Chemical Engineering Master's Defense

Optimization of particle size of α-Alumina separator on performance of Lithium Ion Batteries

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abstract

Lithium ion batteries prepared with a ceramic separator, have proven to possess improved safety, reliability as well as performance characteristics when compared to those with polymer separators which are prone to thermal runaway. Purely inorganic separators are highly brittle and expensive. The electrode-supported ceramic separator permits thinner separators which are a lot more flexible in comparison. In this work, it was observed that not any α-alumina could be used by the blade coating process to get a good quality separator on Li4Ti5O12 (LTO) electrode. In this work specifically, the effect of particle size of α-alumina, on processability of slurry was investigated. The effect of the particle size variations on quality of separator formation was also studied. Most importantly, the effect of alumina particle size and its distribution on the performance of LTO/Li half cells is examined in detail. Large-sized particles were found to severely limit the ability to fabricate such separators. The α-alumina slurry was coated onto electrode substrate, leading to possible interaction between α-alumina and LTO substrate. The interaction between nano-sized particles of α-alumina with the substrate electrode pores, was found to affect the performance and the stability of the separator. Utilizing a bimodal distribution of nano-sized particles with micron sized particles of α-alumina to prepare the separator, improved cell performance was observed. Yet only a specific ratio of bimodal distribution achieved good results both in terms of separator formation and resulting cell performance. The interaction of α-alumina and binder in the separator, and its effect on the performance of substrate electrode was investigated, to understand the need for bimodal distribution of powder forming the separator.

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