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# Study of Carbon Nanotube and Their Multifunctional Applications for Nanoelectronics

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***Abstract: Recently the Multifunctional applications in the field of communications technology can be found in association with The Nanoscale Transistors, Semiconductor Flash Memory, Wave Interference Devices including Electronic Wave guiding and Quantum computing. Nanotechnology has become a broad and interdisciplinary research field. Nano-science is well recognized as a revolutionary step in various field of science and technology field of study for researchers in the coming years as it is, the study of fundamental principles of molecules of Nanomaterials and structures between one nanometer (one billionth of a meter) and 100 Nanometers in size. The carbon nanotube (CNT) is a hollow tube composed of carbon atoms. Its diameter averages tens of nanometers ($10^{-9}$ meters) and its length can vary from nanometers to centimeters ($10^{-2}$ meters). Since their discovery in 1991, carbon nanotubes have been widely experimented and analyzed, for their potential as important new material for future of micro-and nanoelectronics. In particular, there has been extensive parameters of research done on the suitability &Sustainable Development For using CNTs in transistor technology.Carbon nanotubes have the potential for future development in the field of electronics due to their unequal electrical properties of the transmission efficiency is studied for various parameters including length, thickness, width, and composition of the antenna as well as the wavelength of incident light. Modeling-based automated design optimization framework is developed to optimize nano-antennas.The electromagnetic model is integrated with and genetic algorithm and their electrical performance in two major directions carbon nanotube nanoelectronics in the nanoelectronics direction Nanotechnology has been developed in many areas over the decades, one of the most important areas of this technology is nanomaterials level, which plays an important role in wireless technology. Carbon nanotube networks in digital circuits, display applications, and printed electronics. In this part, we discuss the existing challenges and future directions of nanotube based nanoelectronics. We discuss to the performance of carbon nanotubes for digital circuits and circuits designed for radio-frequency their multiple applications for Carbon nanotube networks for wireless technology and communications System and nanotube based nanoelectronics.***

***Keywords: - Carbon nanotube (CNTs), Nanoelectronics, RF -antenna, Nanotechnology, Multiwall carbon nanotubes, Single-walled nanotubes.***

