Chirality Dependence of Elastic Properties of Supercarbon Nanotubes

P.A.G. Gunatilake[1,2] and S.R. Herath[1]

[1]Department of Civil Engineering, Faculty of Engineering University of Peradeniya
[2]Regional Support Centre (North Western Province), National Water Supply and Drainage Board, Kurunegala

Carbon nanomaterials are studied extensively among many nanoscale materials investigated during the last decade. Carbon nanotubes (CNT's) are linear fullerenes which can have aspect ratios as large as 10^3 to 10^5. After the discovery of Y branching of CNT's, attention now is on the hierarchical structures (Supercarbon structures) which can be made of Single Walled Carbon Nanotubes (SWCNT's). When SWCNT's are arranged to form a higher order structure, it is called a supercarbon nanostructure. The present study focuses on the versatile elastic properties of Supercarbon nanotubes (SCNT's) which can be mastered by changing various parameters such as geometry and chirality of constituent SWCNT's and the chiral index of the SCNT. A simple mechanics model is used to estimate the stiffness of these supercarbon nanotubes and the results agree well with previous studies on these structures using molecular dynamics modelling. It was found that in super carbon nanotubes with Y junctions, the length of the constituent SWCNT and its chirality, influence the elastic modulus, stiffness and its ultimate tensile strength. Further the study shows that the higher the length of SWCNT the lesser the elastic modulus. It was also seen that for a given length, L_0 ,and diameter, d, of SWCNT, the elastic modulus of the super nanotube turns out to be the same for both armchair and zigzag SWCNTs.

By manipulating atoms to form different structures, it is possible to obtain different geometries of nano-structured materials. These new materials can be mastered to have desired material properties in any range. Therefore, these can be used to make bullet-proof clothes and vehicles, high-strength composite materials, nano electromechanical devices (NEMS) etc. At the same time, these low density, flexible materials can be used in light weight composite structures..