A Targeted Functional Design for Highly Efficient and Stable Cathodes for Rechargeable Li-Ion Batteries

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Abstract

Despite the great success of the Li-ion batteries (LIBs) up to now, higher demand has been raised with the emergence of the new generation electrics, such as portable devices and electrical vehicles.[1] Even with the improvement on anodes, the cathodes with high capacity and long-lasting remains a challenge. A new 3D $NiCo_2O_4$@V_2O_5 sandwich arrays (SAs) on Carbon cloth as cathodes in LIBs is reported in this work.[2] The nano-designed materials realized the theoretical specific capacity of V_2O_5 with high power rate, ~ 292.0 mAh g^{-1} at the current density of 0.1 C, based on the total mass of the framework and amount of active materials. The electrodes achieved superb cycling stability, 0.0126% capacity decrease per cycle within 500 cycles at the high current density of 10 C, among the most stable cathodes for LIBs ever reported. From both in-situ TEM and quantum level calculations, the 3D $NiCo_2O_4$ nanosheets frameworks provided high electron conductivity and the skeleton of the robust SAs without participate the lithiation/delithiation; the thickness of the layered V_2O_5 plays a key role for Li diffusivity and the capacity contribution of electrodes. The structures herein point to new design concepts for high-performance nanoarchitectures for LIB cathodes.

References

[1] J. -M. Tarascon, M. Armand, *Nature*, *414*, (2001), 359;
[2] G. He, X. Han, R. Zou, T. Zhao, Z. Weng, S. Ho-Kimura, Y. Lu, H. Wang, Z. X. Guo, I. P. Parkin, *Adv. Funct. Mater.*, 27, (2017), 1604903

Figures

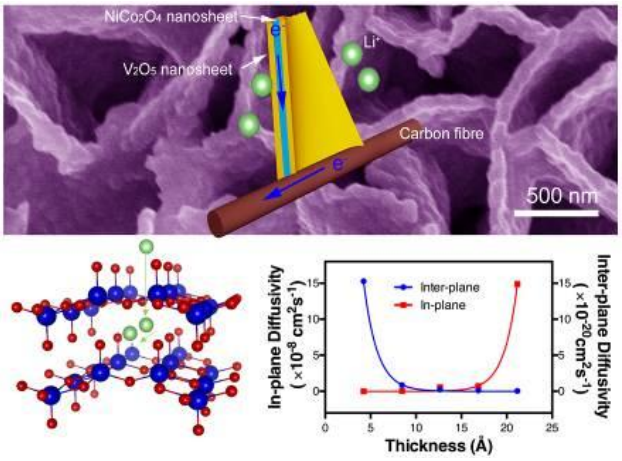

Figure 1. Nano-architectured cathodes materials for lithium ion batteries are introduced. The high capacity and stable characteristic routed from the bi-pathway design of electron conduction (the core material) and lithiation/delithiation reaction (the shell material). Further optimized thickness of the shell to balance the capacity and Li diffusivity efficiency was studied from both experimental and theoretical approaches.