Customized electrolyte solutions from E-Lyte Innovations for high-energy lithium-ion batteries containing silicon-based anodes and nickel-rich cathodes

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Lithium-ion batteries (LIB) are currently used in a variety of applications, including electro-mobility, medical technology, consumer electronics, robotics and aviation (Fig. 1). Each application field has specific requirements on the battery regarding cycle life, safety, energy and power density and can benefit from customized cells. In order to meet the increasing demands for higher energy densities, e.g. for electric vehicles, LIB cells with novel electrode materials and electrolytes are needed [1].

For the positive and negative electrode nickel-rich NMCs and silicon-containing materials are promising candidates to boost the energy-density compared to the state-of-the-art due to the high specific capacities of these materials. However, these cell chemistries show a limited compatibility with currently used electrolytes and require innovative, tailor-made electrolyte solutions.

Silicon-based LIBs typically suffer from short cycle life caused by enormous volume changes of silicon during charge/discharge, going along with material and electrolyte degradation in every cycle, as well as low Coulombic efficiencies. A cost efficient and scalable approach to enhance the cycling stability is the modification of the electrolyte by the addition of small amounts of functional components, so called electrolyte “additives” [2]. In particular film-forming additives can improve the properties and stability of the electrode/electrolyte interphases at both electrodes (SEI at the anode and CEI at the cathode) and minimize detrimental side reactions with the electrolyte, leading to a significant improvement in cycling stability.

Here, we report novel electrolyte formulations for LIBs with silicon-based anodes and nickel-rich cathodes. The presented optimization approaches focus on the identification of additive combinations with synergistic effects that stabilize the interphases at both electrodes with the aim to increase the specific discharge capacity, Coulombic efficiency, and capacity retention.

[1] R. Schmuch, R. Wagner, G. Hörpel, T. Placke, M. Winter, Nature Energy, 3 (**2018**) 267.

[2] A.M. Haregewoin, A.S. Wotango, B.-J. Hwang, Energy Environmental Science, 9 (**2016**) 1955.

Figure 1: Schematic illustration of application fields of lithium ion batteries in which tailor-made electrolyte solutions are inevitable.