

3.1- Purification of carbon nanotubes

~~Preparation condition of carbon nanotube~~ The conditions (such as catalysts, temperature, power source and vacuum ~~has~~) under which CNTs are prepared have a huge impact on ~~the their~~ quality of carbon nanotube. ~~As~~ Raw MWNTs, when produced, ~~raw MWNTs~~ contain large amounts of polyhedral graphite nanoparticles and small amounts of graphite impurities. ~~As~~ Raw SWNTs, when produced, ~~raw SWNT~~ contain large amounts of carbon ~~nanoparticles~~ nanoparticles, amorphous carbon, fullerenes and metal catalysts. Different methods ~~have been~~ are used to purify ~~both~~ SWNTs and MWNTs. ~~One of the methods is Gas~~ method is gas-phase oxidation, which is appropriate ~~on for~~ purification of MWNTs. ~~(12) To help the oxidation of the cathodic~~ Cathodic deposits, ~~they were~~ are soaked in aqueous solution to help their oxidation. Therefore, carbon particles ~~were~~ are wetted and to form a stable suspension. The ~~suspension was~~ suspension is cooled down to $-35\text{ }^{\circ}\text{C}$ and thawed ~~at to~~ $20\text{ }^{\circ}\text{C}$. This ~~cause~~ causes cleavage of graphite layers in the graphite component of the deposits. The material ~~was is~~ then dried at $100\text{ }^{\circ}\text{C}$ ~~and oxidized with~~ $^{\circ}\text{C}$ and exposed to oxygen at $700\text{--}800\text{ }^{\circ}\text{C}$ followed by annealing in air for $3\text{--}5$ hours. This ~~gave a weight loss of 50~~ causes 50–90% of the deposits to be removed by oxidation. (13) The ~~Gas~~ gas-phase oxidation can destroy SWNTs along with amorphous carbon because ~~the diameter of SWNTs is smaller~~ SWNTs have smaller diameters and they are more reactive. ~~(14) Another method is liquid phase oxidation~~ using agents such as KMnO_4/H^+ , (15), and ~~nitric acid~~ HNO_3 (16), which are widely used to purify ~~carbon nanotubes~~ CNTs. Liquid phase

oxidation, ~~which~~ can be ~~done~~ carried out at lower ~~temperature~~ temperatures (70°C ~~–80°C) and give significant~~), gives significantly high yield and ~~facilitate~~ facilitates the characterization and application of ~~carbon nanotube~~ CNTs.

Another method is high temperature gas phase oxidation, followed by washing with HCl ~~acid~~. (17) This method is used to remove the metal catalyst impurities generated by laser ablation on the surface of ~~carbon nanotube generated by laser ablation~~ CNTs. This purification method confirms that the reactivity ~~with of~~ oxygen ~~on with~~ small diameter tubes is higher than with large diameter tubes because of steric strain on small diameter ~~carbon nanotube~~ CNTs. (18) Nikolaev and co-workers used a new method called soft-bake to purify SWNTs produced by laser ablation. -In this method, raw SWNT as produced ~~raw SWNT was is~~ annealed at low temperature in humid air. -This ~~helped the degradation of~~ helps to degrade the graphitic shells ~~which surrounds~~ surrounding the metal particle impurities. -Once ~~this~~ these graphitic shells degraded ~~then~~, metal particles will be exposed and reacted with hydrochloric acid HCl. This method ~~introduced~~ offers higher reproducibility, higher yield, less process time, and better removal of metal impurities.

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