# Interface characterization in dry polymer cathodes by EIS and XPS - the PEO/ LFP interface

Verena Wurster [a, b], Christine Engel [a], Heiko Graebe [a], Fabian Simon [a], René Hausbrand [b], Wolfram Jaegermann [b]

[a] *Robert Bosch GmbH, Robert-Bosch-Campus 1, 71272 Renningen, Germany*

[b] *Darmstadt University of Technology, Surface Science Division, Otto-Berndt-Str.3, 64287 Darmstadt, Germany*

E-mail: verena.haerdtner@de.bosch.com

Solid-state batteries are a promising future battery technology. These batteries have the potential to reach higher energy densities and to be safer than batteries with liquid electrolyte. An important requirement of battery cells for automotive applications is the fast-charge and fast-discharge capability. Therefore, the total cell resistance, including all interfacial resistances, should be as low as possible. In this regard, solid-state batteries suffer from poor connections between the different materials, which are in general inferior to those in batteries with liquid electrolyte. Detailed information on the resistances of the various interfaces as well as their root causes is largely missing.

Solid-state cells with dry polymer electrolytes offering high safety, flexibility and durability, are potential candidates for automotive applications. However, they suffer from large internal resistances and require a high operation temperature of 80 °C to reach the required conductivity of lithium ions [1].

In our study of dry polymer cells containing a LFP/PEO cathode and a lithium-metal anode, resistances of the external and internal interfaces of the cathode were differentiated by means of electrochemical impedance spectroscopy (EIS); photoelectron spectroscopy (XPS) has been applied for the characterization of the chemical structure of the interfaces.

In case of external interfaces, such as the interface between current collector and composite cathode, characterization was straightforward. The surfaces of these composite cathodes were characterized by XPS and the external interface resistances were analysed by EIS and minimized by improving the contacts to the polymer electrolyte layer and to the aluminium current collector. So the total cell resistance could be lowered and on the cathode side there are only the internal resistances left.

To determine the resistance and chemical structure of cathode-internal interfaces is more challenging. Three different approaches of EIS characterization of these resistances in charged cathodes were pursued.

The first approach, known from the analysis of cells with liquid electrolyte [2], is to disassemble two charged full cells and to reassemble the cathodes in a cathode symmetric cell. Up to now, it was not possible to properly disassemble charged full cells built up with polymer electrolyte. Another way is to chemically delithiate LFP and build up cathode symmetric cells with this material.

Furthermore, full cells with a lithium-coated Au wire reference electrode were characterized. With these cells, the separation of the impedance spectra into an anode and a cathode part is possible.

**References:**

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[2] C. H. Chen, J. Liu, K. Amine, *Journal of Power Sources*, 321-328 (2000)