Presented 93rd Indian Science Congress

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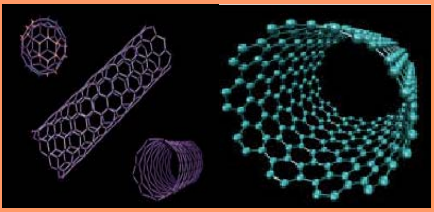
Influence of Nano Modification on Physical Properties of Polymer Composites

▪INTRODUCTION

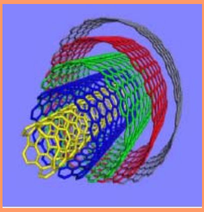
There are two main types of carbon Nanotubes that can have high structural perfection .

▪Single walled nanotubes (SWNT) consist of single graphite sheet seamlessly wrapped into cylindrical tube.

▪Multiwalled Nanotubes (MWNT) comprise an array of such nanotubes that are concentrically nested like rings.



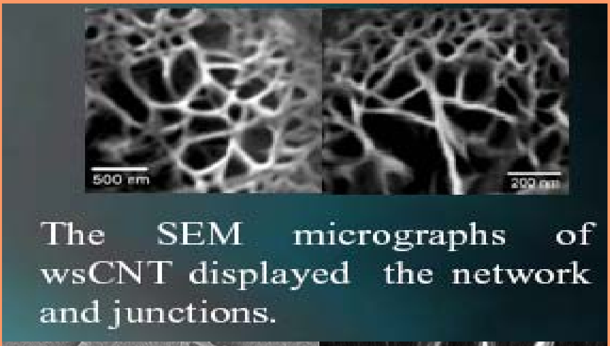
SWNT

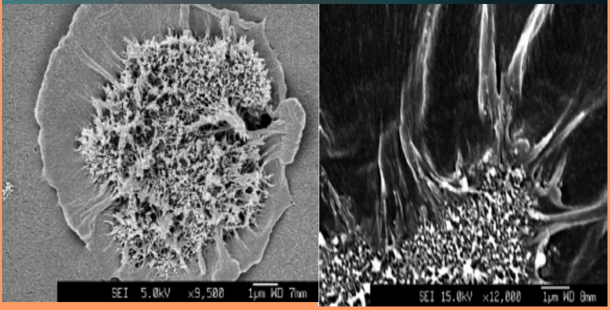


MWNT

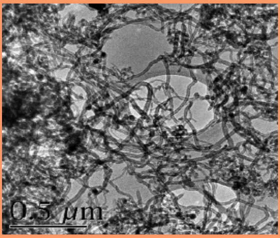
▪CHARACTERISATION

- ➢Scanning Electron Microscopy (SEM)
- ➢Transmission Electron Microscope (TEM)
- ➢Raman Spectroscopy
- ➢Atomic Force Microscopy
- ➢X-Ray Diffraction

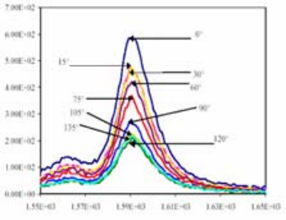




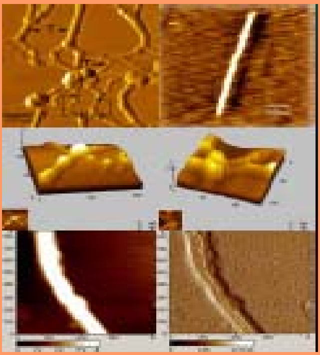
FESEM images of fracture surface of CNT-Polysterene composite



TEM MICROGRAPHS OF MWNTs

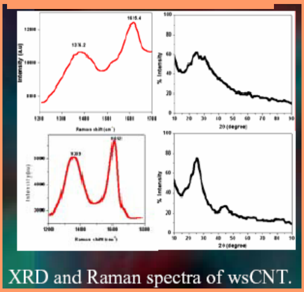


Raman spectrum from a 0.1 wt% SWNT polyimide fiber .



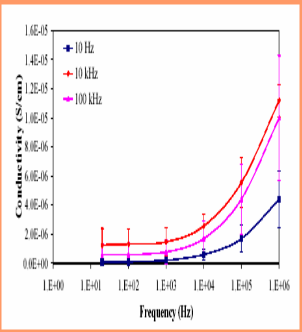
AFM images show the presence of CNTs

▪ Peaks of CNT could be detected from the spectra of polymer/CNT composite that serves as a direct confirmation of the successful filling of the polymers with the nanotubes.

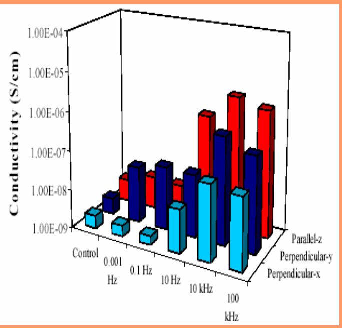


▪ENHANCEMENT IN PHYSICAL PROPERTIES:

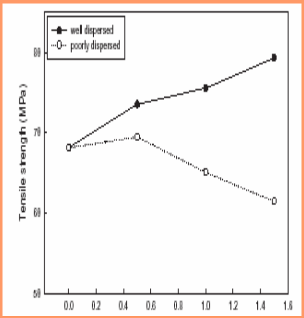
The conductivity, strength, elasticity, toughness, and durability of formed composites may all be substantially improved by the addition of nanotubes.



