II. Development of Scalable Manufacturing Processes for Silica Precursor and Carbon Based on Gas-Assisted Spinning

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The development of scalable manufacturing processes for the fabrication of carbon and silica-based materials with tailored nanostructures is in great need in industry. The gas-assisted electrospinning system that the PI group has been devised to overcome many shortcomings that conventional electrospinning setup have. Using the concentric, multi-layered nozzle configuration, high-speed, circumferentially uniform air flow can offer i) enhanced stretching of fluid jet and thus 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 research, we utilize the gas-assisted electrospinning to process various carbon allotropes such as carbon nanotubes (CNTs) and graphenes, as well as silica precursors including polyhedral oligomeric silsesquioxanes (POSS). For carbon allotropes, gas-assisted spinning can allow us to control their dispersion and orientation in a polymer matrix even at high loadings, while a very effective curing process by small fiber dimension with large surface area during the electrospinning will be explored for silica precursor systems. The resulting carbon nanocomposite and silica nanocomposite materials will be applied to energy applications including electrodes and separators for Li-ion and Li-air batteries by investigating the interplay between material properties and cell performance.

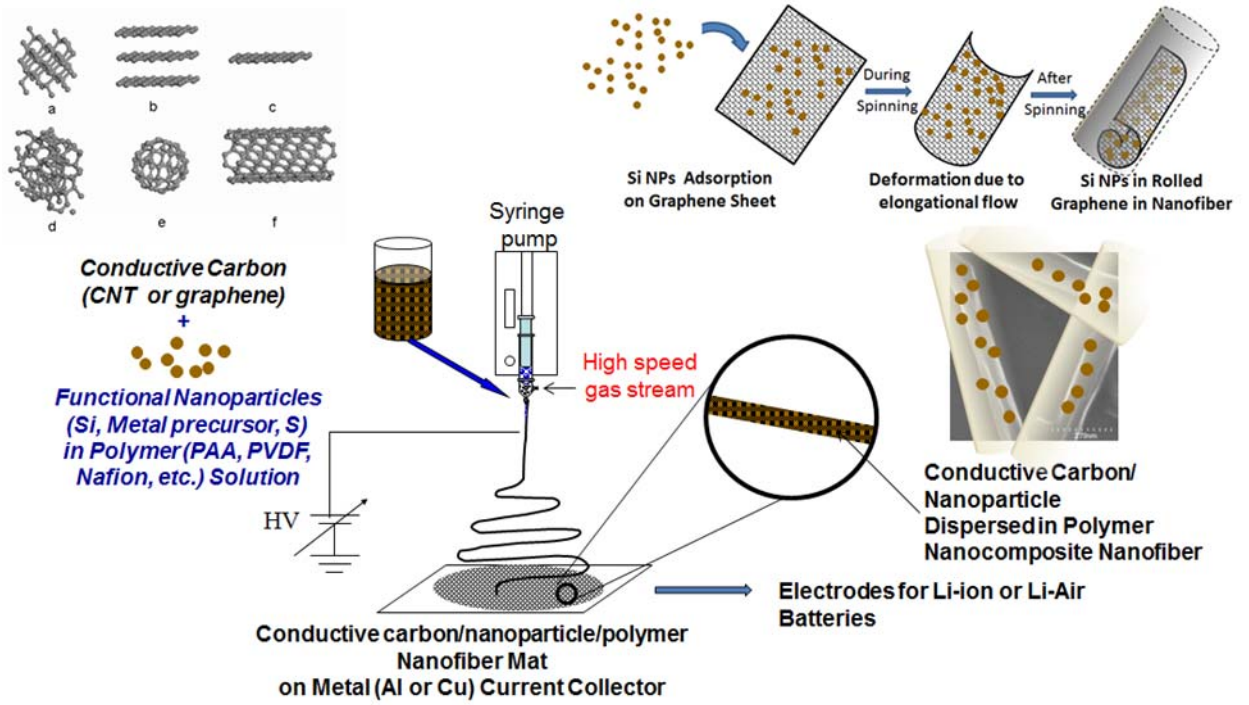

Fig. 2*. Schematic of facile fabrication of conductive carbon/nanoparticle/polymer nanofibers via gas-assisted electrospinning of carbon/nanoparticle/polymer solutions directly onto the current collector. Si nanoparticles adsorbed in a rolled graphene sheet in polymer nanofiber is depicted as an example.*