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Multi-walled carbon nanotubes functionalized with silver nanoparticles

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Abstract – Multi-walled carbon nanotubes (MWNTs) grown by Spray Pyrolysis have been decorated with silver nanoparticles prepared by the traditional silver mirror reaction. Good dispersion of silver nanostructures were obtained on the surface of MWNTs, thereby providing an efficient and simple wet chemistry way of increase the reactivity of the carbon nanotubes surfaces.

In recent years, many efforts have led to the development of versatile methods to modify carbon nanotubes (CNTs) to obtain derivatives with more attractive features. To this end, CNTs decorated with metal nanoparticles (NPs), which exhibit increased chemical activity due to their large surface to volume ratios and crystallographic surface structure, have been examined toward applications in the area of nanoelectronics, as gas sensors and in heterogeneous catalysis. Several methodologies have been developed for the decoration of CNTs with silver nanoparticles, including solid-state reaction, thermal evaporation, and surface chemical reduction [1]. For gas sensing application, functionalization of CNTs side walls can improve the excellent potential of carbon nanotubes as sensitive material for detecting biological and chemical molecules, enhancing the interaction between a specific chemical species and the nanotubes, as well as the selectivity of the adsorption process.

In this work, multi-walled carbon nanotubes (MWCNTs) have been synthesized by the Spray Pyrolysis method using toluene and ferrocene as precursors. After that, a stable homogenous MWCNTs suspension was obtained by dispersing 25 mg of pristine MWCNTs into 1.0 wt% of sodium dodecyl sulfate (SDS) aqueous solution and sonicated for two hours. The resultant MWCNTs suspension was introduced to the Tollens reagent formed adding to a 1.0 wt% of silver nitrate ($AgNO_3$) solution 5% of ammonia drop wise under stirring until the brown precipitate just dissolved. Formaldehyde (0.5 ml) were dropped to the system and the system was kept stirring at 60^{o}C for 45 min. The final silver-functionalized MWCNTs were collected by centrifugation and washed with water and ethanol several times. The obtained black powder was dried at room temperature for 24 h. Different concentration of silver nitrate solutions were used varying from 0.2 to 1.0 wt %.

The surface analysis was carried out using a scanning electron microscope ZEISS, model DSM 960. Figures 1 and 2 show silver nanoparticles uniformly dispersed around the CNTs surface with NPs with diameters smaller than 50 nm. The presence of metal nanoparticles in the decorated MWCNTs was also probed using energy dispersive X-ray analysis (EDAX). Raman and X-ray photoelectron spectroscopy were also performed to characterize the functionalized MWCNTs.

The silver mirror reaction scheme is promising for the development of sensor arrays suitable for analyzing gas mixtures enhancing the gas sensitivity of CNTs with respect to pure carbon nanotubes.

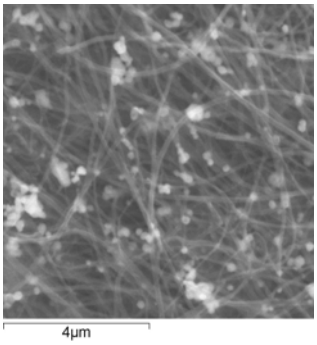

Figure 1: Ag-MWCNTs decorated at 0.3 wt % of $AgNO_3$ solution.

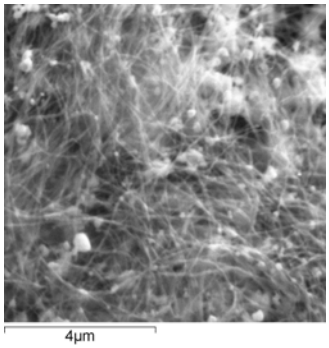

Figure 2: Ag-MWCNTs decorated at 1.0 wt % of $AgNO_3$ solution.

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References

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