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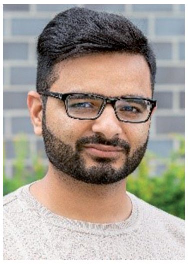
Interphase Design of $LiNi_{0.6}Mn_{0.2}Co_{0.2}O_2$ as Positive Active Material for Lithium Ion Batteries via Al_2O_3 Coatings Using Magnetron Sputtering for Improved Performance and Stability



Atif Javed

Markus Börner

meet

BACCARA

Invited for this month's cover picture is the group of Markus Börner at MEET Battery Research Center from the University of Münster. The cover picture depicts skiers (NMC active material) competing in a skiing race (electrochemical stability). RF-magnetron-based homogenously coated NMC outperformed inhomogeneously coated and uncoated ones due to better protection. Read the full text of the article at 10.1002/batt.202300580

What prompted you to investigate this topic/problem?

The continuously evolving EV market demands lithium ion battery active materials that enable high specific energy and energy density. $LiNi_xMn_yCo_zO_2$ (NMC, $x+y+z=1$) is one of the most present and versatile cathode active materials for lithium ion batteries due to its comparatively high specific capacity and high operating potential. However, NMC materials are prone to various degradation effects including moisture uptake, the formation of impurities at the particle surface, transition metal dissolution, oxygen evolution and particle cracking during charge/discharge cycling and/or at elevated temperatures. Surface coatings of cathode materials have proven to be a promising approach to improve the electrochemical performance, thermal properties and surface structural stability.

An innovative coating technique (developed at MEET) based on RF-magnetron sputtering was applied to deposit alumina coating with different thicknesses on NMC cathode powders. Long-term charge/discharge cycling stability and capacity retention were investigated, and cells based on alumina-coated NMC were found to show better capacity retention than cells based on uncoated NMC. Furthermore, alumina-coated electrodes demonstrated enhanced thermal stability, less structural degradation and reduced particle cracking.

What is the most significant result of this study?

Interphase design is crucial for many future materials systems and alternative battery technologies, as protective surface coatings prove to be a promising approach to improving the electrochemical performance, thermal properties and surface structural stability of lithium ion batteries. So, despite reported studies showing the beneficial effect of coatings, a detailed understanding of their influence was missing, which was

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facilitated by the novel coating method that allows uniform coating and comprehensive analysis. In this study, not only is a novel coating approach based on magnetron sputtering reported, but detailed experiments were also carried out to understand the degradation mechanism and beneficial effect of coatings on electrochemical cycling and safety properties.

What other topics are you working on at the moment?

In follow-up studies, we have investigated different coating materials (WO_3, ZrO_2, and LiPON) using the same coating technique to coat NMC622 and NMC811 particles. WO_3 and ZrO_2 coatings are being investigated to protect cathode active materials against decomposition, transition metal dissolution, and surface degradation. All of these effects are studied in detail. LiPON and Li_3PO_4 coatings are applied to improve rate capability and enable aqueous processing of NMC811. Moreover, we are working on using the coated materials in addition to electrolyte additives to enable fast charging/discharging and understand the synergetic effect of both coatings and electrolyte additives at cathode interphase.