

Investigation of the surface composition of carbon xerogels used in carbon-carbon composites for sodium-ion batteries

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The negative electrode of sodium-ion batteries remains a challenge because graphite, the classical material of lithium-ion systems, does not efficiently intercalate sodium¹. Other carbonaceous materials such as hard carbons are promising and have shown capacities of 300 mAh/g². However, their specific surfaces are usually high, leading to significant Solid Electrolyte Interphase (SEI) formation at the 1st cycle³. In previous studies^{4,5}, carbon xerogels (CX), *i.e.* micro-mesoporous hard carbons with a controllable pore texture⁶, were synthesized by the pyrolysis of a phenolic resin. A secondary carbon layer was then deposited by chemical vapor deposition (CVD), using ethylene as a precursor, to cover the micropores and reduce SEI formation⁶. The study of those carbon-carbon composites showed that the closed micropores inaccessible to the electrolyte are beneficial to sodium ion storage^{4,5}.

In this work, the study of the composites was further developed by investigating the impact of the surface composition of the CX on the electrochemical performance, in particular on the SEI formation. More precisely, the effect of the presence of oxygen at the CX surface was studied *via* two post-treatments: (i) oxidation under air (variable time)⁷ and (ii) reduction under diluted hydrogen (variable temperature). The treated CX were then covered by a secondary carbon layer using CVD to close the microporosity. The different samples were then characterized by physicochemical and electrochemical techniques. The electrochemical results showed that oxidation increases the irreversible capacity at 1st cycle while maintaining an identical initial coulombic efficiency whereas reduction does not modify the results significantly. Strikingly, the CVD treatment allows to homogenize the performance for CX with different surface compositions, meaning that, in addition to closing the micropores, the secondary carbon layer also gets rid of any influence of surface composition fluctuations.

References

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