Lignin-derived hard carbon as a high-performance anode in sodium ion batteries: Na storage mechanism

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Hard carbon is considered as one of the most promising anode materials in sodium ion batteries (SIBs). However, the underlying mechanism of sodium ion insertion/extraction is still under debate. The uncertainty of sodium ion storage mechanism hindered the optimization of hard carbon as anode material in SIBs. Herein, we present systematical investigation of the relationship between the active sites and sodium ion (Na^+) storage in the sloping and plateau voltage regions. By using ex-situ XRD, ex situ XPS, ex situ SAXS, ex situ solid state NMR, electrochemical techniques, GITT method, and space-filling model, new mechanistic insights into Na^+ ion storage were proposed. First, Na^+ ions were adsorbed on defect/edge sites; then partial micropore filling occurred in the sloping region above 0.1 V. In the plateau region below 0.1 V, Na^+ ions were intercalated in the graphitic layers, and further adsorption in the micropores occurred near the cutoff potential.