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Carbon Nanotube

Carbon nanotubes can be defined as cylindrical structures of diminutive nano-scale diameters forged by carbon atoms. These cylindrical molecules have a diameter measuring on the nanometer scale, with one nanometer being equivalent to one-billionth of a meter. Carbon nanotubes are unique given that the boding between different atoms making them is very strong and have extreme aspect ratios (Lambin 249). In science, the unique properties of carbon nanotubes makes them applicable in electronics, nanotechnology, optics, as well as other fields of technology and material science (Lambin 249). Owing to nanotubes' extraordinary mechanical and electrical properties as well as themal conductivity, carbon nanotubes can also be used as additives in production of various structural materials. This paper will discuss carbon nanotubes, their structure, properties, as well as their techniques.

Synthesis

Various techniques have been conceptualized to produce nanotubes in sizeable quantities. These techniques include laser ablation, arc discharge, and chemical vapor disposition (CVD). Arch-Discharge technique utilizes high temperatures usually above 1700℃ for carbon nanotubes synthesis. Essentially, this process causes the expansion of carbon nanotubes with less defects compared to other methods. According to Lambin (251), arch-discharge use water-cooled high-quality electrodes with diameters of between 6-12 mm, separated between 1-2 mm gaps in chamber with helium. The chambers contain graphite anode and cathode as well as metals catalysts and evaporated carbon molecules.

The major advantage of arc-discharge is that it is a simple technique that produces high-quality nanotubes. Again, the technique is inexpensive in comparison to other methods. The drawback of arc discharge is that it utilizes very high temperatures. Accordingly, purification will be required to cleanse the nanotubes of impurities. Furthermore, sometimes it produces tangled nanotubes (Lambin 251).

Laser ablation entails the use of a pulsed laser to vaporize a graphite substance in high-temperature reactor. An inert gas is bled into the reactor to speed up the production of nanotubes. A water-cooled surface is included into the system to provide a platform where vaporized carbon condenses. The laser ablation technique yields approximately 70% carbon nanotubes with a controllable diameter based on reaction temperature (Lambin 251).

The main advantages of the laser ablation method are that it consists of high yield nanotubes with relatively low metallic impurities due to the kind of metallic atoms produced, which tend to evaporate from the tube end once it is closed. The drawback of this technique is that the nanotubes produced are not uniformly straight since they contain some branching. Again, laser ablation technique is not economically viable because the procedure involved entails high-impurity graphite rods. Moreover, the laser power needed for the process is very high and end up not producing lower quantity of nanotubes compared to arc-discharge technique.

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Chemical Vapor Disposition (CVD) is the most preferred method for generating carbon nanotubes. In CVD technique, metal nanoparticles are added to a catalyst substance such as Al_2O_3 or MgO to increase the surface area to create a space for higher yields for the catalytic reaction (Teker et al. 271). On the various methods discussed above, CVD is the most applicable especially for industrial-scale deposition because it is capable of generating nanotubes directly

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unlike other techniques. Again, CVD' price/unit ratio is cost effective, hence giving users a profit incentive.

The major advantage of the CVD method is that it is most economical and practical method for large-scale production of nanotubes. Accordingly, the method is simple, utilizes low temperatures, and produces substances with high rates of purity. The main disadvantage of the CVD is that it not immune to defects. Again, synthesized carbon nanotubes arising from the technique are usually single-wall nanotubes.

Characterization

Current discoveries in science and technology have motivated further research on the application of carbonmonstructrures. In this regard, various productions methods for caborn nanotubes have been discovered. Parameters such as surface area, size distribution, structure, surface charge, surface chemistry, purity of samples, as well as agglomerate states have a significant impact on the receptivity of carbon nanotubes (Agboola 289). Most of the methods used to produce nanotubes take place either with process gases or in a vacuum (Agboola 289). The CVD growth technique is the most popular since it yields higher quantity of nano substances as well as according a higher degree of control over length, diameter, and morphology (Agboola 289). While using particulate catalysts can produce large quantities of nanotubes, achieving the repeatability is a major problem with all the three techniques. Whatever the technique used, carbon nanotubes will always have impurities such as non-carboneus impurities and some form of carbon impurities. As such, one ought to choose a method that promises low rates of impurities while offering high quantity of nanotubes.

Conclusion

Since this discovery on carbon nanotubes was made, they have been found to have unique applications in the various fields of science. In particular, this technology can be applied in the field of medicine. However, there remains a couple of issues to be resolved if these technologies are to be utilized effectively. Issues surrounding the division of individual nanotubes, presence of residual metals, as well as sensitivity to various gases and species need to be addressed as far as production of carbon nanotubes is concerned.

Works Cited

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