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## I. INTRODUCTION

Nanotechnology has been developed in many areas over the decades; one of the most important areas of this technology is Multifunctional communications level, which plays an important role in biomedical application [1-2]. Carbon nanotubes (CNTs) have emerged as a viable electronic material for molecular electronic devices because of their unique physical and electrical properties. Modern technology is characterized by its emphasis on miniaturization. In the last decades much has been put in electronic industry to decrease the size of electronic devices [3-4]. The smallest structures are today produced with electron-beam lithography. This fabrication method allows structuring of a solid into narrow wires of 30 to 50 nm width [5-6]. Although these wires are in the nanometer scale, they are composed of a large number of atoms, more than 1000 atoms in cross section. Since the size of the fabricated structures has been progressively decreased, one can ask when miniaturization of the electronic devices will reach its ultimate limit [7]. The ultimate limit is surely determined by the narrowest possible conducting wire, which is a chain of atoms. Fabrication and electrical contacting of such a system is very challenging. It implies the neccessity of manipulating single atoms [8]. Today it is possible to move atoms in a controllable manner with a tip of a scanning tunneling microscope (STM).the standards & emergence development in nanoelectronics have enabled and implemented of several areas of Electronics & Nanoelectronics for Understanding their behaviour & simulation performances. Because role of simulation is plays very important for understanding its behaviour. it has not yet been possible to place a chain of atoms between two reservoirs onto an isolating substrate [9].the most striking example is electronics, where remarkable technological progress has come from reductions in the size of transistors, thereby increasing the number of transistors possible per chip With more transistors per chip, designers are able to create more sophisticated integrated circuits For example, nanotubes have a lightweight and record-high elastic modulus, and they are predicted to be by far the strongest fibers technology that can be made. Their high strength and high flexibility are unique mechanical properties. Nanotechnology consist manipulations of living and non living organs & matter. Nanometer (nm) is one billionth of a meter. Nanoscience has enhanced its performance day by day including information technology, computing and communications system that analyse variety of task. It also has amazing electrical properties. The electronic properties depend drastically on both the diameter of the carbon lattice along the tube for several years, the study of nanotechnology has only focused on physical and chemical properties as well as the properties related to its size. However, at present more is focused on industry and application of nano-size particles The cell parts of the organism are the small particles Benefitting from the flexibility in engineering their optical response, metamaterials have been used to achieve control over the propagation of light to an unprecedented level, leading to highly unconventional and versatile optical functionalities compared with their natural counterparts. Recently, the emerging field of nanoelectronics which consist of photonic artificial atoms has offered attractive functionalities for shaping wave fronts of light by introducing an abrupt interfacial phase discontinuity. The phase discontinuity takes place when the helicity of incident circularly polarized light is reversed. Carbon nanotube research was greatly stimulated by the initial report of observation of carbon tubules of nanometer dimensions and the subsequent report on the observation of conditions for the synthesis of large quantities of nanotubes In particular, in several recent papers it has been suggested how nanoelectronics of different geometries may be employed as at optical frequencies. Bringing the antenna concepts up to the visible regime may indeed revolutionize wireless technology and communications, in terms of size reduction, speed and bandwidths of operation. The applications the field of Communications can be found in association with The Nanoscale Transistors, Semiconductor Flash Memory, Wave Interference Devices including Electronic Wave guiding and Quantum computing. Nanotechnology has become a broad and interdisciplinary research field .However, for different reasons the optical nanoantenna science is still in its early stage and the recent experiments on optical nanoantennas may be well compared with the first attempts performed by Hertz. In this context, we have recently proposed a general theory that may bring and utilize the concepts of input impedance, radiation resistance, and antenna loading and matching of optical nanoantennas, in order to translate the well known and established concepts of RF antenna design into the visible regime [10]. In particular, we have applied these concepts to the design and operation of nanodipoles consisting of a pair of closely spaced thin nanorods, recently, the feature size of semiconductor transistors has reached the nanometer regime following the scaling trend, Semiconductor Flash Memory, Wave Interference Devices including Electronic Wave guiding and Quantum computing. Nanotechnology has become a broad and interdisciplinary research field. The work of Hertz at the end of the nineteenth century is at the foundation of the modern antenna science and engineering, and therefore of an important part of nowadays wireless technology it has been growing exponentially in the past few years. The interaction of light with plasmonic nano-antennas is investigated. An extensive parametric study is performed on dipole nano-antennas [11]. the characteristics of of nanotube requires consideration, is the biological tags, where the interaction with biological target happens by biological coating or layer attached to nanoelectronics.Directions of nanotube-based nanoelectronics.We discuss to the performance of carbon nanotubes for digital circuits and circuits designed for radio-frequency their multiple applications for Carbon nanotube networks for wireless technology and communications System of nanotube-based nanoelectronics their applications for health. Electrical conductivity of CNT composites depends on the properties and loading of CNTs, the aspect ratio of the CNTs, and the characteristics of the conductive network.

## II. MULTIWALL CARBON NANOTUBES DYNAMIC CONDUCTIVITY

Dynamic conductivity of a carbon nanotube represents a macroscopic quantity relating the disturbance of electron flow along the nanotube due to an incremental temporal variation in the applied electric field along it. Carbon nanotubes (CNTs) have emerged as potential candidates for replacement of conventional metals due to their significant mechanical, electrical, and thermal properties and abilities CNTs have been of interest in nanoelectronics and nanoantenna applications since the density of CNT For conventional carbon nanotube structures, the length of the nanotube is much greater than its circumference. Thus, for most practical cases, it is assumed that the equivalent current along the surface of the nanotube is transversely symmetric and parallel to the axis of the nanotube. In the following analysis the geometry of the nanotube is assumed to be presented in cylindrical coordinate system, where the axis of the nanotube lies along the *z*-axis. Thus, the proposed dynamic conductivity in this case is the relation between the surface current density $J_z$ and the applied electric field $E_z$ .The applied field is presented as a time harmonic propagating wave along the axis of the nanotube as follows

$$E_z(z,t) = \mathrm{Re}\left(E_z^0 e^{j\omega t-\gamma z}\right) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 1$$

Where $E_z^0$ the amplitude of the incident field, $\omega$ is is the angular frequency and $\gamma$ is the complex propagation constant along the nanotube. This complex propagation constant is discussed in detail in Section 5. However, in the present case, the dependence of the electric field on *z* can be assumed to be constant by taking the limit where an incremental length.

