Silver Nanoparticle-Carbon Nanotube Composites: Synthesis and SERS Properties

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Composites consisting of carbon nanotubes and silver nanoparticles (AgNPs) possess a variety of interesting mechanical and electronic properties, which enables their application in sensors, catalysts and SERS (Surfaced-enhanced Raman Spectroscopy) detection. In this work, we prepared silver nanoparticle-carbon nanotubes composites by thermal treatment of multiwalled carbon nanotubes (MWCNT) and silver acetate at 300 ° C in N_2 atmosphere.[1] Three distinct composite systems were prepared by employing: *i*) pristine MWNT (MWNT-AgNPs), *ii*) MWNT purified by acid treatment (MWCNTp-AgNPs), *iii*) and MWNT functionalized with cysteamine via DCC (MWCNTc-AgNPs). We characterized the products by Scanning Electron Microscopy (SEM) and Raman Spectroscopy (excitation at 633 nm). SEM images indicate a low AgNPs loading over the surface of the nanotubes for the MWCNT-AgNPs product, possibly due to lack of defects and chemical groups capable of assembling the nanoparticles over the MWCNT. Conversely, uniform deposition of AgNPs was detected for the MWCNTc-AgNPs sample. This can be assigned to the presence of thiol groups over its surface that can act as effective sites for heterogeneous nucleation and growth of Ag particles. Lastly, particle aggregation as well as non-uniform distribution was observed for the MWCNTp-AgNPs sample. The registered Raman spectra support these observations. While all samples showed high signal intensity as a result of the SERS effect, the magnitude of their intensity could be correlated with the degree of aggregation of the Ag nanoparticles over the MWCNT surface. Moreover, the SERS spectra of the MWCNT showed distinct enhancements in the signal intensities for the different modes of the MWCNT, suggesting a significant chemical interaction between the Ag nanoparticles and the carbon nanotubes. These results show that the control over the synthetic strategy is crucial to obtain Ag nanoparticle-carbon nanotube composites with optimized morphologies and SERS properties.

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[1] Lin et al. ACS Nano, 2009, 3, 871-884.

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