

Investigation of Lithium difluorophosphate as a novel salt-type Electrolyte Additive for $\text{LiNi}_{0.5}\text{Mn}_{0.25}\text{Co}_{0.25}\text{O}_2$ cathodes

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Although the $\text{LiNi}_{0.5}\text{Mn}_{0.25}\text{Co}_{0.25}\text{O}_2$ holds the merits of high theoretical capacities and a relatively high operating voltage, the battery performance suffers from the severe cycling decay due to the unstable solid electrolyte interface on the cathode. Therefore, improving the battery performance via stabilizing the electrode/electrolyte interface is a main focus of the additive research [1].

There are some attractive examples in literature which describe electrolyte salt as film-forming additive[2]. In this work, we present LiPO_2F_2 as a salt-type additive to enhance the cycling stability of large-size crystallite $\text{LiNi}_{0.5}\text{Mn}_{0.25}\text{Co}_{0.25}\text{O}_2$ cathodes. Results demonstrate that addition of LiPO_2F_2 widening the stability of the electrolyte. When the content of LiPO_2F_2 increased to 1.0 wt%, the capacity remains 156 mAh g^{-1} with an efficiency of 91.6% after 100 cycles at 55°C . The cathode with 1 wt% LiPO_2F_2 -added electrolyte formed a relatively thin (15 - 20 nm) and uniform SEI layer, which mean LiPO_2F_2 has a significantly positive effect on internal resistances (R_{SEI} and R_{CT}) and mitigate undesirable electrolyte decomposition. We also observed that the concentration of O-P-F species decreases on the XPS spectra of P2p, indicating a less extensive decomposition of LiPO_2F_2 formed LiF and Li_3PO_4 during the cycling.

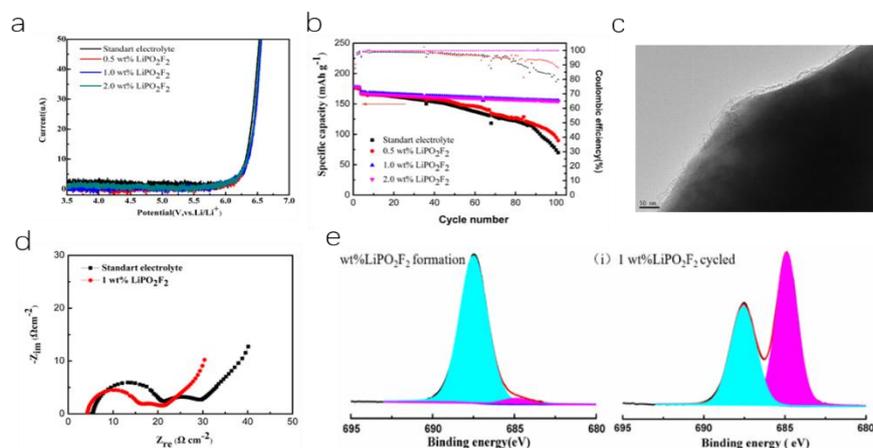


Figure 1. Linear sweep voltammetry (LSV) scans of electrolyte with various amount of LiPO_2F_2 (a), The specific capacity of the $\text{LiNi}_{0.5}\text{Mn}_{0.25}\text{Co}_{0.25}\text{O}_2/\text{Li}$ cells as a function of the cycle number at various amount of LiPO_2F_2 at 55°C (3 cycles of formation process at a rate of C/10 and cycling at a rate of 1C) (b), TEM images with 1 wt% LiPO_2F_2 electrolyte after 200th cycles (c), Nyquist plot of $\text{LiNi}_{0.5}\text{Mn}_{0.25}\text{Co}_{0.25}\text{O}_2/\text{Li}$ cells without and with 1.0 wt% LiPO_2F_2 additive (d), XPS spectra of P2p with 1.0 wt% LiPO_2F_2 -containing electrolytes (e).

References:

- [1] W. Zhao, Y. Ji, Z. Zhang, M. Lin, Z. Wu, X. Zheng, Q. Li, Y. Yang, *Current Opinion in Electrochemistry*, 6 (2017) 84-91.
- [2] Xu K. *Chem Rev*, 2014, **114** :11503–11618: