Laser structuring of NMC 811 high energy electrodes in battery production for enhancing the electrochemical performance for xEV energy storage systems

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Layered oxide cathodes, especially thick-film electrodes like lithium nickel manganese cobalt oxide, NMC, are under continuously investigation to meet the ambitious requirements, e.g. 700 Wh/l, for future Li-ion batteries in electric drive applications. The objective of the most current studies is to reduce the Co content with a concurrent increasing Ni-content in the NMC cathodes such as NMC 811 [1]. It must not leave the fact out of consideration, that NMC cathodes suffer from low high rate capability and corresponding low capacity retention at high C-rates. In particular, the negative impact is even higher for thick-film high energy cathodes. To counteract the negative effect, high repetition ultrafast laser ablation is applied to create appropriate 3D electrode designs [2]. New Li^+-diffusion pathways, applied by the laser structuring process, shell enhance electrolyte wettability and reduce overpotentials at high C-rates.

It is attempted to integrate the laser structuring into a continuous roll-to-roll electrode production process. In this way, the positive properties achieved through 3D structuring can also be obtained for Li-ion batteries that are produced on a large scale. By using this novel production technology, future NMC batteries can be produced with improved performance characteristics for xEV applications. Furthermore, this technology can also be applied for other generation 3b battery cells. This work is performed under the frame of the RealLi! project, in which the following aspects are covered:

a) Development of thick film NMC811 electrodes with high areal capacity
b) Passivation approach to improve cycle stability and lifetime
c) Cell Assembly and electrochemical characterization
d) Holistic evaluation of the potential environmental impact of the NMC811 cells via life cycle assessment
e) An experimentally validated electrochemical model to describe electrode structures and their optimization.
f) Improved electrochemical performance of NMC811 electrodes on a laboratory scale by using 3D laser structuring.
g) Scale up of the 3D laser structuring process and corresponding improved electrochemical performance of NMC811 electrodes in pouch cell format by using 3D laser ablation.

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References

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