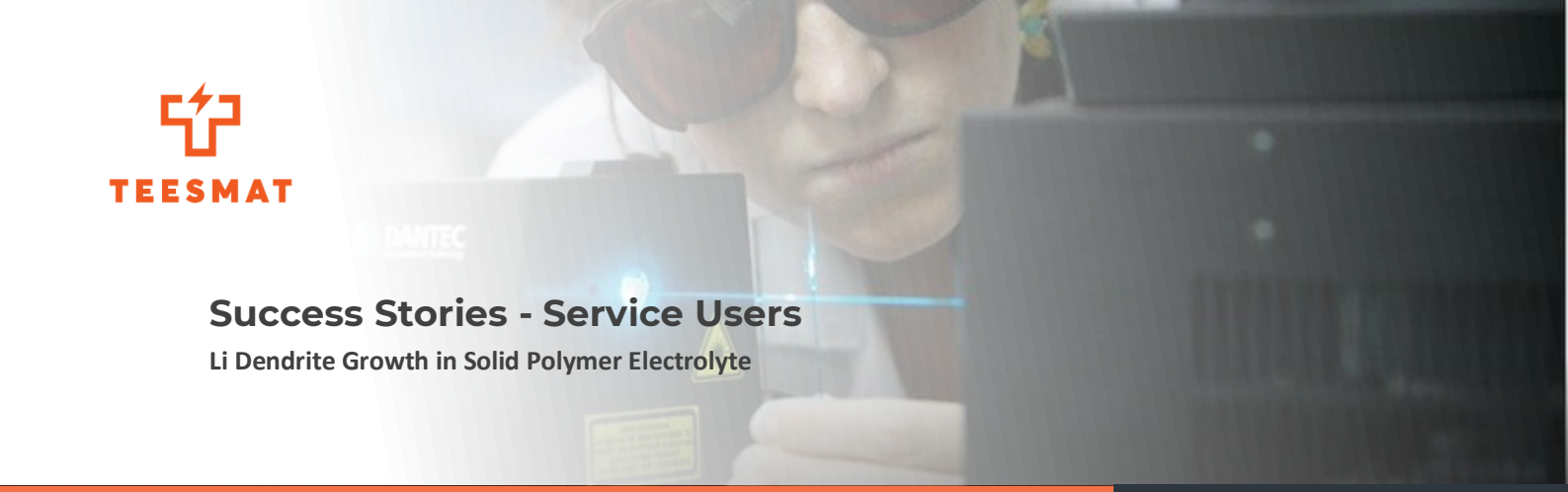

TEESMAT

Success Stories - Service Users

Li Dendrite Growth in Solid Polymer Electrolyte

Toyota Motor Europe (TME)

TME is the European operating subsidiary of Toyota Motor Corporation (TMC), with focus on R&D, manufacturing and sales. TMC is one of the largest car manufactures in the world and a leader in the development and sales of new generation electric, hybrid and H_2 fuel cell cars.

Brussels, Belgium | www.toyota-europe.com

TOYOTA

Problem to be solved

One of the major advances of solid state battery technology is the use of pure Lithium as an anode material. While this can significantly increase the specific energy density of the battery, it is also a safety concern due to the uneven deposition/striping of Li during the charge/discharge of the battery, causing dendritic growth, shorting of the electrode and subsequent thermal runaway. Therefore a characterization technique able to sense the presence and follow the growth of the dendrites in a number of solid state electrolyte technologies is a needed tool and valuable asset in the development of solid state batteries. In this user case TME provided a solid polymer electrolyte cycled under specific conditions in a symmetric cell to be assessed for the presence of Li dendrites.

Solution provided by TEESMAT

The assessment of the presence of Li dendrites is a challenging problem from the characterization perspective: dendrites are buried in the solid electrolyte and are often impossible to detect by techniques operated in visible light range. Electrochemical and other indirect measurements do not typically detect the presence of the dendrites until it is too late and the electrodes are already shorted. Fortunately, TEESMAT provides several techniques based on X-ray and neutron probes able to penetrate deep into the electrolyte and perfectly fit for the problem in hand. Both of the used techniques, X-ray diffraction provided by ESRF and neutron imaging provided by external partner ILL, did not detect any dendrite formation in this user question. In the case of X-ray diffraction, solid lithium in the electrolyte is presented as a diffraction signal from the Li crystallites composing the dendrites, and in the case of neutron imaging, the dendrites can be directly seen in the radiograph thanks to the relatively high absorption cross-section of Li. Even though the dendrites were not detected, it allowed the providers to test and validate their characterization techniques for this kind of problems, given that the dendrite growth was clearly detected on the calibration samples.

Impact

The service provided by TEESMAT testbed clearly answered TME's questions about the presence of Li dendrites. Such information helps TME in developing solid state battery technology and understanding the safety limitations of the new materials. Moreover, this result reveals that the failure mechanism of this system was not due to dendrite formation, which is definitively of great help for further development.

TEESMAT is an EU project that has received funding from the H2020, under Grant Agreement n 814106 (H2020-NMBP-TO-IND-2018)