Deposition of silver nanoparticles on carbon nanotube arrays

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The exceptional electronic, mechanical and thermal properties of carbon nanotubes (CNTs) have inspired academic and industrial research to find ways to integrate them in robust and diverse applications. Utilizing macroscopic CNT-based structures, including mats, fibers and foams, and incorporating other nanoparticles in these structures is a rather promising method to efficiently combine high-performance building blocks to get superior hybrid materials (Georgakilas *et al.*, 2007).

The incorporation of nanoparticles in CNT-structured matrices has been mainly obtained through wet chemistry strategies. However, they usually require tedious procedures and end up altering the electronic properties of CNTs. In this study, we used a facile dry physical deposition method to prepare silver (Ag) nanoparticle-decorated CNT arrays which could be used, for example, in antibacterial applications (Akhavan *et al.*, 2011).

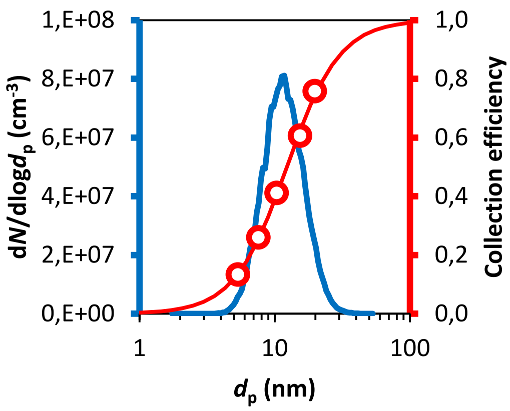

Figure 1. The number size distribution of the generated Ag nanoparticles (blue line) measured with the SMPS and the particle collection efficiency of the system (red markers).

The CNT arrays used in this study were synthesized in a chemical vapor deposition system with floating catalyst (Raney *et al.*, 2011). Ag aerosol nanoparticles with diameters of approximately 10 nm were generated through an evaporation–condensation method (Harra *et al.*, 2012). Figure 1 shows the particle number size distribution (blue line) measured with a scanning mobility particle sizer (SMPS). After generation, the nanoparticles were charged with a small corona charger introduced by Arffman et al. (2014), and collected on top of the CNT arrays using an electrostatic precipitator. The particle collection efficiency of the used system (red markers) is presented in Fig. 1. A collection efficiency of 50 % was achieved for particles with a diameter of 12 nm.

Figure 2 shows a scanning electron microscopy (SEM) image of the surface of a CNT array with deposited Ag nanoparticles. The inset in figure shows an individual CNT, with a thickness of approximately 100 nm, coated uniformly with nano-sized Ag particles. The homogeneous distribution of the Ag nanoparticles on the surface of the CNT array was further confirmed with elemental mapping.

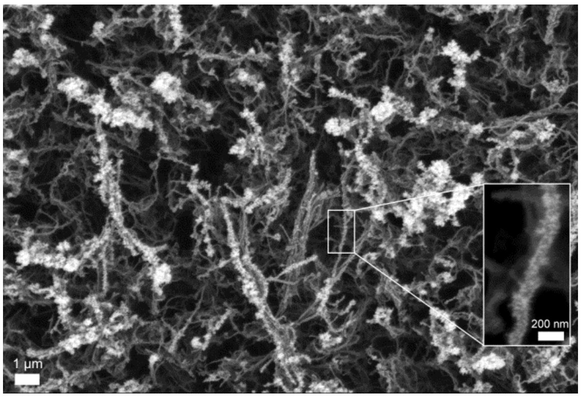

Figure 2. An SEM micrograph from the surface of an Ag-decorated CNT array. The inset shows a higher magnification of an individual decorated CNT.

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