Carbon Nanotube Superconductors

Raminder Gill
Apex Institute of Technology, Rampur, India
rgill12dec@rediffmail.com

Abstract
Carbon Nanotubes have attracted a lot of intention of various scientists from all over the world because of its nano size and amazing properties in the various fields of interest. Carbon Nanotubes (CNT’s) are very thin and light weight tubes made up of carbon and are invisible to naked eye. These tubes manifest superconductivity at 15 K [1]. The calculations also indicate that the smaller the tube diameter, the higher the superconducting temperature. This is due to the greater curvature of the tube, which increases the interaction between electrons and lattice vibrations known as phonons—a property essential for superconductivity. And hence CNT’s can be used as powerful yet tiny logic chips in computers and have high potency as compared to conventional silicon chips. I have tried to explain the important properties, synthesis and the future importance of these nanotubes.

Introduction
Following the recent discovery of superconductivity in carbon nano tubes [2, 3] impress us to study this phenomenon in detail. The existence of superconductivity at different temperature ranges in different compounds has been seen for more than half a century [4, 5] and still we are trying to find the material which can conduct electricity at very cheap rates. In the present work an attempt is made to develop the microscopic study of CNT’s, their structure and their use as superconductors.

Materials and Methods
A group of researchers from several institutions in Japan has observed superconductivity — a phenomenon in which electrons flow with no resistance — in billionth-of-a-meter sized cylindrical [6] carbon molecules known as “multi-walled carbon nanotubes (MWCNT)”. The nanotubes ability to superconduct adds to their many intriguing electrical and physical characteristics.

Synthesis of multi walled carbon nanotubes
A carbon nano tube is a grapheme sheet rolled into a cylinder of nanometer size diameter (fig.1).CNT’s were produced by arc discharge method[7]. Arc discharge set up consists of double
walled stainless steel chamber with high rate of cooling by water circulation. Graphite was taken as electrodes; one of the electrodes (anode) is rod type whereas the other electrode (cathode) flat surface of bigger diameter. To keep uniform arcing during experiments, the anode was attached to a manipulator (step -motor), which controls the gap between two graphite electrodes by moving forward or backward. The chamber is pumped out to a base pressure of 100m Torr and then helium gas is purged to desired pressure. Voltage was kept constant of 40 V and variation of current was observed during the entire experiment till the anode was consumed completely. The MWCNT deposited at the cathode was collected for further processing.

Fig. (1): Carbon nanotube

**Outlook**

These tiny, black and tabular type nano materials, having from single to multi shell structure, will revolutionize everything from computer, bio-and medical device, nano composite-based vehicles to electronic nano-device, whereby their related products will ultimately change the way we live, work and communicate. Due to its typical structure and physical properties, it can be used in low energy computer display terminal, flat panel industry, super compact fuel cell batteries, as sensors, and catalyst as well. Also owing to its light weight and high strength, layers of carbon nano tubes can be used as electrodes to power a compact fuel cell for use in mobile devices enabling our cell phones and laptops to work for days without recharging.

**CNT'S as Superconductor**

Carbon nanotubes are not superconductors but they can carry a super current injected from a superconducting contact. Analysis of the tunneling spectra [8] of a nanotube connecting two superconductors reveals details of the bound electron-hole states that carry such a super current. The electrons in conventional conductors move individually, but superconducting electrons move in pairs. The energy needed to separate the paired electrons is known as the superconducting gap, which is an evidence of superconductivity in the system. Superconductivity would occur in nanotubes due to enhanced coupling between the phonons of crystal lattice and the electrons. Ping Sheng and his co-workers at the Institute of Nanoscience & Technology, Hong Kong ,China have observed superconductivity in 4A single walled carbon nanotubes (SWCN).These nanotubes have been observed directly by transmission electron microscopy as well as indirectly by diffuse X-ray
Carbon Nanotube Superconductors

scattering and micro Raman measurements of the nano tube-breathing mode. These tubes manifest superconductivity at 15 K (Fig.2). These can be used as powerful yet tiny logic chips in computers and have high potency as compared to conventional silicon chips.

Fig (2): Superconducting nanotubes inside zeolite pores (inset), against backdrop of zeolite crystals.

**Conclusion**

We conclude in our study that the unusual shape and size of carbon nanotubes give them a host of intriguing electronic properties, the most recently discovered one being superconductivity. Superconductive carbon nanotubes are just the kind of molecular components that engineers might someday use to shrink electronic devices to nearly unimaginable dimensions. The more experimental and theoretical studies in this field can throw a light on the very important compounds: carbon nanotubes. But in the absence of exact theoretical parameters and experiments, this research is still unbeatable.

**Future Scope**

These small-diameter nanotubes might be used as conducting wires or as the basic material for electronic components of nano sized electronic circuitry. If the carbon nanotube superconductor could be mass produced cheaply, it would revolutionize the electronics industry. For example, one battery could be made to last for number of years. In the future, people may look back at this basic research and compare it to the first discovery of fire.
References