-dimensional energy storage materials.

References:

[1] Zhenhua Li, Haohong Duan, Mingfei Shao,* Jianbo Li, Dermot O'Hare, Min Wei,* and Zhong Lin Wang*, *Chem*, **2018**, 4, 2168–2179.

[2] Jianbo Li, Zhenhua Li,* Fei Zhan and Mingfei Shao*, *Chem. Sci*., **2021**, *12*, 1756–1761.

[3] Zhenhua Li, Ke Liu, Kui Fan, Yusen Yang, Mingfei Shao,* Min Wei, and Xue Duan, *Angew. Chem. Int. Ed*., **2019**, *58*, 1–6.

Mingfei Shao received his PhD degree from Beijing University of Chemical Technology (BUCT) in 2014, after which he joined the staff of BUCT. He was also a visiting student at the University of Oxford in 2013. His research interests focused on the controlled synthesis of layered materials and their applications in electrochemical and photoelectrochemical energy storage and conversion.