SUBLIME

Solid state sUlfide Based LI-MEtal batteries for EV applications

Deliverable 4.2 Report on interface stability using optimized materials

Pedro López-Aranguren
CIC energiGUNE

Vladislav Kolotygin
CIC energiGUNE

Sublime is funded by the European Union's H2020 research and innovation programme under GA Agreement no. 875028

SUBLIME

Publishable summary

In the framework of WP4 for lab electrode and cell preparation, the following deliverable includes results on the electrochemical performance of optimized materials from WP3. Sulfide solid electrolytes Gen 1, Gen 2 and Gen 3, along with $LiNbO_3$-NMC811 cathode active material have been used to prepare labcells of 1-2 mAh capacity for their electrochemical evaluation as described in task 4.2. Cathode formulations have been optimized in order to gain insights on the performance of the active material. The pressure has been identified as a key parameter for processing the sulfides to obtain high density pellets with improved ionic conductivity. The effect of polymeric binder additives on the densification, mechanical and electrochemical properties of obtained materials has been assessed. Symmetric Li metal cells with densified sulfide electrolytes have been assembled to evaluate the stripping plating abilities of the materials. Thanks to the knowledge gained on the processing and understanding the properties of materials developed in WP3, full cells with Li metal anode have been successfully assembled and cycled following testing protocols published in D6.1.

Sulfide-based full cells with $LiNbO_3$-coated NMC811 active material have been assembled to test against graphite and Li metal electrode. The optimization of solid electrolytes along with the formulation of the electrodes and processing of the components enabled to obtain promising performance of the cells at room temperature. The impact of the pressure applied during electrochemical measurements was also evaluated with specific pressure devices designed at SUBLIME. The cells with optimized materials were able to deliver 120-140 mAh/g on initial cycling and 80-100 mAh/g after 20-30 cycles, at current rates between C/20 and C/10 with a high coulombic efficiency of 90-100%. One of critical limitations of sulfide-based solid electrolytes is the insufficient stability towards both high-potential cathode materials and metallic Li. The long-term performance of the cells with sulfides can be stabilized by protection of the electrodes with buffer layers, inert towards sulfide materials but which at the same time possess reasonable Li-ionic conductivity and ensure Li transfer between the electrolyte and active material. $LiNbO_3$-coating on cathode active material particles has been reported to be an effective way to improve the stability of the cathode/electrolyte interface (Strauss, 2020) (Randau, 2020). On the other hand, protection of Li metal with oxides, nitrides, fluorinated materials or other compositions with nonnegligible Li diffusion might also improve the performance and lifetime of the sulfide electrolyte-based cells (Zhao, 2020) (Tong, 2020). Thus, one of the tasks of the present deliverable is comparative testing of sulfide electrolytes with and without $LiNbO_3$ protective coatings for NMC cathode. The compatibility between $LiNbO_3$-coated NMC811, sulfide electrolyte and Li metal over time has been assessed by EIS.