Conformal Carbon Coating on Hard Carbon Anode Derived from Propionaldehyde for Excellent Performance of Lithium-Ion Batteries

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Hard carbon anode material is one of the most promising candidates for next-generation lithium-ion batteries with high power performance. Nevertheless, the poor conductivity and low initial Coulombic efficiency largely impede its commercial implementation. Herein, we demonstrate the utilization of propionaldehyde as a new coating precursor for synthesizing a core-shell structured hard carbon material by a chemical vapor deposition (CVD) coating route. The surface of the hard carbon can be evenly coated with a thin carbon layer of 0.5~2 μm in thickness. The powder conductivity measurement shows that the coated carbon shell can effectively improve the conductivity of the hard carbon from 27.3 to 36.3 S cm^{-1} . Further, the resultant core-shell structured product shows enhanced lithium storage performance. Especially, the electrode with high areal mass loading of over 5 mg cm^{-2} can deliver a large reversible capacity of 404.3 mAh g^{-1} and a high initial Coulombic efficiency of 85.2 %, representative of the increment of 79.1 mAh g^{-1} and 10.1% with respect to the uncoated counterpart, respectively. Importantly, coupled with a commercial NCM523 cathode, the full battery (18650 type) displays excellent cyclic stability with a low capacity decay of $\sim 0.012\%$ per cycle over 800 charge-discharge cycles at high rates of 6C/6C. We suggest that the CVD coating treatment by using propionaldehyde as a carbon precursor is an effective method in improving the overall electrochemical properties of hard carbon anodes for lithium-ion batteries.

Keywords: hard carbon, core-shell structure, propionaldehyde, chemical vapor deposition, lithium-ion batteries.

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