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Black Phosphorus with Superior Lithium Ion Batteries Performance Directly Synthesized by the Efficient Thermal- Vaporization Method

Qianqian Jiang[a],[*] Jie Li[a], Nannan Yuan[a] , Zexing Wu[b] and Jianguo Tang[a]

[a] Institute of Hybrid Materials, College of Materials Science and Engineering, Qingdao University, Qingdao, 206000, P. R. China

[b] Key Laboratory of Sensor Analysis of Tumor Marker of Education Ministry，State Key Laboratory Base of Eco-chemical Engineering, College of Chemistry and Molecular Engineering, Qingdao University of Science & Technology, Qingdao 266042, P. R. China

ABSTRACT

Black phosphorus (BP), obtained from a low-cost abundant raw material with layered structure of puckered sheets, is a promising candidate amond 2D nanomaterials as an anode material for lithium ion batteries. Although black phosphorus owns a high theoretical specific capacity, it shows a large capacity drop after the first cycle, which leads to inferior cycle performance probably caused by the poor electrical conductivity, representing a huge challenge to overcome. Herein, we report the high-performance black phosphorus anode for lithium ion batteries, which is grown on the surface of carbon paper by the efficient vapor deposition approach directly from the red phosphorus. The BP anode delivers a high reversible capacity of 2168.8 $mAh \cdot g^{-1}$ with excellent cycling stability (1677.3 $mAh \cdot g^{-1}$ after 200 cycles) and high capacity retention (75.58 %), due to the high crystallinity and good electrical conductivity. Meanwhile, it can maintain high specific capacities of 2111.8, 1569.5, 1387.7 and 1177.5 $mAh \cdot g^{-1}$, at 0.1, 0.2, 0.5 and 1 C, respectively. Furthermore, the as-prepared BP with excellent electrochemical performances from the novel efficient vapor deposition approach can