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# 1 Core-shell carbon composite material as anode materials for 2 lithium-ion batteries

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## 11 Abstract

12 The core-shell structured humic acid (HA)-based carbon composites were  
13 synthesized through liquid-phase coating coupled with further carbonization treatment  
14 at 900 °C. The crystal structures and morphologies of samples were explored by  
15 scanning and transmission electron microscopy, X-ray diffraction, and Raman spectra,  
16 revealing that graphitized HA (GHA) has the same microstructure as microcrystal  
17 graphite, and intercalation/de-intercalation of lithium ion can be profitable.  
18 Meanwhile, a uniform carbon shell and distinct boundary between the GHA core and  
19 carbon shell can be noticed in a carbon coating GHA (CGHA) composite. By  
20 electrochemical characterizations, the first charge and discharge capacities of the 10%  
21 CGHA composite electrode are 463.0 and 597.1 mAh/g at a current rate of 0.1 C,  
22 respectively, with an initial coulombic efficiency of 77.5%. Moreover, 10% CGHA  
23 composite electrode continues to deliver a reversible specific capacity of 251.7 mAh/g

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