Developing P Based Anode Materials for Na Ion Batteries

Quan Li
The Chinese University of Hong Kong

Abstract:

Unlike Lithium ion batteries (LIBs), anode material development remains as a major obstacle for the practical application of Na ion batteries (NIBs). Among various material choices, P based material caught much research attention in recent years. Phosphorus is a most promising candidates for anode applications in sodium ion batteries due to its highest theoretical capacity （2596 mA h/g） and reasonably low redox voltage (~0.6 V vs. Na/Na^+), implying achievable high energy density. Nevertheless, experimentally pure phosphorous anode suffers from fast capacity decay during cycling and low initial coulomb efficiency. These are caused by intrinsic characteristics of the phosphorous, including (1) low electrical conductivity (~10^{-14} S/cm); (2) instability of the Na-P phases; and (3) electrode pulverization due to sodiation induced volume expansion (390% to its original volume). In the present work, we will discuss two different approaches (forming metal phosphides or dispersing phosphorus in conducting matrix) that can improve the electrochemical properties of the anode. We show that although phosphide formation can largely stabilize the electrode for longer cycle life, the stable chemical bonds of metal-phosphorous make the sodiation difficult, and thus significantly reduce the capacity of the electrode. Manipulation of material chemistry may lead to an optimized balance between the stabilization of P and their active sodiation, resulting in high capacity, high rate performance and long cycle life.