

Impacts of Mn Dissolution in Lithium Manganese Oxides on the SEI Formation

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Thanks to its high voltage, low cost, and good rate capability, lithium manganese oxide spinel has been extensively studied and commercially used as a promising cathode material for lithium ion batteries in Hybrid Electric Vehicles (HEVs) or Electric Vehicles (EVs). However, despite of its good electrochemical performances at room temperature, some challenges are still to be overcome in order to mitigate the degradation of such batteries during prolonged operation conditions, and to meet the cost and regulatory requirements.

One of the critical challenges is the severe capacity fade due to Mn dissolution from the spinel, especially at high temperature. Many methods have been proposed to mitigate the Mn dissolution, including coating or doping the cathode, and adding additives to the electrolyte.¹⁻³ However, relatively less attention has been paid to how the dissolved Mn may impact the anode. Mn presence on the anode may well impact the formation and evolution of SEI (solid electrolyte interphase), which accompanied by electrolyte decomposition and cause subsequently Li loss and battery degradation. Without knowing how Mn dissolution impacts the battery performance from the basic and microscale steps, an ultimately effective solution to mitigate it is difficult to achieve.

In this talk, we will show how Mn dissolved from the spinel cathode impacts the SEI formation on the anode. The main focus is to realize how Mn dissolution influences the electrode surface and how the changes in surface chemistry may influence battery long term viability. Spinel/graphite full cells after different electrochemical conditions are compared, and the surface films formed on the anode are investigated with TOF SIMS (time-of-flight secondary ion mass spectrometry), XPS (X-Ray photoelectron spectroscopy), and EIS (electrochemical impedance spectroscopy). Mn was found throughout the SEI, but not uniformly distributed. Also, the presence of Mn substantially increased the SEI formation, and changed its composition and impedance.

[1] R. J. Gummow, A. de Kock, and M. M. Thackeray, *Solid State Ionics*, 1994, 69, 59.

[2] G. G. Amatucci, A. Blyr, C. Siagala, P. Alfonse and J. M. Tarascon, *Solid State Ionics*, 1997, 104.

[3] S. Komaba, B. Kaplan, T. Kataoka, N. Kumagai, H. Groult, *Journal of Power Sources* 119-121(2003)378

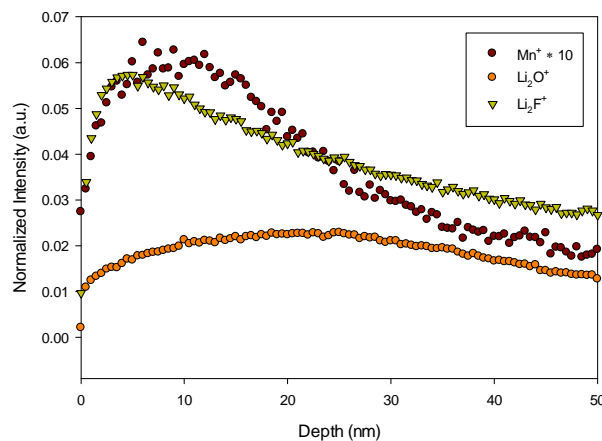


Figure 1. TOF SIMS depth profiles showing Mn deposited on the graphite anode of a graphite/LMO full cell. Li₂O⁺ and Li₂F⁺ represent components from the SEI. The Mn⁺ intensities were multiplied by 10 to show the distribution trend.