Development and Design of Novel Polymer/Ceramic Separators Li-ion Batteries

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The development of scalable manufacturing processes for the fabrication of ceramic/polymer hybrid materials with tailored nanostructures is in great need in industry. We have devised a gas-assisted electrospinning (GAES) system to overcome many shortcomings that conventional electrospinning setup have. Using the concentric, multi-layered nozzle configuration, the GAES employs both high electric field and high-speed, circumferentially uniform air flow which can offer i) enhanced stretching of fluid jet and thus much higher throughput and thinner fibers, and ii) better control of directing the jet towards the collector with less electrical interference among adjacent nozzles. In the proposed MEng project, we utilize the GAES to process room temperature-curing silica precursors and a very effective curing process by small fiber dimension with large surface area during the electrospinning is explored. Silica precursor such as polysilsesquioxane (PSSQ) can be considered as a nano form of silica, and is comprised of a ladder of four silicon corner atoms and four oxygen edge atoms, where each of the four silicon atoms may carry one of an extremely wide range of functional groups, generating hundreds of possible compounds. The ease of functionalization of PSSQ offers a unique opportunity not only to control the curing behavior but also to develop silica-polymer nanofibers with tailored functions and properties for next generation Li-ion battery separators. Due to the easy functionalization, PSSQ can be incorporated into various polymer solutions, creating unique interconnected blend morphologies in silica-polymer hybrid nanofibers. The resulting silica/polymer nanocomposites will be optimized for energy storage applications such as thermally stable separators for Li-ion batteries by investigating the interplay between material properties and cell performance.

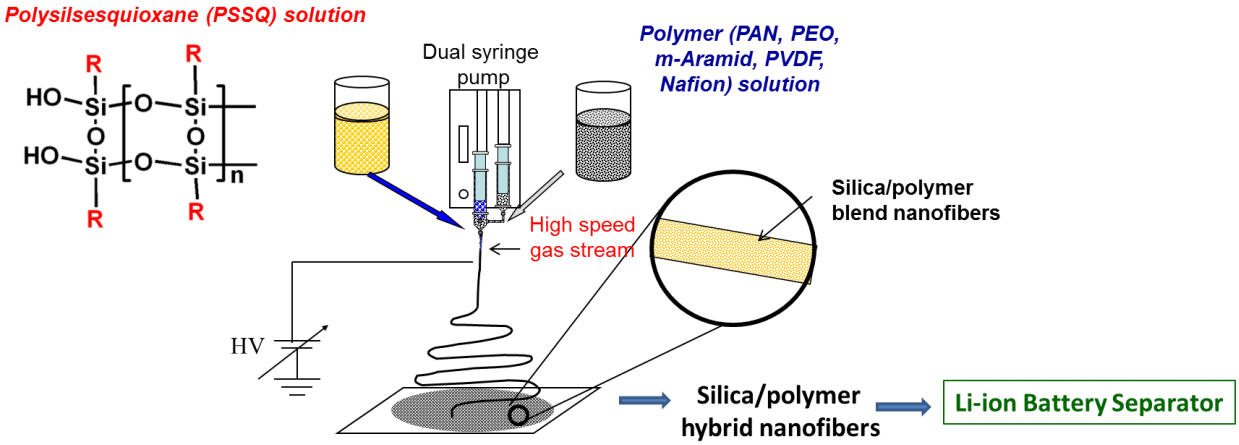

Figure: Schematic of facile fabrication of ceramic/polymer nanofibers via gas-assisted electrospinning of room temperature curing ceramic precursor/polymer solutions. The resulting ceramic/polymer hybrid nanofiber mat can be used as a thermally stable separator for Li-ion batteries