STRUCTURAL CHANGES IN POROUS POLYOLEFIN SEPARATOR MATERIALS DUE TO MECHANICAL STRAIN CHARACTERIZED BY EX SITU AND IN SITU XRD

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Separators play an important role in the operation and safety of lithium ion batteries (LIB). These films are responsible for facilitating ionic transport as well maintaining electronic isolation between the anode and cathode. A separator must therefore possess adequate mechanical strength and chemical stability to ensure proper operation for the lifetime of the LIB. A detailed understanding of the mechanisms which give rise to a separators mechanical properties and response is important for cell design as well as accurate modeling of a battery's response to applied stress. The most common type of separator found in commercial cells is nano-porous polyolefin sheets. These are made through a highly controlled process of extrusion, heating/cooling, and stretching which results in an anisotropic film with ordered nano-pore structures that penetrate the entire thickness of the film. Some permutations of this design use layers of different polymers (generally polypropylene and polyethylene) in order to create a safety shut-down mechanism that closes the pores when a cell exceeds a certain temperature to prevent thermal runaway. An array of separators including those of the single and triple ply varieties were examined using both ex situ and in situ X-ray diffraction techniques. Changes to the crystalline structure and texture of each material were assessed as a function of strain. A comparison between dry and electrolyte wetted samples were also performed in an attempt to better understand the true behavior of these materials in an actual cell. The tensile strain behavior of these materials was correlated with observed structural changes, and the results and implications of this work will be discussed.