The formation of carbon fiber with embedded red phosphorus nanoparticles as an anode for li-ion batteries

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The increasing demand for high-performance energy storage devices has driven the search for new and innovative electrode materials with superior electrochemical properties. Red phosphorus (RP) has gained significant attention as a promising anode material for lithium-ion batteries due to its high theoretical capacity, low cost, and abundance. The theoretical capacity of RP is about 2596 mAh g^-1, which is much higher than that of commonly used graphite anodes (~372 mAh g^-1). Therefore, RP has the potential to greatly increase the energy density of lithium-ion batteries (LIBs). However, the practical application of RP is hindered by its poor conductivity and large volume expansion during cycling, leading to severe capacity fading and structural instability.

To overcome these issues, various strategies have been proposed to enhance the electrochemical performance of RP, such as nanostructuring, surface modification, and composite formation.

One effective approach is to embed RP nanoparticles in a carbon matrix, which can effectively address the volume change issue and facilitate fast electron and ion transport, resulting in enhanced electrochemical performance. The carbon matrix can also provide good mechanical support to prevent the aggregation and detachment of RP nanoparticles during cycling

In this study, we report the simple synthesis and characterization of obtaining RP nanoparticles which are embedded in porous carbon nanofibers (polyvinylpyrrolidone) by electrospinning method. During the preparation process the different parameters were varied such as red phosphorus particle milling parameters (time and ratio), solution concentration, nanofiber coating parameters (speed, voltage and distance to the collector) and annealing parameters (temperature and atmosphere). A schematic illustration of nanofiber production is shown in Figure 1. The resulting red P@C nanofiber was evaluated as freestanding or conventional anode material for LIBs, and their electrochemical performances were compared to that of pure carbon nanofibers. Our results demonstrate the potential of the red P@C nanofiber composite as a high-performance anode material for energy storage applications. The other characterization and test results will be presented and discussed at the conference.

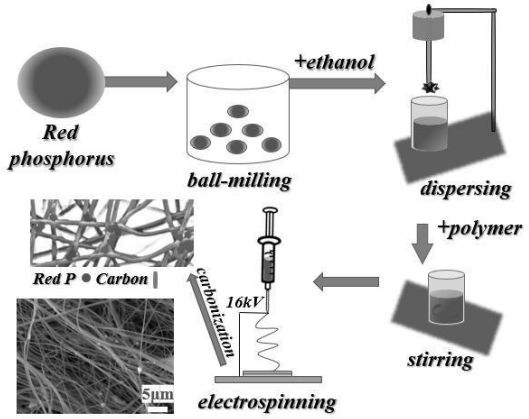

Figure 1. Schematic illustration of the preparation process for red P@C nanofibers.

References

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Yelnury Baltash, young researcher. She completed her master's degree in a two-degree program (Kazakhstan and Russia) in chemistry. She works as a Junior Researcher on the project "Development of composite anodes based on red phosphorus for the next generation of lithium-ion and sodium-ion batteries" at the Institute of Batteries. Her scientific interests include obtaining new composite anode materials with improved electrochemical characteristics, search and realization of new methods of anode formation.

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