Investigation of chemically induced degradation on the microstructure and morphology of Li-ion battery cathode

Libor Ďuriška[1], Ivona Černičková[1], Jakub Rafajdus[1], Martin Kusý[1], Marián Drienovský[1], Lenka Blinová[1], Santanu Mukherjee[2], and Jakub Reiter[2]

[1]*Slovak University of Technology in Bratislava, Faculty of Materials Science and Technology in Trnava, Ulica Jána Bottu č. 2781/25, 917 24 Trnava, Slovakia*
[2]*InoBat Auto j.s.a., Voderady 429, 919 42 Voderady, Slovakia*

Nowadays, $LiNi_xCo_yMn_{1-x-y}O_2$ (NMC) is one of the most widely used active cathode materials (CAM) for Li-ion batteries in automotive, mainly due to its high specific capacity combined with low manufacturing costs. However, NMC cathode materials are sensitive to air due to their tendency to absorb moisture and react with CO, forming surface layers that degrade battery performance. High-nickel compositions are especially unstable, leading to surface reactions and structural degradation in ambient conditions [1-3].

The aim of this work was to investigate the NMC811 cathode in pristine condition as well as after its storage under exposure of ambient atmosphere at room temperature and humidity for progressively increasing times (1, 2 and 3 months). Microstructure and morphology of the cathode in both top view and cross-section were observed using scanning electron microscopy (SEM), the distribution of elements was mapped by means of energy-dispersive X-ray spectroscopy (EDX). The structure of cathode active material was identified by X-ray diffraction (XRD), using two configurations: Theta-2Theta, Grazing incidence. The phase transformations during heating and cooling were analyzed by differential scanning calorimetry (DSC), while mass changes by thermogravimetry (TGA). To evaluate the functional groups on the surface of the cathode, the Fourier-transformed infrared spectroscopy (FTIR) was used.

The results showed that impurities appeared in the cathode after exposure to ambient conditions and their amount increased with longer exposure time. Structural changes were also observed, which were more pronounced at the surface compared to the bulk.

Funded by the EU NextGenerationEU through the Recovery and Resilience Plan for Slovakia under the project No. 09I04-03-V02-00046.

[1] B. Xu et al., Mater. Sci. Eng.: R: Rep. 73 (2012) 51–65.
[2] W. Li et al., Chem. Soc. Rev. 46 (2017) 3006–3059.
[3] W. Li et al., Nat. Energy 5 (2020) 26–34.