Significance of Electroactive Material Selection in Suspension Based Electrochemical Energy Storage Systems

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Due to their high energy density, extended cycling life, low self-discharge, high operating potential, lithium ion batteries (LIBs) are the preferred power source for many applications from portable devices to electric vehicles [1]. The initial step of manufacturing a LIB is typically preparation of suspensions, and those suspensions can be utilized directly (in flow based systems) [2] or in dried form (in solid state batteries) [3]. In either case, the performance of the resulting system is greatly influenced by the electrode/suspension microstructure. In the reported studies, several parameters such as mixing organization of components [4], solids loading [5] and particle characteristics (shape, size, size distribution etc.) [6] found influential on microstructure of the suspension and hence, the flow and electrochemical properties of the resultant electrode. The importance and necessity of using homogeneous suspensions comprised of dispersible (non-aggregated) electroactive particles in electrochemical energy storage systems was highlighted to obtain better electrochemical performance. In addition to this, it can be anticipated that the impact of utilizing aggregated particles will extend beyond electrochemical performance, where processability problems can be encountered due to instability and high viscous structure of the suspension. Thus, selecting the electroactive particle with suitable features and suspension microstructure design is very crucial to acquire suspensions with the low, i.e., affordable and operational viscosities and high electrical conductivities.

In the present study, to understand the variation in the suspension microstructure by virtue of used particle characteristics, two different electroactive materials, in aggregated and individual forms, were used to demonstrate the significance of the aggregation state of electroactive material on suspension characteristics. Rheological behavior and electrochemical impedance spectroscopy tests were carried out to comprehend microstructural evolution.

The results revealed that the rheological behavior of the suspensions could be improved almost one order of magnitude through utilization of dispersible electroactive particles. Moreover, higher solids fraction in the suspension achieved when these particles were used as they give chance to construction of higher energy dense storage systems.

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