SELF-HEALING POLYMER INTEGRATION INTO CORE/SHELL NMC CATHODE MATERIAL

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Li-ion batteries are prone to the failure mechanisms because of drastic structural changes, degradation and finally loss of functionality caused by thermodynamic, chemical, and mechanical instability of materials. These degradation processes in the battery cells can be minimized or avoided through the preventing approaches, for instance by using so-called self-healing materials – materials that recover battery functionality after mechanical damage, chemical deterioration or properties changes **[1]**. Recent studies have shown that self-healing systems can enhance significantly the lifetime of battery materials relying on the improvement of the mechanical characteristics and battery cycling stability **[2-3]**.

The aim of the present work was to investigate the effect of the self-healing functionalities on the electrochemical performance of the Lithium-Nickel-Manganese-Cobalt-Oxide (so-called NMC) based cathode materials. For this purpose, Ni-rich Core/Mn-rich shell cathode particles have been synthesized by means of cost efficient and easy process-controlled co-precipitation method. As precursors, aqueous solutions of the Li, Ni, Mn and Co salts have been employed in the required ratio. The co-precipitation of the precursor solution has been performed by dropwise addition of the oxalic acid solution under continuous stirring with following drying and heat treatment of the obtained precipitate. For achievement of core and shell in different compositions, two-staged synthesis approach has been applied.

To study the influence of the polymer binder on the electrochemical performance of the synthesized NMC particles, battery half-cells have been produced using two different binders – PVDF binder and PANI/PVA-Borax self-healing polymer (SHP). Results of the electrochemical impedance spectroscopy have shown the lower charge transfer resistance of the SHP-integrated sample compared to the sample, containing PVDF binder. Initial galvanostatic charge/discharge results demonstrated that PVDF containing NMC sample leads to a higher first cycle capacity than SHP-integrated powder. However, the initial coulombic efficiency loss of SHP sample was 60 mAh/g lower than of PVDF sample in first cycle, proving the higher efficiency of the SHP sample characterized by the cycling test. After the formation procedure both electrodes showed similar specific capacity. But the NMC-PVDF electrode has lost sharply its capacity after 400 cycles, while the NMC-SHP electrode has continued to work with minor capacity reduction.

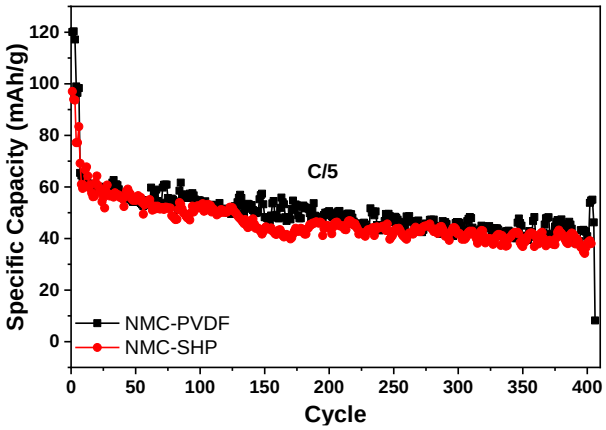

Figure 1. Evolution of galvanostatic charge/discharge cycle capacity of NMC-PVDF and NMC-SHP electrodes in half cell.

REFERENCES

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