Interfacial characterization of $LiNbO_3$ coating layer on NCM622 cathode material for all-solid-state Li-ion batteries

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All-solid-state lithium-ion batteries (ASSBs) are currently attracting much attention as next generation energy storage systems, with both higher energy and power densities than state-of-the-art lithium-ion batteries (LIBs). Practical ASSBs may be realized through application of layered Ni-rich oxide cathode materials such as $LiNi_xCo_yMn_zO_2$ (NCM) combined with thiophosphate-based solid electrolytes (SEs). Nevertheless, one obstacle towards their commercialization is the large interfacial resistance between thiophosphate-based SE and cathode material resulting from decomposition of the former [1]. This causes large overpotential and irreversibilities, and therefore overall poor electrochemical performance [2]. A strategy to avoid such problems is to employ a thin oxide buffer layer on the cathode material (to prevent SE degradation) [3]. Following this line, we employed 1 wt.% sol-gel derived $LiNbO_3$ as coating layer on $Li_{1+x}(Ni_{0.6}Co_{0.2}Mn_{0.2})_{1-x}O_2$ (NCM622). The surface modified NCM622 cathode material was implemented along with *ß*-Li_3PS_4 and $Li_4Ti_5O_{12}$ as SE and anode, respectively, to form the ASSB. The protective coating enabled us to achieve highly reversible specific capacities (~140 mAh/g), with efficiencies close to liquid electrolyte-based LIBs. Complementary surface sensitive techniques such as attenuated total reflection infrared spectroscopy (AFT-IR), X-ray photoelectron spectroscopy (XPS) and transmission electron microscopy (TEM) were applied to probe the composition of the coating layer. Collectively our research data demonstrate the positive effect of the surface coating on the cycling behavior of layered Ni-rich oxides in bulk type ASSBs.

References:

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