

# **Carbon Nanotubes**

Carbon Nano Tubes is a very recent discovery done in the year 1991 by Sumio Iijima. It is along with graphene are called materials of the future world. The moment 1991 for the discovery of carbon nanotubes was highly important as it opens new doors for future products especially in terms of strong fiber and thermal conductivity property.

## **Processing**

One of the problems of carbon nanotube mass adoption is its processing, its processing is comparatively easy as compared to graphene but not as easy as carbon fiber. There are different methods to produce Carbon nanotubes, for the multiwall CNT it is made when multiple carbon combustion and vapor deposition. In the case of single-wall CNT, a metal catalyst is added for its creation several other methods are used for its creation.

## **Laser method**

It was invented in 1996 it uses a dual pulsed laser and the yield we got is around 70% purity In this process CNT is prepared by laser vaporization of rods made up of graphite in the 50:50 ratio if catalyst mix of nickel and cobalt at 1200 C in following element argon. Then a heat treatment in a vacuum at thousand of degrees Celsius is performed.

Two laser pulses are used one after the other to vaporize the target uniformly as the use of a second laser reduces the amount of carbon that can be deposited as soot. The second laser breaks large particle and adds them to CNT, hence rope is formed

Plasma Arcing this process one electrode is evaporated as cations which then follows by its deposition at another electrode. In other methods, we use plasma arching in the presence of cobalt the cobalt is added as a catalyst Single wall CNT are formed this method was initially used for the production of C60 fullerenes, and it is one of the easiest ways to produce a CNT. This method uses arc- vaporization of two rods made up of carbon then both are placed on the opposite side of the system, and then an inert gas is filled in the system and one side of the electrode surface vaporizes and is then deposited to the other side. But in this method, we get an impure substance so lots of further purification is required.

## **Ball Milling**

In this method, graphite powder is placed in a stainless steel box with 4 hardballs made up of steel. The container is cleaned then the noble gas argon is added. This process is done at room temperature and can take as much as 150 hours. After this, the powder is heated and cool to remove impurity under argon flow for around 6 hours which causes the production of CNT which is multiwalled.

## Structure

A carbon nanotube is a single layer of carbon atom in hexagonal shape folded in cylindrical shape its diameter is in nanometers and length in micrometers. In other words, we can say graphene is a sheet of paper being folded to form a cylindrical structure. Graphene is a single layer of graphite and is also a wonder material. Initially in 1991 multiwall carbon nanotubes were discovered by Iijima using arc discharge methods. After two years he discovered Single Wall Carbon Nanotubes by the addition of transitional metal particles in the electrodes of carbon. That's why both years 1991 and 1993 are important the single-layer carbon nanotube is more narrow, curved, and has a diameter ranging from 1nm to 2 nm.

Configuration of carbon nanotubes

Carbon nanotubes have a configuration in armchair and zigzag. The zigzag one is on a graphene-like lattice that turns 60 degrees, left, and then alternates to the right. We read in the armchair model there are two left turns of 60°

properties

- A carbon nanotube is a very good electron field emitter.
- A carbon nanotube is 100 times stronger than steel due to its covalent  $sp^2$  bond.
- A carbon nanotube is elastic
- Carbon nanotube shows the property of semiconductor and has a very good conduction
- Carbon nanotubes show a great deal of flexibility.
- Carbon nanotube has good thermal conductivity and thermal expansion

## Performance

- The discovery of Carbon nanotubes is regarded as one of the great discoveries because of all things it can achieve and some of which it has already achieved.
- Super fiber rope:- carbon nanotubes can be used to make ropes for products to give them high strength. CNT is already used in some tennis rackets.
- Advance body armor. Carbon nanotubes body armor is another product that is already in production carbon nanotube body armor provides better protection than kevlar.
- Space elevator:- in the future carbon nanotubes can be used in the space elevator to make space travel more efficient
- Battery:- one of the biggest challenges we have is to store energy CNT can help in its storage
- Biomedical:- we have observed cell growth can be done on CNT so CNT can act as a biocompatible material
- Filter:- Companies have already developed a system of filtration of water and air using carbon nanotubes.
- Electromagnetic shielding CNT can be used as an electromagnetic shielding from electromagnetic pulse and can be used in electrostatic discharge materials

# World Trade Center Collapse

World Trade Center collapse was one of the most tragic accidents in the United States in recent history. There have been many debated for the reason of its collapse, and very definitive answers for its collapse has been discussed in this paper

The most interesting aspect of this paper that I find is the construction of the World Trade Center and how much a load of wind is faced by the building daily. And such calculations and constructions have been done in the 1960s to early 1970s.

What I already knew about the event was the collapse occurred was inwards, and that the World Trade Center was designed effectively, and terrorist use plane as a Molotov cocktail. What I learned through reading is that the perimeter tube design survived the loss of several exterior columns due to aircraft impact but it was the fire that caused the later steel failure and angle clips were weak point along with it I learned that it was the fire which was the bigger reason for the collapse than the initial impact. I also didn't know the uneven temperature of fire across a building which cause the loss of structural integrity was one of the major reasons for the collapse.

Some of the materials that are discussed in depths in this paper are

Steel:-steel has been widely discussed in this paper and how its structural integrity was lost

Aluminum:- a theory of aluminum burning that causes the collapse of the world trade center was debunked in this paper

Concrete:- concrete has been explained in this paper as how much rubble caused by it and was only a few stories tall as the building was 95% air

Hydrocarbons (jet fuel):- these are discussed here on how hot they burn and how they are the major reason for the collapse.

5 Technical terms I didn't get are

- Cantilever
- stoichiometric proportions
- joists
- asbestos
- perimeter tube