Electrospun Electrolytes and Electrodes for Li-ion Batteries

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The quest for more efficient and low environmentally impacting energy conversion and storage technologies has become a priority for modern society. In particular, rechargeable, high capacity and high power electric energy storage systems, if developed, would play a central role in accelerating the transition toward an electric transportation economy, which, in turn, would dramatically reduce the risks associated with the burning of fossil fuels. To this purpose, 'ad hoc' engineered functional materials that join improved electrochemical properties with scalable preparation process for electrodes and electrolytes are needed. The most promising of such materials are those with nanometric-scale dimensions, including nanoparticles and nanofibers. These materials, having very high surface to volume ratio, show enhanced bulk charge transport and faster electrodic reaction rates. Nowadays, new methods have emerged for manipulation, assembly and characterization of nanostructured materials, particularly regarding functional electrodes and electrolytes based on nanofibers. Among the methods for generating nanofibrous structures, electrospinning is a top-down approach proved to be simple, cost effective and versatile allowing the fabrication of polymeric and inorganic nanofibers in a scalable process. Electrospinning is based on the application of an electric field to a drop of a viscous solution on the tip of a spinneret. The electric field elongates the drop to form a conical shape known as the Taylor cone. For an electric field critical value, the repulsive electrical forces between the charges in the fluid overcome the surface tension of the drop and a charged jet of the solution is ejected from the tip of the Taylor cone. The jet becomes unstable and rapidly whipping leading to the evaporation of the solvent and the formation of dry, continuous, ultra-thin fibers on the collector [Fig. 1]. The collected electrospun mats present peculiar properties, such as very high surface to volume ratio, low density, high pore volume and remarkable mechanical strength.

In this presentation, the electrospinning technique will be illustrated particularly regarding the optimization of the system and process parameters, which mostly influence the electrospun nanofibers. The characteristics of some gel electrolytes formed by electrospun polymeric separators will be discussed. Finally, the preparation by co-electrospinning followed by air stabilization and carbonization of nanosized tin particles embedded in electrically conducting porous multichannel carbon microtubes (Sn-PMCMT) will be described [Fig. 1]. Composite electrodes prepared using Sn-PMCMT powders exhibit a superior rate capability and cycle life in cell tests at room temperature.

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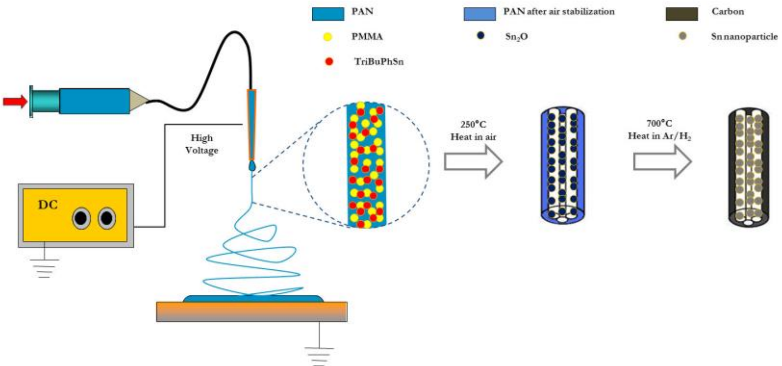

Figure 1