High-voltage cathode material for Li-ion batteries stabilized by surface coating

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In order to meet the energy demands of the future, particularly in the transportation sector, environmentally friendly and high energy density batteries must be developed. Li-ion batteries are currently the highest achieving alternative, and by choosing a high voltage cathode material the energy density can be further increased [1]. $LiNi_xMn_{2-x}O_4$ is an interesting candidate due to its high operating voltage of 4.7 V vs Li^+/Li^0, its high safety, and its economical and environmental advantages compared to other materials [2]. However, the loss of Ni and Mn from the electrode during cycling due to a lack of a stable electrode/electrolyte interface is reducing the lifetime and durability of the battery [3].

Surface coating of the cathode material can be an effective way to stabilize the electrode/electrolyte interface, and consequently increase the lifetime and cyclability of the battery [4]. Al_2O_3 has been successfully applied as a stabilizing interface between Li metal and a garnet-type solid-state electrolyte in a Li-ion battery [5], proving it to be a good Li-ion conductor, and making it the initial choice for a stabilizing coating material in this study.

High quality $LiNi_xMn_{2-x}O_4$ powder has been prepared by three synthesis routes; spray pyrolysis, precipitation and a citric acid method. Characterization of the products showed phase pure and homogenous powders. Coating with Al_2O_3 by atomic layer deposition (ALD) has been conducted, and the coated material has been tested in half-cell configuration with standard electrolyte (1M $LiPF_6$ in 1:1 EC/DEC). The initial electrochemical testing shows promising results for the first core shell structures with improved lifetime and stability, and other coating techniques and materials will eventually be attempted. Full cell tests using Si as anode is also being investigated.

References:

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