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Modulating properties of solid carbon nanospheres via ion implantation with hetero-ions

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Solid carbon nanospheres of ~200 nm diameter have been prepared and then doped by ion implantation, using a specialized end-station adapted for the uniform implantation of powders. Boron, nitrogen and neon ions were chosen initially, the latter for control purposes. Herein, the dependence of the physicochemical properties of solid carbon spheres on the fluence of the implanted ions was investigated by controlling the dosage of the 100 keV of B+, N+ and Ne+ ions into the carbon shell over 7 h and 14 h implantation periods at room temperature. SEM analysis revealed significant surface deformation in the form of cracks for the Ne+ implanted samples, whilst little structural deformation was observed when N+ and B+ implanted samples. Furthermore, TEM micrographs confirmed dependence of the structural properties on the ion fluence, as shown by formation of varying thickness of an amorphous carbon layer after implantation with B+, N+ and Ne+ ions, respectively. Finally, magnetic properties showed that the type of the hetero-ion as well as the affiliation of the carbon to the hetero-ion influenced the transition from diamagnetism to super-paramagnetism. The Néel temperature varied somewhat but was below about 10 K. Boron conferred a much greater paramagnetic susceptibility at low temperature than the other ions, and showed indications of a higher electrical conductivity at higher temperatures, suggesting an electronic doping effect. The study showed the importance of the choice of the heteroatom ion on the properties of the solid carbon spheres for the development of next generation carbon-based electronic devices.

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