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Analysis Of Electrical Capacitance Of Carbon Nanotube With Doped Ceramics

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Abstract:
Analysis of electrical capacitance of carbon nanotube material with doped ceramics is based on weak interaction on controlling the densities. The comparative electrical capacitance is viewed with the change in nanotube diameter as the variance of atomic integers (m, n). The virtual calculation has been done for the diameter of metallic carbon nanotube. Theoretical concept is carried on with doping concentration of ceramics. The storage of charge on ceramics induces the conduction in nanotube material. As a result, the capacitance of doped material increases. Since carbon nanotube materialhas least absorption coefficient so it does not produce heat energy as well as ceramics act as a supporting agent to continue the storing charge. Our aim is logically relevant towards the developing theoretical concepts as well as prediction of fabricating qualitative suitable capacitor to be used in electronic devices. The confirmation to the assumed facts is carried on virtually opted data depicted through the graphical variation in distance between the electrodes and capacitance.
Keywords: *Nanotube, ceramics, weak interaction*

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I. Introduction:

Carbon nanotube is the thinnest material ever increasing in the world based on rolled-up grapheme layers [1]. It has unique and remarkable properties to fascinate the world. The excellent mechanical properties of graphene are advantageous for all durable electronic applications.

In this present article it is also used the previous concept that the properties of nanotube change on change of structure. The structural properties vary in interaction and type of contact with change in diameter. Now-a-days materials are used by human beings in different form which can lead to the crucial race in quality and action. Ceramics is one of them pays as dielectric medium between the electrodes of a capacitor. ceramic dielectrics cover a broad area wih a relative permittivity 6 of to complex with ferroelectric compositions with relative permittivity exceeding 20000. As compare to lower –permittivity dielectrics ceramics have higher sensitivity to temperature, frequency and field strength. The article shows the capacitance of carbon nanotube with doped ceramics between the electrodes. If we use lead free ceramics such as La (ZrTi) $O3$[2], produces attractable feature and pollutionless effect.

However, the lead contained ceramics causes environmental pollution and generates instability of the constituent and electrical properties of the products.

II. Theory And Technique

The capacity of storing charge between the electrodes by decreasing the potential difference is the capacitance of a capacitor i.e.

Capacitance, $C = \frac{q}{V}$ ....(1)

Where, q is charge and V, the potential difference

The capacitance of a parallel plate capacitor, $C = \frac{\epsilon_0 \epsilon_r A}{d}$

'd' is the distance between the naonotube electrodes and A is area of the plate or,

$$C = \frac{\epsilon_0 \epsilon_r \pi r^2}{d}$$

$$= \frac{\epsilon_0 \epsilon_r \pi (\frac{d_t}{2})^2}{d}$$ where, d_t is the diameter of the nanotube

$$= \frac{\epsilon_0 \epsilon_r \pi}{4d} d_t^2 \quad \text{...(2)}$$

The nanotube diameter is given by

Since $dt = (□3/□)a_{c-c} \sqrt{(m^2+mn+n^2)}$

□ Where a_{c-c} is the distance between neighbouring carbon atoms in the flat sheet.

It means, □3/□=0.0783 nm i.e □3/□ is a symbol for basic nano scale

From equation (2) $C = \frac{\epsilon_0 \epsilon_r \pi}{4d} \left((□3/□)ac - c\sqrt{(m^2 + mn + n^2)} \right)^2$

$$C = \frac{\epsilon_0 \epsilon_r \pi}{4d} (□3/□)a_{c-c})^2 (m^2 + mn + n^2) \quad \text{.........(3)}$$

Here, we introduce a new constant $C_t = \frac{\epsilon_0 \epsilon_r \pi}{4d} (□3/□)a_{c-c})^2$

Placing the values $\epsilon_0 = 8.85 \times 10^{-12}$, $\epsilon_r = 20000$ (maximum value of ceramic medium)

$\pi = 3.14$, nanotube distance between the electrodes, $d = 3mm = 3 \times 10^{-3}$ m

Constant $C_t = 1.08 \times 10^{-14} = 10.8$ Famto order

From equation (3) $C = C_t(m^2 + mn + n^2)$..(4)

From this equation , the capacitance of nanotube using ceramic material medium for different values of integers m and n can be calculated.

Table 1

S.N.	CNT(m,n) m=n	$(m^2 + mn + n^2)$	C_t	$C = C_t(m^2 + mn + n^2)$
1	(1,1)	3	10.8×10^{-15}	32.4 Famto Farad= 0.324nF/cm^2
2	(2,2)	12		1.296 nF/cm^2
3	(3,3)	27		2.91
4	(4,4)	48		5.184
5	(5,5)	75		8.10
6	(6,6)	108		11.664
7	(7,7)	147		15.876
8	(8,8)	192		20.736
9	(9,9)	243		26.24
10	(10,10)	300		32.40

Table 2

S.N.	CNT(m,n) m≠n	$(m^2 + mn + n^2)$	C_t	C=$C_t(m^2 + mn + n^2)$
1	(1,2)	7	10.8×10^{-15}	0.756 nF/cm^2
2	(2, 3)	19		2.052
3	(4,5)	61		6.588
4	(6,7)	127		13.71
5	(8,9)	217		23.43
6	(10,11)	331		35.748
7	(12,13)	469		50.652
8	(15,16)	721		77.868
9	(17,18)	919		129.708
10	(23, 25)	1729		186.732

