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Conclusions

Carbon Nanotubes are expected to play a significant role in the design and manufacture of many nano-material devices in the future. Carbon Nanotubes exhibit many unique properties which generate strong interests in studying their applications. Some of these properties cannot be found in ordinary engineering materials used in our daily lives. Carbon Nanotubes are extremely strong materials and have good thermal conductivity and remarkable electrical properties. Therefore, it is very important to study the characteristic properties of Carbon Nanotubes.

The extraordinary characteristics give CNTs potential in numerous applications where strength, stiffness, toughness and conductivity are key properties.

There has been considerable practical interest in the mechanical properties and conductivity of CNT. Much work has been done on the study of its mechanical properties and reported as a function of growth parameter and its diameter.
CNTs can be conducting and highly conducting and hence can be said to be metallic. Their conductivity has been shown to be a function of their chirality (degree of twist), as well as their diameter. CNTs can be either metallic or semi-conducting in their electrical behavior.

In the present work, a series of CVD prepared multi-walled CNT are studied for their structure using Field Emission Scanning Electron Microscopy (FESEM), Raman spectroscopy, mechanical properties using Atomic Force Microscope (AFM) and their bulk electrical properties as there is considerable practical interest in its mechanical and electrical properties.

Raman spectroscopy experiments were done to study the degree of graphitization of CVD grown MWCNT. More than twenty samples grown at different growth parameters were chosen to characterize. Raman measurements were performed using green laser and data were recorded using CCD. Degree of graphitization for each sample was calculated from the area of the peaks of Raman curves.

To prepare samples of CNT to measure mechanical properties, first a patterned surface was developed using imprinting using CD pattern as a stamp and PDMS as soft surface. CD pattern having
strips of 1500 nm wavelength were transferred onto film of cross linked PDMS prior to curing. After stamping, the PDMS was cured by baking to retain pattern. On the other hand, very dilute solution of CNT in acetone was prepared using sonication and dispersed on the patterned surface with the help of micro syringe. Spinning of patterned surface was done just after putting the drop to spread the CNT. A number of samples were prepared to get at least a few hanging CNT, making bridge over the pattern. High magnification images were recorded to check if bridge like hanging structures are formed. It is also seen that these CNTs adhere on PDMS strongly and no slipping takes place when normal force is applied. Atomic Force Microscopy Spectroscopy technique was used to measure elastic constant of individual CNT. In AFM spectroscopy, stress is applied by the tip of known shape on the freely hanging CNT of known bridge length on patterned surface and deflection is measured. This is done by tracing force distance curves with the help of AFM cantilever of known tip radius. Tungsten tip of known shape and size was fabricated using Focused Ion Beam (FIB) instrument.

Bulk electrical conductivity was measured for few samples. To measure electrical conductivity of bulk material pallets were prepared using hydraulic press and LCR bridge was used to
measure DC conductivity. Out of twenty samples only five samples were selected for conductivity measurements.

Results of Raman analysis with elastic constant and conductivity are in good harmony. It is concluded that degree of graphitization increases elastic properties and also electrical conductivity.