However, the present case of the dependence in the electric field on *z* can be assumed to be constant by taking the limit where an incremental length of the nanotube is considered. Thus, for a very small part of the nanotube, the incident field is assumed to be $E_z(t) = \mathrm{Re}\left(E_z^0 e^{j\omega t}\right)$ ……………..2 this applied electric field introduces a disturbance in the electron distribution function along the nanotube. At equilibrium, the electron distribution function is given by

$$F(\mathbf{p}) = 1/\left[1+\exp\left(\mathrm{E}(\mathbf{p})/k_B T\right)\right].$$

 

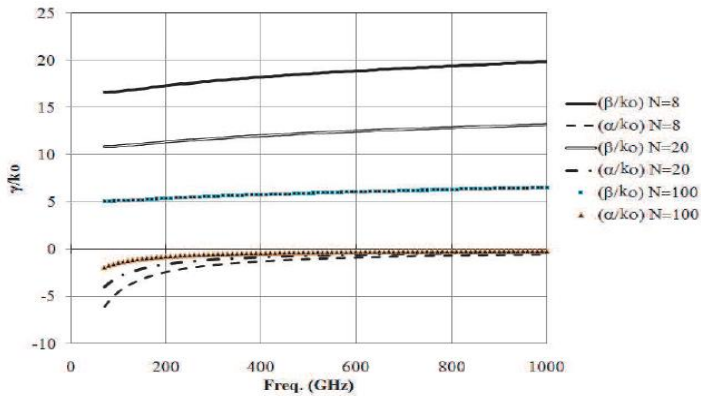


Fig.1. Surface wave propagation on carbon nanotube bundles of different method for electromagnetic formulation of the values of *N*. The bundle is composed of carbon nanotubes with lattice parameters $m = n = 40$ Figure 1 shows complex wave propagation constant of TM surface waves along a carbon nanotube circular bundle for different values of *N* where *N* is the number of carbon nanotubes this configuration, the radius of the nanotube is $rc = 2.7$nm. For a closely bundle & composed of *N* carbon nanotubes arranged in a single circular shell the radius of the bundle is in the bundle. The present results are based on armchair carbon nanotubes of $m = n = 40$. For it can be noted that the attenuation coefficient increases by decreasing the operating frequency as shown in Figure 1. The effect of this attenuation coefficient is **very** negligible in the range of frequency from 100 to 1000 GHz. On the other hand, this attenuation coefficient has a significant effect in the frequency band below 100 GHz.

## III. CARBON NANOTUBE FOR ANTENNA PROPAGATION

Carbon nanotube can also be a good candidate for antenna structures simulations. The Slow wave property of electromagnetic propagation along with carbon nanotube is expected that to play an important role in reducing the size of resonant carbon nanotube antenna. From the mathematical propagation point of view, carbon nanotube antennas can be treated as an antenna composed of finite-conducting cylinders. In this case the dynamic conductivity derived in Section is used to include the electrical properties of carbon nanotube in the mathematical modeling of the corresponding antenna structure. This electromagnetic formulation can be presented in any form like integral equation, finite difference or finite element of the integral equation. Applications for simple wire antenna configuration, electric field integral equation method may be the most used & appropriate method for electromagnetic formulation. We would focus on this method in the following part of this section. This electromagnetic formulation can be presented by in any form like integral equation, finite difference or finite element. However, for simple wire antenna can be configuration by using electric field for integral equation method may be the most appropriate method. Thus we would focus on this method in the following part of this section. For the case of a simple dipole antenna oriented and along with the z axis, the relation between the excitation field and the current distribution can be presented by integral equation as follows:

$$\int_{-L}^{L}\left(\frac{e^{-jk_0\sqrt{(z-z')^2+r^2}}}{\sqrt{(z-z')^2+r^2}}+\frac{1}{Z_0\sigma_{zz}r}e^{-jk_0|z-z'|}\right)I(z')dz' = C\cos k_0 z - j\frac{4\pi\omega\varepsilon_0}{2k_0}\sin k_0\,|z-z_0| \quad \ldots\ldots\ldots\ldots\ldots 3$$

## IV. CARBON NANOTUBES FOR RF CIRCUITS APPLICATIONS

Carbon nanotubes make them competitive elements in many RF applications. New fabrication techniques can be used to synthesize and electrically contact single carbon nanotube up to nearly 1 cm. In addition using solubilised carbon nanotube and dielectrophoresis can be used to accumulate hundreds to thousands of carbon nanotubes in parallel. This wave velocity reduction is due to the additional kinetic inductance and quantum capacitance in the equivalent circuit model of the nanotube transmission line circuit. In this case the wave velocity along the single-wall carbon nanotube transmission line has the same order of Fermi velocity which is nearly 8 x 105 m/s. This means that the wave velocity in this case is nearly two-order less than free space wave velocity. Thus the wavelength along the single-wall carbon nanotube transmission line is nearly two-order smaller than free space wave length. These parameters make carbon nanotube transmission line is not suitable for microwave applications from the point of view of characteristic of impedance of carbon nanotube transmission line.

