Synergistic Effects of WS_2 Incorporation in LNMO for High Performance Cathode Materials

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Abstract

$LiNi_{0.5}Mn_{1.5}O_4$ (LNMO) is a potential cathode material for high voltage (~4.7 V vs. Li/Li^+) battery application. It is cobalt free and exhibits high energy density. However, it suffers from electrochemical drawbacks such as electrolyte decomposition at higher voltage, poor cycling stability, Mn/Ni dissolution, and low electronic conductivity especially at high rates. The addition of WS_2 to LNMO can address these limitations due to its layered structure, good electronic conductivity and interfacial properties. It enhances the charge transfer, suppress interfacial side reactions, stabilize the cathode–electrolyte interface, and mitigate transition-metal dissolution, thereby improving overall electrochemical durability of lithium-ion batteries (LIBs). The present study reports synthesis of LNMO by solid state reaction route and incorporation of WS_2 in LNMO by wet mixing approach. The pristine LNMO and WS_2 coated LNMO cathode based half cells exhibits specific capacity of ~138 mAh/g and ~134 mAh/g respectively. The pristine LNMO shows capacity retention of ~89% after 200 cycles at 2C, whereas the capacity retention for WS_2 coated LNMO is achieved to 86% even after 300 cycles at 2C. It is also observed that the durability of WS_2 coated LNMO is enhanced up-to 400 cycles with 50% retention. Hence, WS_2 is a potential cathode modifier for LNMO based battery application.

References

[1] Zhu, X.; Huang, A.; Martens, I.; Vostrov, N.; Sun, Y.; Richard, M.; Schülli, T. U.; Wang, L., Advanced Materials 30 (2024) 36.
[2] Kim, T.; Oh, H.; Yang, S.; Lee, H. J. ACS Applied Energy Materials (18)8 (2025) 13155–13178.

Figures

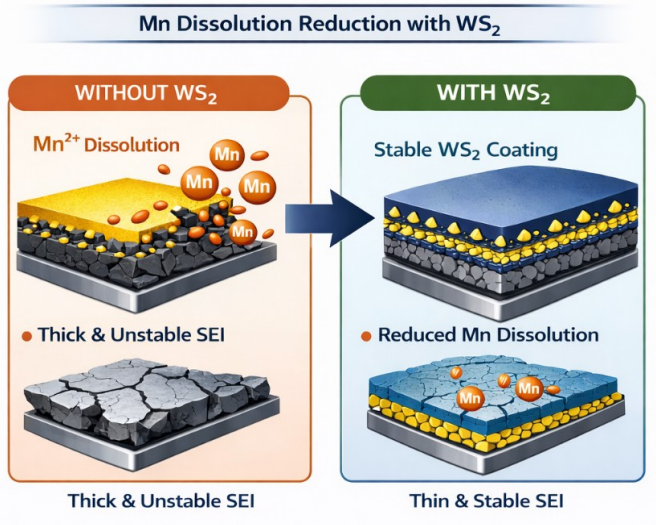

Figure 1: Schematic of advantages of WS_2 incorporation on LNMO.