Octahedral and porous spherical ordered $LiNi_{0.5}Mn_{1.5}O_4$ spinel: the role of morphology on electrochemical properties and electrode/electrolyte interface

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The spinel $LiNi_{0.5}Mn_{1.5}O_4$ material is a promising candidate for high energy lithium ion battery application owing to its high operating voltage of ≈ 4.7 V (vs Li / Li^+) and good high-rate performance. Unfortunately, this material still suffers from unsatisfied electrochemical performance, associated with electrodes/electrolyte interfacial side reactions [1]. The particle morphology, especially the surface crystallographic planes in contact with the electrolyte, is another important factor for the electrochemical performance [2].

In this work, the influence of the morphology of ordered $LiNi_{0.5}Mn_{1.5}O_4$ materials with octahedral and porous spherical morphology on electrochemical properties and electrode/electrolyte interface are investigated. The octahedral sample displays regular, small octahedral meso-particles, while the porous spherical sample is a micrometer size, composed of aggregated nano-sized particles. Crystal morphology has been demonstrated to influence the high-rate performance and cycle life of $LiNi_{0.5}Mn_{1.5}O_4$. The porous spherical $LiNi_{0.5}Mn_{1.5}O_4$ material exhibits better rate performance, associated with the shorten diffusion path of lithium ion, as shown in Figure 1. Howerver, the $LiNi_{0.5}Mn_{1.5}O_4$ with octahedral morphology has a low specific surface area, resulting in a good cyclic performance at high temperature 55 °C. Thus, it is necessary to optimize the morphology of $LiNi_{0.5}Mn_{1.5}O_4$ material and its operating conditions to obtain desirable performances.

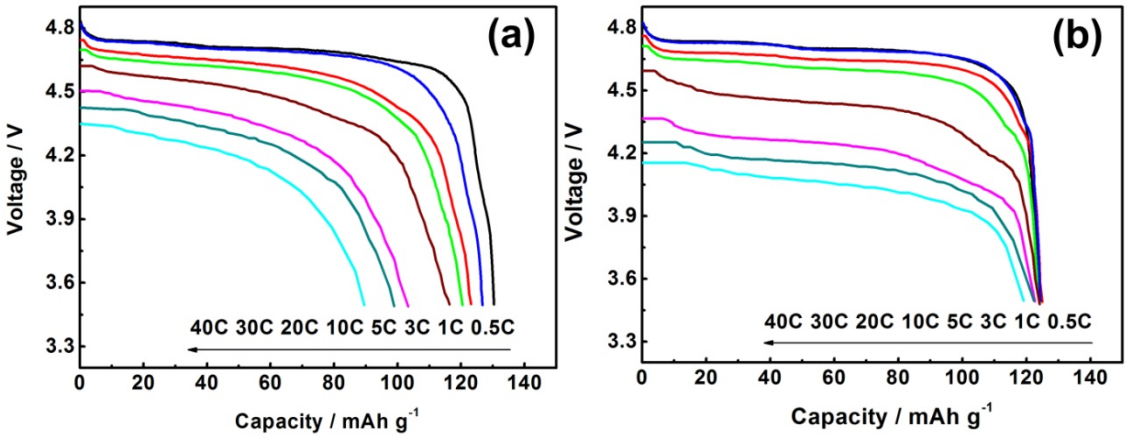

Figure 1. Discharge curves of $LiNi_{0.5}Mn_{1.5}O_4$ materials with octahedral (a) and porous spherical (b) morphology at different rate

References:

[1] A. Manthiram, K. Chemelewski, E.-S. Lee, Energy Environ. Sci. 7 (2014) 1339-1350.
[2] H. Liu, J. Wang, X. Zhang, D. Zhou, X. Qi, B. Qiu, J. Fang, R. Kloepsch, G. Schumacher, Z. Liu, J. Li, ACS Appl. Mater. Interfaces 8 (2016) 4661-4675.