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Carbon Nanotube Production by Fluidized Bed Catalytic

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Description

Rolling up graphene, a hexagonal sp2 carbon layer, creates cylinders with nanometer-sized diameters and lengths up to several millimetres that make up carbon nanotubes. The curved sp2 graphene layers offer extra topological and quantum confinement limitations in the cylinder's circumferential direction, which gives rise to peculiar features of CNTs. There are three primary types of carbon nanotubes: single walls, double walls, and multiwalls. In order to visualise the construction of single wall CNTs (SWCNTs), imagine wrapping a layer of graphite one atom thick into a seamless cylinder. Multiwall CNTs (MWCNTs) are made up of concentric SWCNTs. Basically, how the graphene sheets are wrapped has a direct impact on the properties of SWCNTs. Carbon nanotubes (CNTs) are nanostructures made entirely of carbon and have special physico-chemical characteristics. They have made important advancements in a variety of sectors, including materials, electronics, energy storage, separation, sensors, etc. Commercial production will be necessary if the CNTs are to ever live up to their potential as an engineering material. The combination of a suitable reactor and a catalytic chemical vapour deposition technology is thought to be a scalable and reasonably inexpensive approach that can create high yield CNTs. Fluidized-bed reactors have a considerable promise for the commercial manufacture of this valuable material, according to recent developments in CCVD of CNTs. To regulate product morphology, increase process productivity, and scale up the process, it is necessary to understand the dominant process parameters that affect CNT nucleation and growth [1].

Arc discharge, laser ablation, and CCVD are only a few of the several techniques used to create carbon nanotubes. However, CCVD has been used extensively because it provides a promising method for producing CNTs in large quantities, which may lead to commercialization. The scientific community has been drawn to and has developed CCVD for growing CNTs because of the following characteristics: lower reaction temperature, which results in lower costs; high purity; potential for producing aligned carbon nanotubes; relatively high yield of products; and good potential for large-scale production. A lot of work has gone into understanding the critical factors that affect the production and morphology of CNTs during the CCVD process. By using the CCVD process, carbon nanotubes are grown in a reaction furnace with flowing gaseous carbon feedstock and a catalyst. For CCVD of CNTs, there are primarily two processing system types, namely horizontal and vertical. Typical horizontal system employed in the floating and fixed-bed catalyst techniques shown in picture. The floating catalyst technology makes use of a mixture of catalyst and reactants that are added to the reactor in the gas phase and kept at a high temperature where the CCVD reaction occurs. The solid phase active catalyst is formed in situ from the gas phase catalyst after it undergoes transformation in the reactor. This method's difficulty in avoiding particle coalescence is one of its shortcomings [2,3].

The advantages of both the floating and fixed-bed catalyst systems are utilised in the FBCVD process. Like the floating catalyst approach, it has efficient heat and mass transmission, and the catalyst nanoparticles are already attached to the support surface and are large and substantial enough to prevent being carried away with the reactant, carrier, and product gas stream. Greater contact between the reactants and catalyst powder in such a system promotes more efficient chemical reactions and heat transmission. As a result, FBCVD is more effective than other methods of CCVD for the synthesis of large amounts of CNTs since the CNT formation rate is directly related to the availability of the active catalyst sites. Although there are several ways to create supported metal catalysts, sol-gel, impregnation, co-precipitation, and CVD are the most used techniques. Through interactions with the active metal phases, the method's efficiency is primarily influenced by the support's surface characteristics. According to reports, the aligned nanotubes grow on a matrix with a highly homogenous distribution of transition metal thanks to the sol-gel manufacturing technique. To make the process reproducible, the supported-catalyst activity must be carefully managed because every applied condition has an impact on it. In addition to the preparation process, the metal-to-support content ratio affects how metal particles are dispersed on the support. The catalyst and support have an ideal metal content ratio, which results in the synthesis of CNTs with the appropriate characteristics [4,5].

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Conflict of Interest

The author reported no potential conflict of interest.

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