SUBLIME

Solid state sUlfide Based LI-MEtal batteries for EV applications

Deliverable D6.2 Report on electrochemical, aging and safety tests

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Publishable summary

Deliverable D6.2 summarises the experimental activities carried out in WP6 to evaluate the electrochemical performance, ageing and safety of the all-solid sulphide electrolyte cells developed by the SUBLIME project partners. All-solid sulphide technology is the most advanced solution for manufacturing all-solid cells. However, a number of important points still need to be resolved before it becomes a mature technology. These include, for example, the processability of all-solid electrodes and the stability of the interface between the electrolyte and the lithium metal. Because of these constraints, it was not possible to carry out all the characterisations and objectives initially envisaged at the start of the project. However, a large number of tests were carried out.
The recent development of solid electrolytes, with high ionic conductivities, comparable to those of conventional liquid electrolytes particularly in the case of sulphide based systems, has shifted a lot of attention towards all solid state batteries (ASSBs). However, the passage from liquid to solid electrolyte implies a complete update in the study of the interfacial phenomena caused by solid-solid contact.

In this perspective, the cell performance was investigated by POL, FEV, CEA and SAFT.

1. POL: Cycle aging was performed on monolayer pouch cells provided to POL by IST/TUB to particularly investigate the chemical reactivity between the electrolyte and electrodes upon electrochemical cycling, which is dependent on the state of charge (SoC). Moreover, theoretically predicted energetically favourable compounds at the cathode–electrolyte interface are generally different from the decomposition products obtained after electrochemical cycling. This implies that the steady-state chemical reaction could be different from that during electrochemical cycling, for this reason, calendar aging was carried out on the monolayer pouch cells provided to POL by IST/TUB. Finally, cells performances were tested through long cycling performed on primary pathway (P1) and secondary pathway (P2) pouch cells provided to POL by IST/TUB.
2. FEV: The rate performance of pouch cells with indium anodes was investigated by FEV. P1 Pouch cells withstood charge and discharge rates up to C/2, Although the cell, exhibited reduced capacities at high C-rates, but capacity retention at C/5 remained promising. Further improvements are anticipated in subsequent cell generations by enhancing initial capacity.
3. CEA: In order to assess the safety of this new technology, overtemperature tests were carried out on two types of cells. Coin cells supplied by CIC and 1Ah cells supplied by TUB. The coin cells were tested in a setup specially developed by the CEA to drive them to thermal runaway in a quartz tube, while the 1 Ah cells were tested in an open vessel to visualise the behaviour of the cell during thermal runaway. For the safety test a new experimental bench has been developed to obtain in parallel measurements of the thermal runaway with classical optical techniques (HD visible imaging) and an Optical Spectrum Analyser. The HD camera allows a follow-up of the dynamics of the thermal runaway (reaction kinetics, flame initiation, etc.), while the spectroscope measurements can give a quantitative estimation of the thermal runaway temperature and the chemical composition of the gas mixture. The suitable binder and solvent matching combination issued from the screening of 11 solvents and 6 binders has been tested in several specimen. We show that the retrieved light spectra give quantitative indications of the thermal runaway stages from a chemical composition of the reacting mixture together with an estimation of the combustion temperature.

Furthermore, from

Figure 47 The post-mortem view of the cell left side: the tear on the bottom-left side of the cell can be clearly observed

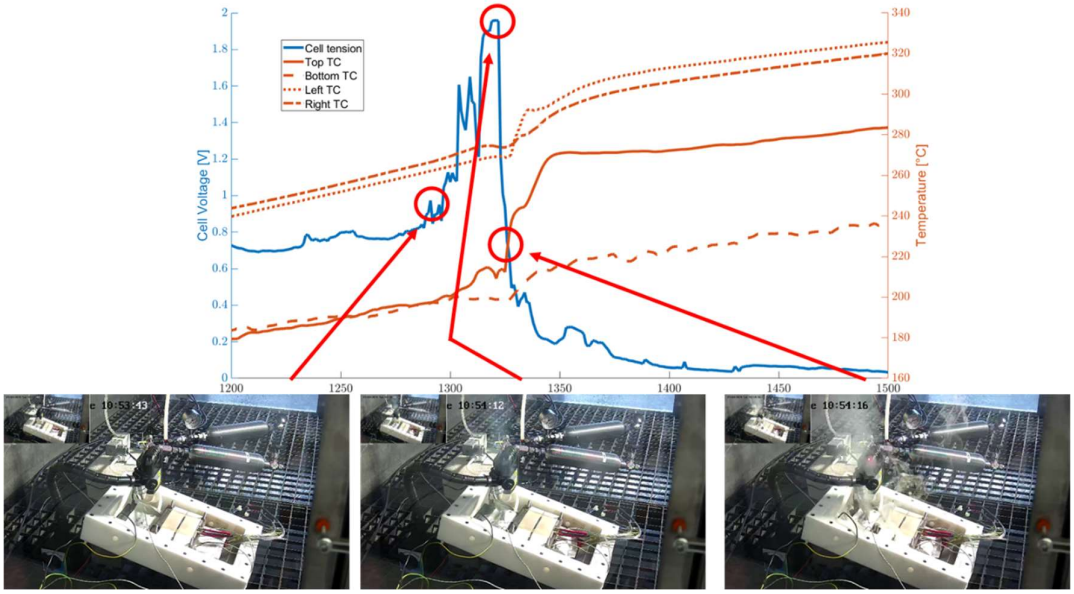

Figure 46 we can observe that the sudden cell voltage drop is followed by a steep increase in the measured cell temperature. Also, we can see that a second hole, on the hidden left side of the cell, is created. Hot gases are then liberated while the measured temperatures all increase. The bottom TC reads the largest increase, together with the left TC, which is coherent with a gas release from the left bottom side of the cell.