Hard carbons for Na-ion batteries: the role of the electrode formulation

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Because of the greater size/mass of Na relative to that of Li and its higher standard electrode potential (-2.71 V *vs*. -3.04 V vs. SHE), Na-ion batteries were hardly considered as a possible solution for energy storage applications. These arguments are, however, not especially relevant if Na is to be used in its ionic and not in metallic form. If this is the case, in commercial full cells, wherein both anode and cathode are based on Na hosting materials, the gap in the energy density between Li- and Na-ion system will decrease significantly, rendering the latter an interesting energy storage alternative. Although a search for ideal negative and positive electrode materials still continues, there are already some potential candidates, such as hard carbon (HC) anodes. Particularly, HCs derived from biomass are of a great interest due to their availability, low cost and environmentally friendly nature [1, 2]. But the material is just a starting point and there are other equally important factors that define the performance of the cell.

Herein on the example of HCs derived from four different precursors: cellulose, chitin, chitosan, and lignin, we emphasize how important is the electrode formulation for enhanced and stable operation of the Na-ion battery. The selected bio-precursors were converted into carbons by annealing at 1300°C under argon and their BET surface area, pore size distribution, graphitization level, and other properties were thoroughly characterized. With carefully adjusted electrode formulation each of these carbons delivered at least 200 mAh/g at C/3 rate and remained thereabout for dozens of cycles. However, a ready-made recipe for the preparation of HC-based electrode could not be given as it depends very much on the individual physicochemical properties of each HC. Chitin-derived HC reached > 275 mAh/g when PVDF binder/superP was used. To the contrary, in a similar electrode composition cellulose-derived HC attained only 200 mAh/g (Figure 1). For the latter material water-based CMC binder/superP combination seemed to be more preferable.

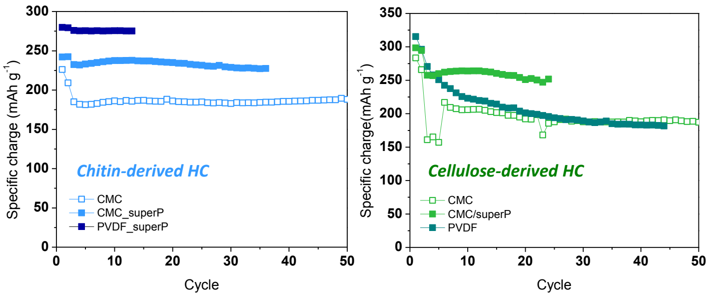

Figure 1. Electrochemical performance of Na-ion cells in $NaPF_6$ EC:DEC electrolyte with chitin- and cellulose-derived HC material.

References:

[1] J Górka, C Vix-Guterl, C Matei Ghimbeu, J Carbon Research 2 (2016) 24.

[2] C Matei Ghimbeu, J Górka, V Simone, L Simonin, S Martinet, C Vix-Guterl, NanoEnergy 44 (2018) 327-335