Self-Assembled Hierarchical $KTi_2(PO_4)_3$@C Porous Spheroid as the High Rate-Capacity Anodes for Sodium-Ion and Potassium-Ion Storage

Zhixuan Wei, Fei Du* and Chunzhong Wang

Key Laboratory of Physics and Technology for Advanced Batteries (Ministry of Education), College of Physics, Jilin University, P. R. China

E-mail: dufei@jlu.edu.cn

Exploring appropriate host materials for sodium and potassium ion storage is imperative for the development of alternative energy storage system to lithium ion batteries for cost concern. Throughout the investigation of anode materials, NASICON-type (Na-super ionic conductor) structure has attracted worldwide attention owing to their robust three-dimension open framework, giving plenty of active sites for fast insertion/extraction of alkaline ions with negligible lattice strain during the electrochemical process. Taking advantage of the unique structure, a microscale secondary porous spheroid-like self-assembled hierarchical structure composite consisting of numerous primary $KTi_2(PO_4)_3$ nanoparticles homogenously coated by carbon layer is achieved by a facile electrospray method. The conductive carbon network together with the sufficient space for the infiltration of electrolyte from the porous structure give rise to the impressive ion storage performance in terms of high reversible capacity (284 mA h g^{-1} and 293 mA h g^{-1} for Na-ion and K-ion batteries, respectively), superior rate capability (136 mA h g^{-1} at 10 A g^{-1} for Na-ion batteries and 133 mA h g^{-1} at 1 A g^{-1} for K-ion batteries) and outstanding long-term cycling stability. The different diffusion behavior and kinetic properties were also studied to probe the different performance in the two systems. The results indicate that this $KTi_2(PO_4)_3$@C composite can be a promising candidate for sodium/potassium-ion storage. This materials engineering process can also be extended to other functional materials for rechargeable batteries.