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Influence of preparation conditions on the electrochemical properties of layered cathodes for lithium-ion batteries

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Most of the layered cathode materials for lithium-ion batteries (for example LiNi0.8Co0.2O2, LiCo1/3Ni1/3Mn1/3O2, LiNi0.8Co0.15Al0.05O2, LiNi0.5Mn0.5O2, LiNi0.95Fe0.05O2 and etc) show abnormal phase separation during the first charge instead of solid solution behavior [1]. Among them, LixNi0.8Co0.15Al0.05O2 (NCA) is one of the most common cathode materials for Li-ion batteries. It has a high practical specific capacity (~200 mA·h/g) and exhibits a good cyclability at room temperature. The abnormal phase-separated state in this compound disappears completely during the first discharge and it is never observed in the following charge-discharge cycles. There is a possibility the abnormal state in layered cathode material depends on preparation conditions. Thus in our previous work [1], it was established that stronger compaction of the electrodes partially suppresses the phase separation of the NCA cathode material. The observed correlations made it possible to suggest that the widespread morphology of layered cathode materials (10-20 μm framboid-like secondary particles which consist of 0.5-1 μm primary particles) affects the phase separation of NCA.
In the present work, this assumption has been verified. X-ray diffraction was used for new investigations of the phase-separated state of NCA. In addition to the compaction degree, parameters such as grinding of the cathode material and the amount of binder were changed. The electrode preparation procedure was developed, which allows obtaining only primary particles of the cathode material in the battery electrodes and uniform distribution of the components (NCA, carbon black and binder). It was shown the grinding of the cathode material fully changes abnormal phase separated state to solid solution state in NCA during the first cycle. The observation for NCA could be expanded to layered cathode materials with similar morphology.
[1] Bobrikov I.A., Samoylova N.Yu., Ivanshina O.Yu., Vasin R.N., Sumnikov S.V., Kornieieva K.A., Balagurov A.M. Abnormal phase-separated state of LixNi0.8Co0.15Al0.05O2 in the first charge: effect of electrode compaction. // Electrochimica Acta (2018) 265 PP. 726-735.

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