Truncated octahedral design to construct high-performance spinel $LiMn_2O_4$ cathode material for ultrafast and long-life lithium-ion batteries

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Nowadays, rechargeable lithium-ion batteries (LIBs) have covered extensive applications in electrochemical energy storage and conversion including hybrid electric vehicles (HEVs), electric vehicles (EVs), portable electronic devices and energy storage systems (ESSs). Spinel $LiMn_2O_4$ is a promising cathode candidate with high operation potential, good power capability as well as obvious advantages in nontoxicity, safety and abundance. However, urgent problems still exist: (1) inferior cycling stability originating from Mn dissolution; (2) poor high-rate capability hampered by the limited Li^+ diffusion. Since the electrochemical properties strongly depend on the exposed surfaces interfacing with electrolytes for Mn-based cathode materials, developing nanostructured $LiMn_2O_4$ with tailored exposed planes can help to solve the above problems.

Here in this work, a truncated octahedral $LiMn_2O_4$ with high crystallinity has been successfully synthesized through a facile hydrothermal approach followed with thermal treatment at the optimal temperature of 750 °C. Benefiting from the unique structure which is exposed with (111) planes mitigating Mn dissolution and (100), (110) planes facilitating Li^+ diffusion, the truncated octahedral $LiMn_2O_4$ exhibits large reversible capacity, superior cycling performance and rate capability simultaneously. Remarkably, the capacity of 143.4 mAh g^{-1} and 124.8 mAh g^{-1} can be delivered at 0.2 C and 30 C with acceptable capacity retention of over 80 % after 1500 cycles. The $LiMn_2O_4/Li_4Ti_5O_{12}$-TiO_2 full cell can demonstrate 56.0 mAh g^{-1} at 30 C and the electrochemical performances at 55 °C can also be enhanced. The facilely synthesized truncated octahedral $LiMn_2O_4$ shows great potentials in high power applications of electric vehicles and smart grids.

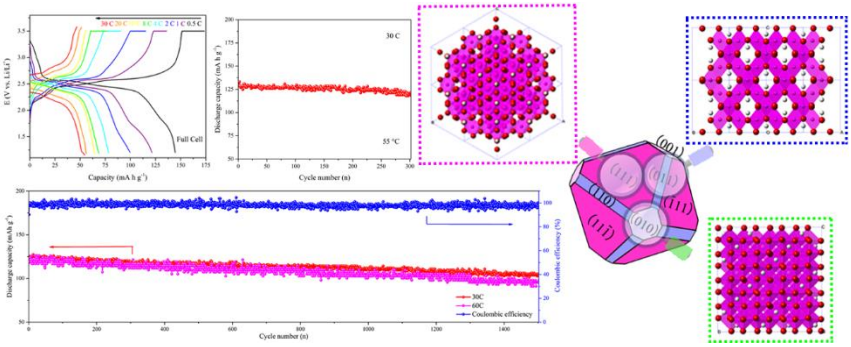

Fig. 1 Graphical abstract of this work.