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Carbon nanoparticles synthesized by sputtering and gas condensation inside a nanocluster source of fixed dimension

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Due to their unusual chemical and physical properties, spherical carbon nanoparticles have been the subject of numerous studies. In general, these nanoparticles are synthesized by arc-discharge, by laser ablation and by various chemical vapour deposition processes. However, most of these methods lead to the synthesis of nanoparticle agglomerates, the formation of spherical particles with various diameters or the production of nanoparticles mixed with nanofibres and nanotubes. Here, another technique is proposed in which carbon nanoparticles are generated in an aggregation tube by condensation of free carbon atoms resulting from the magnetron sputtering of a graphite cathode. The technique is known to obtain non-agglomerated metallic nanoparticles with a narrow size distribution and, to the best of our knowledge, the synthesis of isolated carbon nanoparticles had never been tested before this work. The carbon nanoparticles resulting from the gas aggregation tube are negatively charged and their morphology was studied according to positive biasing of substrate holder. The carbon nanostructures were deposited on formvar grids to be analysed by transmission electron microscopy (TEM). For positive voltages larger than 30 V, results showed spherical and randomly dispersed nanoparticles with a mean diameter which varied from about 10 nm to 20 nm depending on the choice of plasma parameters. By contrast, if the voltage is grounded or is lower than or equal to 30 V, only nanoribbon-like structures mixed with compact or fractal group of nanoparticles are observed on TEM grids. Results are discussed in terms of a 3 steps process inside the aggregation tube: nucleation, coalescence and agglomeration of negatively charged nanoparticles.

Keywords
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