Environmentally-table Interface of Layered Oxide Cathodes for Sodium-Ion Batteries

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Sodium-ion batteries are promising for large-scale energy storage.[1,2] Layered oxides especially for manganese-based ones have been the most popular cathodes due to the high reversible capacity via use of earth-abundant elements. However, the interface concern always inflicts the atmospheric and electrochemical corrosion on layered cathodes, leading to the severely declined electrochemistry. Herein, we present environmentally-stable interface via superficial concentration of titanium, providing a smart solution to not only overcome the above limitations, but present unique surface chemistry/electrochemistry.[3] Results show that atomic-scale interface is composed of spinel-like titanium (III) oxides, elevating the structural/electrochemical stability and electronic/ionic conductivity. Consequently, the interface-engineered electrode $NaMn_{0.8}Ti_{0.1}Ni_{0.1}O_2$ (NMTN) shows the best cycling performance among all layered manganese-based cathodes as well as performing high energy density. Our findings highlight the significance of a stable interface and moreover open up new opportunities for design of well-tailored cathode materials for sodium storage.

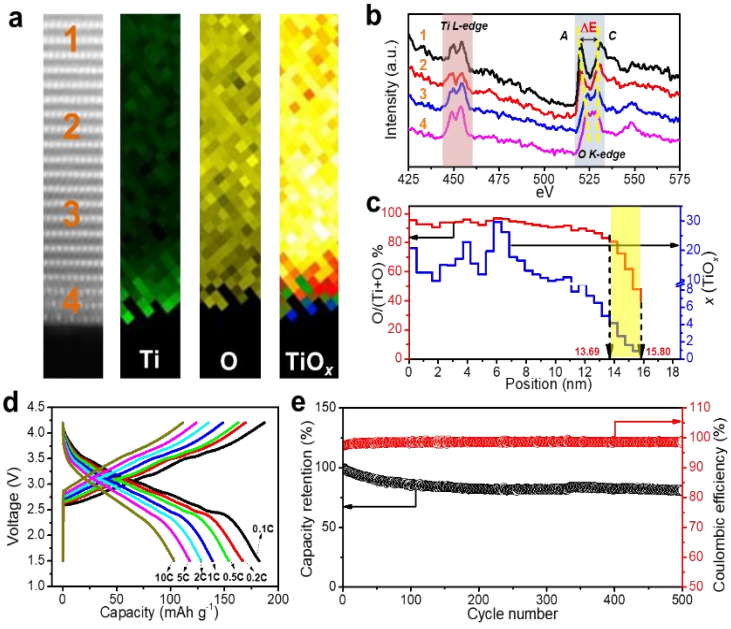

Figure 1 | Oxidation state, composition, and sodium storage performance of NMTN samples. (a) The HADDF-STEM and EELS mapping images focusing on the Ti and O composition and chemical shift from core to shell for the typical location, the numerical marks indicate the selective spots for EELS spectras. **(b)** Energy-loss near-edge spectrum (ELNES) of the Ti-$L_{2,3}$ (vertical brown shading) and O-K (vertical blue shading) edges, wherein the yellow dotted lines show the peak A and peak C of O-K edges, respectively. **(c)** Chemical composition of Ti and O, and the vertical yellow shading represent the interface locations; **(d)** Rate capability of NMTN electrode; **(e)** The cycling performance and coulombic efficiency of NMTN at 5C-rate.

References:

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[2] Shaohua Guo, Pan Liu, Haijun Yu*, Yanbei Zhu, Mingwei Chen, Masayoshi Ishida, Haoshen Zhou*, "A Layered P2- and O3-Type Composite as a High-Energy Cathode for Rechargeable Sodium-Ion Batteries", Angew. Chem. Int. Ed., 2015, 54, 5894-5899.

[3] Shaohua Guo, Qi Li, Pan Liu*, Mingwei Chen, Haoshen Zhou*, "Environmentally Stable Interface of Layered Oxide Cathodes for Sodium-Ion Batteries", Nature Commun., 2017, 8, 135.