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# Low temperature carbon-plasma based facile approach of carbon doping and encapsulation for energy storage applications

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Current battery technologies mostly use transition metal oxides such as $LiCoO_2$, $LiFePO_4$, or $LiNiMnCoO_2$ as cathode and a graphite anode, both of which depend on intercalation/insertion of lithium ions for lithium ion battery (LIB) operation. There is enormous interest and ongoing research for development of high-capacity anode materials to overcome limited capacity of graphite. Conversion reaction materials, such as transition metal oxides, sulfides, phosphides, and nitrides have been extensively investigated as potentially high-energy-density alternatives to intercalation-based graphite anode. In particular, a number of transition metal oxides and sulfides have shown excellent electrochemical properties as high-capacity anode materials. However, the fast capacity fading serves as the major limitation for their practical implementation. To overcome this challenge, two dimensional carbon-doped and carbon-encapsulated transition metal oxides have been successfully constructed using carbon-plasma treatment in a simple RF plasma system. Environmentally-friendly and sustainable tea tree oil is used as the precursor to achieve controllable carbon doping and thin uniform carbon encapsulation. Hence, in this case we are extending the application of tea-tree oil based RF-PECVD system from horizontal and vertical graphene nanosheets formation [1-3] to carbon doping and carbon encapsulation of active materials. As anode materials for LIBs, the carbon-doped transition metal oxide with conformal carbon coating delivers much superior capacity and rate capability as compared to virgin transition metal oxide electrode during long-term cycling process, which may be attributed to the improved structural integrity, greater stability of solid electrolyte interphase layer, and electrochemical actuation of the carbon-introduced nanosheet architecture. The results demonstrate that the carbon-plasma processing, represent an effective way to realize excellent performance in LIB for practical applications.

References

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