Deciphering the structural and electrochemical properties of activated BN-doped spherical carbons for supercapacitors application

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Abstract

In this study, the effect of K_2CO_3 activation on the structural and electrochemical properties of carbon spheres (CSs) and boron and nitrogen co-doped carbon spheres (BN-CSs) was evaluated. After activation, the specific surface areas for the CSs and BN-CSs increased from an initial value of 6 and 15 m^2 g^{-1} to 471 m^2 g^{-1} and 529 m^2 g^{-1}, respectively. The XPS results showed the presence of 5.9 at.% B and 4.7 at.% N in the BN-CSs while the activated BN-CSs had 1.5 at.% B and 1.0 at.% N. The BN-CSs comprised of 64 % pyridinic-N, 24 % pyrrolic-N and 7 % graphitic-N whereas the activated BN-CSs had 19 % pyridinic-N, 40 % pyrrolic-N and 22 % graphitic-N displaying the effect of activation on the type of N-configurations in BN-CSs. Electrochemical analysis of the electrode materials revealed that BN doping, carbon morphology, structure and porosity played a crucial role in enhancing the capacitive behaviour of the CSs. In a 3 M KNO_3 electrolyte, the activated BN-CSs showed a specific capacitance of 70 F g^{-1} at a specific current of 1 A g^{-1}. A symmetric device comprising the activated BN-CSs displayed a specific energy of 4.6 Wh kg^{-1} with a corresponding specific power of 800 W kg^{-1} at a specific current of 1 A g^{-1} within an operating cell potential of 1.6 V. The study illustrates the role of K_2CO_3 activation in influencing the physical and electrochemical properties of template-free activated BN-CSs as potential electrode materials for high power demand systems.