## V. SINGLE-WALLED NANOTUBES

The growth of SWNTs with a narrow diameter distribution by the arc-discharge and the laser-ablation techniques requires and critically depends on the composition of the catalyst. By classical molecular-dynamics simulations using realistic many-body carbon–carbon potentials it was shown that wide nanotubes, which are initially open, continue to grow maintaining the hexagonal structure. However, nanotubes narrower than a critical diameter of about 3 nm, grew curved with pentagonal structures, which lead to tube closure. First-principles molecular-dynamics simulations show that the open-end of small diameter SWNTs close spontaneously at experimental temperatures of 2000–3000 K into a graphitic dome with no residual dangling bonds. The reactivity of the closed nanotube tips was found to be considerably reduced compared to that of open-end nanotubes. It was concluded that it is unlikely that SWNTs could grow by sustained incorporation of carbon atoms on the closed hemifullerene-like tip. The synthesis of nanotubes with small diameters 1.4 nm requires catalyst and it is necessary to clarify the role of the catalyst in the nanotube growth. There are plausible suggestions for the explanation of the catalytic growth but for the time being it has not been Single-walled nanotubes the growth of SWNTs with a narrow diameter distribution by the laser-ablation techniques requires and critically depends on the composition of the catalyst. By classical molecular-dynamics simulations using realistic many-body carbon–carbon potentials it was shown that wide nanotubes, which are initially open, continue to grow maintaining the hexagonal structure. However, nanotubes narrower than a critical diameter of about 3 nm, grew curved with pentagonal structures, which lead to tube closure. First-principles molecular-dynamics simulations show that the open-end of small diameter SWNTs close spontaneously at experimental temperatures of 2000–3000 K into a graphitic dome with no residual dangling bonds. The reactivity of the closed nanotube tips was found to be considerably reduced compared to that of openend nanotubes. It was concluded that it is unlikely that SWNTs could grow by sustained incorporation of carbon atoms on the closed hemi fullerene like tip. The synthesis of nanotubes with small diameters there are plausible suggestions for the explanation of the catalytic growth but for the time being it.

## VI. KEY APPLICATION AREAS OF CARBON NANOTUBES IN FIELD OF NANOSCIENCE

The above discussed findings that carbon nanotubes are ballistic, one-dimensional conductors that can operate in the quantum capacitance limit and can be utilized to create novel devices such as the band to band tunneling transistor are the key for the author’s conclusion about CNTs’ particular usefulness for low-power device applications. Combining the intrinsic advantages of carbon nanotubes in future generations of devices and circuits is believed to be the most beneficial application since nanotubes (and nanowires) can operate as transistors; it is natural to discuss their properties as interconnects, as well. As transistors, we have predicted that the frequency can be in the THz range. However, this is only possible if the parasitic capacitances can be minimized. One way to do this is to use nanotubes and nanowires themselves as the interconnects. Therefore, the RF properties are of some technological importance. While our model below is formulated for single-walled metallic nanotube, it should be approximately correct for semiconducting nanotube as well. In the presence of a ground plane below the nanotube or top gate above the nanotube, there is electrostatic capacitance between the nanotube and the metal. Due to the quantum properties of systems, however, there are two additional components to the ac impedance: the quantum capacitance and the kinetic inductance. The equivalent circuit of a nanotube consists of three distributed circuit.

“Nano” in mathematical terms means $10^{-9}$.A nanometer refers to a scale of measurement that is a billion times smaller than a meter. The height of an average person falls just short of two billion nanometers ($10^{-9}$ ). Biological cells, the building blocks of living Organisms are thousands of nanometers across in diameter. A DNA molecule is about 2.5 nanometers wide. Individual atoms can be up to a few tenths of a nanometer in diameter of Modern electronics is termed microelectronics because, decades ago, a manipulation on the micrometer ($10^{-6}$ m) scale was the technological limit. The nanotechnology of today refers to engineering on scale that is 1000 times’ smaller technology.

## VII. CARBON NANOTUBES APPLICATIONS IN MEDICAL SCIENCE

Recent developments in various forms of carbon nanostructures have stimulated research on their applications in diverse fields. They hold promise for applications in medicine, drug and gene delivery areas in medical science. For instance, carbon nanotubes have the potential to carry drugs in the organism as they are hollow and much smaller than the blood cells. The methods were developed for attaching DNA and protein molecules to the inside and outside of the nanotubes. This gives one the ability to target and destroy individual cells that may be cancerous or infected by a virus.Nanotubes with attached enzymes might, in the long term, be used as enzymatic biosensors that could simultaneously detect and measure a variety of biological molecules. Carbon nanotube arrays a play a key role in the artificial development. It has been established that growing of the carbon nanotube requires use of small metal catalyst particles