Increase in Conductivity parallel to aligned SWNTs with frequency.



Comparison of conductivity in directions parallel and perpendicular to SWNTs at 10KHz.



Tensile strength of well & poorly dispersed CNT epoxy composite with respect to CNTs Loading

By Dr. Smrutisikha Bal & Y. Nayak , N.I.T Rourkela

CNT Based Polymer Composites

▪Applications:

Polymers and polymer matrix composite materials are being utilized in an increasing number of industrial applications including transportation, automotive, aerospace, defence, sporting goods, energy and infrastructure sectors.

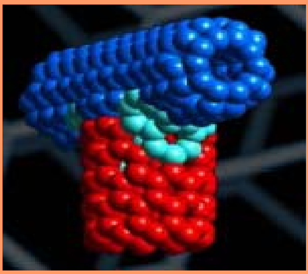


FIGURE OF NANO ENGINE

Fundamental Aspects of Dispersion :

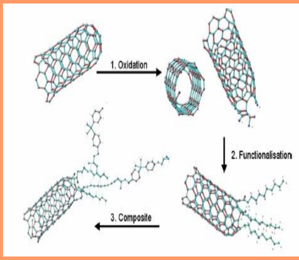
A good dispersion:

▪Makes more filler surface area available

▪Prevents aggregation of the filler action as stress concentrators

▪controls slippage of nanotube during composites loading, which all decrease the performance of the composites greatly .

Effect of Functionalisation



Schematic representation of functionalisation process

▪ **Step-1**

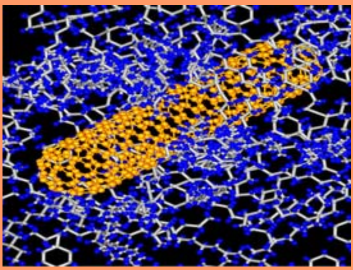
An oxidative treatment of the nanotubes is used to develop carboxylic groups that leads to an opening of the CNT cap , which would enable a direct bonding of the tube ends to the matrix via the carboxylic groups.

▪ **step-2**

The carboxylic groups would react with multifunctional amines and form bonds either ionic or covalent to these amines via an acid/base reaction.

▪**Step-3**

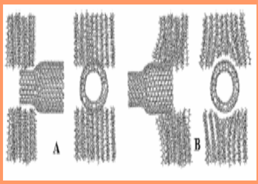
▪With the addition of the epoxy resin, the free amino functions on the surface of the CNTs will react with the epoxy molecules forming equivalent bonds, which lead to an improved nanotube matrix bonding.



POLYMERIC NANO-COMPOSITES

Limitations & Challenges:

A relevant question is, will the high modulus and strength predicted for nanotubes be really available when used as fillers?



A molecular model of a CNT embedded in polyethylene array. Extra energy is needed to pull the CNT through the 'interlock'.* A is point of entry *B is near-pullout position.

Factors to be resolved:

A good CNT/matrix interfacial bonding.

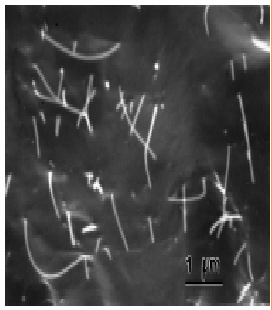
▪A perceptible reinforcement of the matrix with the nanotubes.

Methods of Dispersion

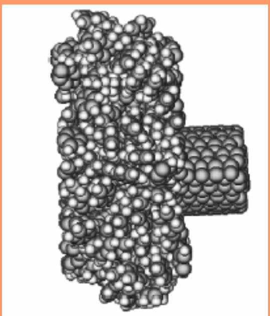
▪Sonication

▪Stirring

▪Shear Mixing



Distribution of the nano tubes through the resin



A Molecular Model of CNT matrix

Mechanism of load transfer

▪**Micromechnical interlocking**: This could be difficult in nanotube composites due to their atomically smooth surface.

▪**Chemical bonding between the nanotubes and the matrix**: This improves interfacial interaction through ionic or covalent bond that enables a stress transfer.

▪**Weak Vander Waals bonding between the fiber and the matrix:** Under no chemical bonding between CNT-polymer, the origins of CNT–polymer interactions are electrostatic and Vander Waals forces.

Conclusion

The chemical surface functionalisation of CNTs along with perceptible dispersion of nanotubes in the matrix are the key issues in developing CNT/polymer composites.

Future Scope

The factors like intratube load transfer in MWNTs and shearing in SWNT bundles are the central issues for the production of composites with exceptional mechanical properties. Despite of the obstacles in the development of nanotube- based composites, the good load transfer measured between a matrix and CNTs is very encouraging for the future. Now that these problems have been identified, we believe that solutions will be found for making CNT polymer composites in which the exceptional Young's modulus and strength of CNTs will be reflected in the overall physical properties.

References

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THANK YOU