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Production of Single-Walled Carbon Nanotubes by the Electrical Arc Method under Low Pressure

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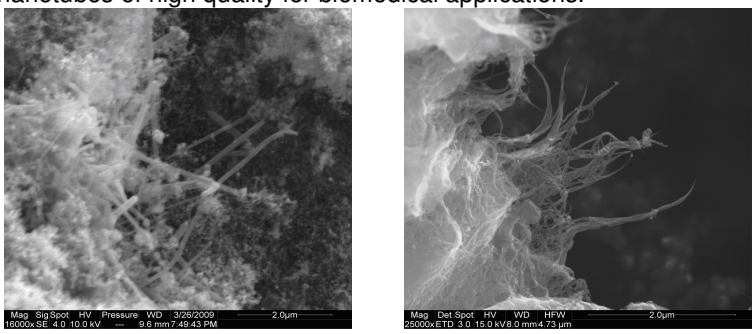
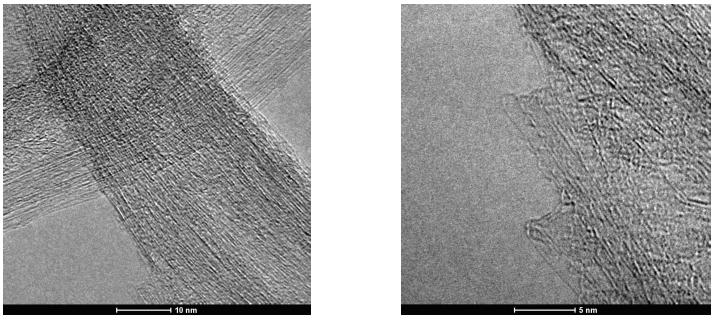
Abstract – Single-Walled Carbon Nanotubes (SWNTs) have been processed by electrical arc discharge method under low pressure (He atmosphere of 40 Torr) using Ni/Y/FeS as metallic catalyst. The atomic ratio of Ni-Y-FeS was 4.2-1-1 at% into graphite anode electrode. The morphology and structure of the SWNTs were obtained and observed using Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM) and Raman Scattering measurements. In summary, we have developed a new method of production SWNT with high quality.

Single-walled carbon nanotubes have attracted the interest of many scientists because of their potential applications, and the production this material by electrical arc method is usually carried out under high pressure (inert gas atmosphere of 400-600 Torr) [1]. In this work, we report that new process at low pressure (He atmosphere of 40 Torr) to produce SWNT. A lot of impurities, such as amorphous carbon and catalyst metals are includes in the produced soot besides SWNTs. It is fundamental to remove these impurities for obtaining pure SWNT that in the classical electric arc discharge this purification is hard and involve multi-step process. These impurities in SWNT at low pressure are easily eliminated and as result we obtain high purity carbon nanotubes using few steps. Our purification method is following: first the as grown material was washing in toluene to extract fullerenes, after the sample was heated at 390 ºC for 50 min under atmospheric condition then, the sample was keep in 6M hydrochloric acid solution for 24h to remove metallic nanoparticles. Finally, the sample was filtrated with PTFE 1 μm Millipore filter and the deposit was dried at 100 ºC for 24 h. The figure1 shows SEM images of SWNT NiYFeS 40Torr obtained before (figure 1a) and after purification (figure 1b). It is clear that impurities are removed as result of purification. The figure 2 shows TEM images of SWNT pure and presents the quality of produce material under low pressure. The figure 2 (b) show the distribution of diameter nanotubes (1.2 – 1.5 nm) in agree with Raman measurements not showed here. We expect that the new method of production SWNT under low pressure promote the formation of carbon nanotubes of high quality for biomedical applications.



(a) (b)

Figure 1: SEM images of SWNTs before (a) and after (b) purification.



(a) (b)

Figure 2: TEM images of SWNTs pure.

References

[1] Mathur, R.B et al, Carbon 45.(2007)132-140