EFFECT OF THE TEMPERATURE ON THE RHEOLOGICAL BEHAVIORS OF LITHIUM-ION BATTERIES ANODE SLURRY

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ABSTRACT

It is important to design and control the rheological behavior of lithium-ion battery slurry since it has a substantial impact on the productivity and performance of the electrode. While there are numerous alternatives for controlling the rheology of slurry, most are related to LIB slurry components such as concentration of components, type of active material, and polymeric binder molecular weight. In this work, we demonstrate that the rheological behavior of LIB anode slurry is temperature-dependent and that temperature, a process variable, might be a beneficial alternative to modify the rheological behavior of anode slurry. It was discovered that at lower temperatures, the values of G' and G" of the slurry gradually decreased with increasing temperature. We attribute the observed temperature dependency to changes in the segmental motion of the CMC polymer binder. At low temperatures, an increase in temperature leads to a rise in the segmental motion of the CMC polymer binder. This results in a reduction of entanglement between the concentrated CMC polymer and graphite surfaces, leading to a decrease in the values of G' and G". Beyond a specific temperature threshold, the rheological properties of the slurry exhibit a rapid increase, which is attributed to the change in entropy-driven hydrophobic interaction. Water molecules form a clathrate cage structure around graphite particles, reducing the slurry system's total entropy due to its oriented and structured state. Consequently, graphite particles tend to aggregate stronger, minimizing the interface between graphite and water and increasing the system's entropy[1,2]. The increase in both G' and G" values beyond a specific temperature threshold, where the entropy plays an important role, is related to the intensification of the hydrophobic interaction due to the temperature increase. It's worth noting that the increase in G' and G" is only observed in the small strain amplitude region of the strain amplitude sweep test, while G' and G" continuously decrease at larger strain amplitudes. This observation supports our interpretation, as previous studies have shown that yielding at small strain amplitudes is correlated with graphite-graphite attraction, whereas yielding at large strain amplitudes is correlated with polymeric binder interaction[3].

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