Polymer-based Solid-State Batteries: Advanced Processing and Cell Design

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Lithium-ion batteries (LIB) are one of the most attractive battery systems for future applications due to its high energy density. However, safety and toxicity problems still remain in commercial LIB with liquid electrolyte. By replacing this electrolyte with a lithium-ion conducting polymer or ceramic these issues may be resolved and result in increased energy density. These so called all solid-state lithium-ion batteries systems have been extensively studied with regards to the ionic conductivity of the electrolytes and the contact problems between the electrodes and the electrolyte.

One of the most important tasks when creating polymer-based solid-state batteries is the processing of the components. Unlike liquid electrolyte cells the electrodes need to be created with the solid polymer electrolyte (SPE) inside. In this work, one approach to achieve this is the creation of three-dimensional cathodes. Here, the active material is synthesized inside of an electric conductive matrix. The cathode is filled with SPE resulting in a composite cathode where thin layers of active material are in direct contact with electric and ionic conducting material [1]. Alternatively, the cathodes can be created by simple mixing of all components. This is mostly done using organic solvents to achieve homogeneous distribution of the particles. We developed a new technique for creating composite electrodes by dry mixing of all components. The resulting composites show good performance in subsequent processing steps.

Another application of this newly developed technique is the creation of a flexible electrolyte by introducing lithium-ion conducting ceramics into a polymer matrix. In this case, the polymer is used as a functional binder to allow for good processing of the ceramic [2]. The challenge is to adjust the surface of the ceramic particles towards the polymer to allow for good lithium-ion exchange.

References:

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