(~5- 100 nm). Usually 3d metals (Fe, Co, Ni) or their combinations with other metals are very effective as catalysts. Biologically –inspired computing emulation of human and biological reasoning functions of Carbon nanofibers grow through or from the surface of such metal catalyst particles. A combination of carbon nanotube and the magnetic, metal catalyst particles may allow one using carbon nanotubes for the magnetically guided drug delivery purposes. A successful application of such a nanotube magnetic nano particle combination depends on the physical, chemical and biological properties of the material. The particles must be biologically inert and biodegradable, they must have high sorption capacity, the sorption selectivity must be adjustable and convenient binding with antibodies must be possible and high magnetization and magnetic susceptibility in the relatively weak magnetic fields should also be achievable (particularly if such particles are designed for the guided drug delivery). Iron particles with combination of different carbon nanostructures meet all these requirements. Therefore, they are likely candidates for medical applications. Proposed medical applications of the carbon nanotubes require pure nanotube material. However, it has been established that beside nanotubes, the reaction product contains a mixture of different carbon forms, such as amorphous carbon (which covers the nanotubes), multi-shell carbon, as well as metal catalyst residues. The impurities affect the properties of the carbon nanotube reaction product and make its application problematic. Therefore, a controlled synthesis of different kinds of carbon nanotubes, their purification and the property modification became a very important object of materials research investigations.

## VIII. NANOELECTRONICS

Nanoelectronics made of tiny components took a leap forward with the molecule and sized of transistors and logic gates with developing of Bio- Chip for high through put signal. The using cell for analysis of specific single. These basic devices are important for developing for Sophisticated tiny-device and Chip .That will be faster & Cheaper and more powerful than any other existing materials /thing. Nanoelectronics consist on optical, electron-beam Lithography implantation and that allow generating structures on the scale of one micrometer.

## IX. NANOWIRES &ITS FUNCTIONAL APPLICATIONS

The nanowires have two quantum Confined directions to develop faster intra-device communication techniques. Even in current microscale, reading the value from every single pixel can take a relatively long time. The size of nanowires are large enough (>1 nm) The use of very high density arrays of nanoscale will only worsen this problem while still leaving one unconfined direction for electrical conduction to overcome this limitation of new intra-device communication technologies are necessary. In particular, in our vision, allows nanowires to be used in applications for electrical conduction there is a need to understand the impact of using internal wired interconnections based on quantum nanoelectronics and quantum transport mechanisms as well as internal wireless communication through grapheme plasmonic antennas and optical nano-antennas. Because of their unique density of electronic states, nanowires in the limit of small diameters are expected to different optical electrical and magnetic properties of crystal structures related to their parent materials that allowing theoretical predictions of their properties to be made on the basis of of applications .This will have an impact not only in nano-cameras and nanophones, but also on current micro-devices.eg.(MRAM) with its dependent transportation property based on nanoscale films has advantages of nano-volatility &its integrity is high and reliability is also high power the consumption is low access speed and radiation is strong &its applications for smart cell phone , Digital camera ,digital system

## X. NANOELECTRONICS IN BIOMEDICAL& SOPHISTICATED BIOCHIP

The use of Nanoelectronics and nanotechnology for the detections of Bio nano-molecules .It has a range of bio- chips for biomedical diagnosis by harnessing the self Assembly properties of biomolecules are constructed for nanoscale components.there is creation of novel applications for the creations of Nanoelectronic devices such as biosensor systems . It has Applications in new field for the attachment of bio- molecules/Biomedical in parterns.the Biochips will allow faster and better sensation in a time in critical situation. Biotechnology consisting of variety of techniques including the use of living organisms & their manipulation.

## XI. CONCLUSION

Many applications of nanotechnology introduce enhancement in field of technology e.g. where the nanotechnology is in the scale of node on a computer chip or a nanometre thin films in data storage devices such as hard disks.CNTs are new materials with the report of the major developments in both the basic research and the industrial application of the carbon nanotubes & nanoelectronics, which are to be reviewed. For their potential as important for future of micro-and nanoelectronics. In particular, it has been extensive research done on the suitability of using CNTs in transistor technology.Carbon nanotubes have the potential for future development in the field of electronics due to their unequal electrical properties of the transmission efficiency is studied for various parameters including length, thickness, width, and composition of the antenna as well as the wavelength of incident light. The theoretical & Experimental efforts are directed for the understanding of nanoelectronics, characteristics that are as good as or better than other devices, and have significant improvements.

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