TITLE: Sensing capabilities of the separator for Li-ion batteries with integrated scavenging functionality

Summary: Integration of smart functionalities into Li-ion batteries by the proper design of inactive components, as a separator, current collectors, binders, and conductive additives can further improve their quality, reliability, lifetime, and safety (QRLS). The separator in the battery enables ionic connections and prevents electronic short circuits. As such it is exposed to the electrolyte components and to the different degradation species which are diffusing or migrating through the pores of the separator. With a careful selection of building components, one can design separators with a selective transport capability. For instance, nanopores can transport only small ions, while large molecules obtained during irreversible reactions are blocked. By proper design of pores, a selected type of molecules or ions can be trapped in the pore which would correspond to the decrease of ionic transport. The decrease of ionic transport corresponds to the increase of resistance that can be easily detected by electrochemical methods as electrochemical impedance spectroscopy.

Work will be primarily focused on the design of porous materials, for instance, the use of cyclodextrin integrated into the solid matrix or cross-linked polymers. Firstly, we will address transport through the single-channel and study the possible blocking nature with different molecules that are typically found in the degraded battery. Latter, this will be transferred to the layer that will be deposited between two printed electrodes on the separator. Due to the blocking nature of the pores, an increase of resistance will be connected with the QRLS of the battery cell. Work will be done mainly at National Institute of Chemistry in the Department of Materials Chemistry. Printed sensors will be prepared in collaboration with University in Paradubice, Czech Republic.

Research techniques used: To obtain a selective porous layer, we will use biobased polymers incorporated into the synthetic polymers. Classical spectroscopy, low angel XRD and microscopy characterization methodology will be applied. Ionic transport/resistance determination will be achieved by the use of electrochemical characterization with classical polarisation techniques or by the use of electrochemical impedance spectroscopy. Laboratory battery cells are planned to be tested at the end of the project, to verify the possible sensing capability of the designed interlayer with scavenging possibility.

The reason why the topic is innovative: The proposal is in a line with a second pillar (Smart functionalities) of the Battery 2030+ initiative. It is oriented to the design of a new generation of separators, which will be able to capture the degradation products formed during battery operation and with a special configuration of the separator, additional sensing functionality will be added which will help to provide more accurate information about the state of health and state of safety and with that better reliability, longer lifetime and improved safety.

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