

Synthesis of marketable hard carbons for negative electrodes of sodium-ion batteries

Raphaël Janot¹, Nour Daher^{1,2}, Da Huo¹, Philippe Meunier²

¹ *Laboratoire de Réactivité et Chimie des Solides (LRCS), UMR 7314 CNRS Université de Picardie Jules Verne, 33 rue St-Leu, 80039 Amiens, FRANCE*

² *Mersen France Gennevilliers, 41 rue Jean Jaurès 92231 Gennevilliers Cedex, FRANCE*

Na-ion batteries are now widely studied as alternative to Li-ion batteries, especially for large-scale applications, because sodium is highly abundant and much cheaper than lithium. Among the negative electrode materials, hard carbons are the materials of choice, due to their high electrochemical capacities and low voltage for Na⁺ insertion. Hard carbons are often produced by pyrolysis of sucrose or organic polymers. The main objective of this work is the development of a simple route for hard carbon synthesis with a good yield. The process should use low cost precursors and avoid any additional steps such as washing, purification, activation... The precursor used and pyrolysis conditions are key parameters as they strongly influence the electrochemical properties of the resulting hard carbons. The relationship between the synthesis conditions and the carbon properties (crystallinity, morphology, porosity) will be discussed.

Several precursors were investigated (sucrose, pitch, lignin...) using a two-step pyrolysis under nitrogen flow. The effects of the precursor chosen and the pyrolysis temperature on the structural properties will be presented. Then, electrodes were formulated in aqueous solutions and the electrochemical properties were evaluated in coin cells vs. metallic Na. We will show that a careful control of the nano-structure/texture allows obtaining good electrochemical performances. For instance, a hard carbon prepared from a pitch/lignin mixture leads to a reversible capacity of 265 mAh.g⁻¹ and 82 % coulombic efficiency at the 1st cycle for a galvanostatic cycling performed at C/20. We will also show that the surface chemistry of the hard carbons is very important.