From the virtual data taken in table 1 and table 2, Graphical variations are plotted below:

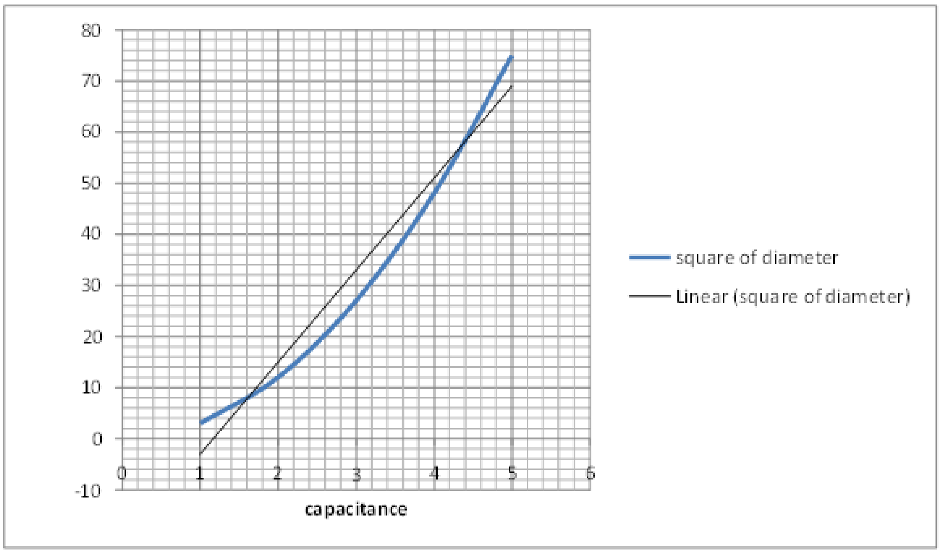

Fig.1 A Graph between Square of nanotube diameter and capacitance.

From Table 2

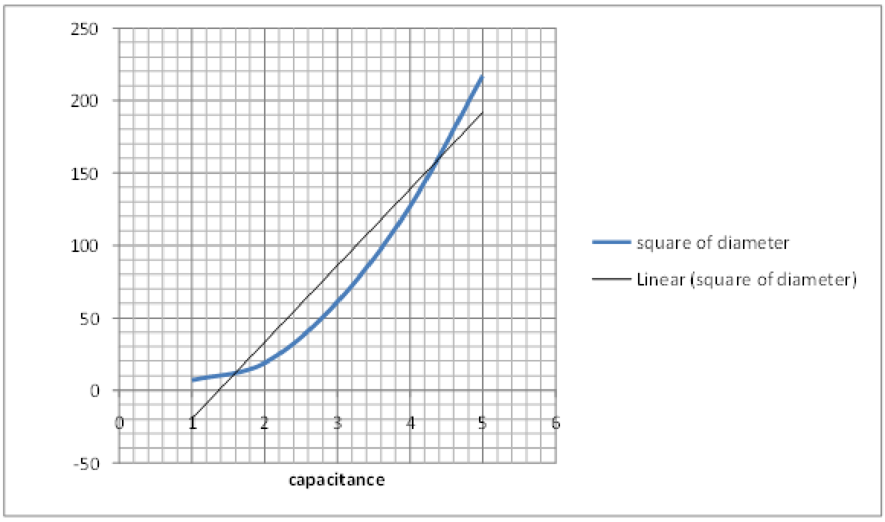

Fig.2 A Graph between Square of nanotube diameter and capacitance in different orders of integers m and n.

III. Result And Discussions

Both the graph 1 and 2 plotted establish a Relation between nanotube diameter and electrical capacitance in ceramic medium.

In fig.1 the capacitance increases with the same order of integer m and n almost linear up to a certain point and then curvature starts. In fig. 2 it is seen that capacitance rapidly increases in different orders of integers, leads to affirm that electrical capacitance increases as diameter of nanotube increases. The rapid increase in capacitance symbolizes the presence of ceramic material with nanotube as to why ceramics have high dielectric constant permits the charge storage. More over potential can be decreased fast so as to reduce the loss of energy.

IV. Conclusion

The whole description of the paper through the virtual calculations and results acquired led us to express the nature of carbon nanotube material with ceramics – electrical capacitance increases corresponding to nanotube diameter. It predicts that well electrical device can be fabricated which can be used in electrical circuits consuming less power leading to the longer durability.

V. Acknowledgement

We appreciate S.Iijima's work on 'helical microbules of graphitic carbon' Nature, vol.354, pp.56-58, 1999 and Ye, Zu-Guang's , Handbook of Dielectric, Piezoelectric and ferroelectric materials: synthesis, properties and application, CRC Press, 2008 inspired deeply to proceed and seek the new result and features.

References

[1] S.Iijima, 'Helical Microbules Of Graphitic Carbon' Nature, Vol.354, Pp.56-58, 1999

[2] Ye, Zu-Guang, Handbook Of Dielectric, Piezoelectric And Ferroelectric Materials: Synthesis, Properties And Application, CRC Press, 2008