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RECENT TRENDS IN NANO TECHNOLOGY

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ABSTRACT
In this paper detailed discussions are introduced for possible applications of Nanotechnology and Nano-materials in the field of RF, Microwave, Superconductivity, Spintronics, Optical and Biomedical applications. The proposed discussion includes different Nano materials and wide range of proposed applications based on above. On the other hand, recent developments in Nano sciences and Nanotechnology have created tremendous enthusiasm among researchers and scientists across the globe. The rapidly increasing interest among various engineering disciplines toward research and development needs the Nanodomain that have spurred the growth in areas such as Energy Applications, Nano-electronics.

Keywords: *Biotechnology & Health Delivery System and Commerce in general.*

I. INTRODUCTION
Basic nanostructures of interest include carbon nanotubes, graphene plates, nanowires and nanocomposites. Carbon nanotubes consist of graphene layers wrapped to cylinders. Graphene (which is stronger than steel, more electrically conductive than copper, and able to transmit electrical signals with an amazing rapidity) could be a candidate for the material to make faster and more powerful electronics. Sure there are challenges and issues to bring it into high volume production; fortunately carbon-based electronics is an active area of research. On the other hand engineered nanowires are 50 to 100nm in diameter and 1μm to 10cm in length. Nanowires are now being developed that performs ferroelectric, dielectric, or sensor functions in nanoelectronics. Semiconductor nanowires can transport electrons and holes, hence, they can function as building blocks for Nano scale electronics. Metal nanowires can be used to transmit photons. In Nanocomposites the components are mixed at the nanoscale, resulting in materials that often have properties that are superior to conventional microscale composites and, at the same time, can be synthesized using simple and inexpensive techniques. If we go on to the field of superconductivity, Nanotechnology combined with superconductivity could pave the way for 'Spintronics'. Nano photonics or Nano-optics is the study of the behavior of light on the nanometer scale, and of the interaction of nanometer-scale objects with light.

II. NANOTECHNOLOGY IN RF AND MICROWAVE
Carbon nanotubes are nanometer-diameter cylinders of a graphene sheet wrapped up to form a tube. Graphene is a graphite monolayer with a thickness of only one carbon atom of a diameter 0.34 nm. They can be wrapped as a single layer which is known as single wall carbon nanotube (SWCNT) or multi-layer which is known as multi-wall carbon nanotube (MWCNT). Carbon nanotubes are competitive elements in many RF applications like high frequency transistor, AM demodulator, matched load, transmission lines and antennas. If we go on to the interaction of electromagnetic wave with carbon nanotube, the ac conductivity of these carbon nanotubes are characterized by negative imaginary part compared with conventional conductors like copper. This negative imaginary part corresponds to an inductive effect. This inductive effect is due to the stored kinetic energy in the carbon nanotube structures. This kinetic inductance is found to be much larger than the traditional magnetostatic inductance of transmission line section. This property has two main effects on electromagnetic wave propagation along the carbon nanotube transmission line; slow wave propagation and high characteristic impedance. The wavelength of single wall carbon nanotube transmission line is much smaller than free space wave length. This property can be of great importance in reducing the size of antenna and passive circuits. However, these additional inductance and capacitance introduce high characteristic impedance of order 12.5 kΩ. In addition, the single well carbon nanotube transmission line is connected to metallic pads at its two ends. This connection introduces an additional ohmic contact resistance of order 3.2 kΩ. To reduce the characteristics impedance of carbon nanotube transmission line, carbon nanotube bundles were introduced. This carbon nanotube bundle is a set of parallel single wall carbon nanotube [1] [12].

Carbon Nanotubes in Microwave and RF Passive Circuits RF Nano-switches based on vertically aligned carbon nanotubes consists of carbon nanotube perpendicular to the substrate. Two different architectures are proposed for this carbon nanotube switch; series-based switch using ohmic contact between carbon nanotubes and a capacitive-based switch implemented in shunt configuration. RF ohmic switch is designed by implementing carbon nanotubes in two sides of a coplanar waveguide discontinuity. By applying dc voltage an electrostatic force is introduced between the two arms of the carbon nanotube switch. This electrostatic closes the switch and the RF signal is transmitted across the coplanar aveguide. Other RF and microwave applications like switches, filters and resonators can also be obtained by using electromechanical propertied of carbon nanotubes. It is found that carbon nanotube has a mechanical resonance in the frequency range from 1 to 3 GHz with quality factor of 1000. The resonance of this filter is controlled by the value of the applied dc voltage [1].

Carbon Nanotube Antennas It is assumed that the antenna is simply a flared part of a transmission line section where the wave travels approximately with the same velocity on it. . This wave velocity on the carbon nanotube transmission line equals nearly the Fermi velocity in carbon nanotube. Here the wave velocity would be slightly affected by the flaring since it depends only on the variation of the capacitance effect which is sensitive to the log of the distance between the two arms. Thus, based on this assumption, they showed that a lossless carbon nanotube of length 150μm would be resonant at 10 GHz which corresponds to the half plasmonic wave length at this frequency [4]. The performance of bundled carbon nanotubes as a conducting material for the fabrication of half-wave strip antennas in the terahertz frequency range is being analyzed. It is found that by decreasing the number of nanotubes in the bundle the resonant length is decreased. However, the antenna efficiency is also decreased due the impedance mismatch [1]. Another approach for using carbon nanotubes in antenna technology is based on developing flexible E-textile conductors on polymer-ceramic composites. E-textile conductors are fabricated with single wall carbon nanotube and Ag coated textiles. The combination of E-textile conductors and polymer-ceramic composites is an excellent candidate for flexible antennas and microwave passive circuits. E-textile fabrics coated with carbon nanotubes and sputtered with gold/silver particles for improved conductivity [5][6].

Carbon Nanotube Microwave Transistors and Active Devices In the latest review of the most recent developments on nanotechnology in RF and THz electronics, based on the equivalent circuit model of a SWCNT (Single wall carbon nanotube transistors) transistor, it is predicted that a cutoff frequency of THz should be achievable. This prediction is based on the calculated capacitance and measured transconductance [7]. Other interesting configurations for active component based on CNT are cold cathode THz vacuum tubes which were proposed by the National Aeronautic and Space Administration (NASA) Jet Propulsion Laboratory (JPL). An example of these THz vacuum tubes is a monolithic 1.2-THz nano klystron circuit which uses CNTs as electron emitters and silicon-based reflex klystron type cavities [8][9].

Graphene Transmission Lines and Passive RF components Graphene is a flat monolayer of carbon atoms tightly packed into a two-dimensional honeycomb lattice. Graphene is a basic building block of graphite, quantum dotes and carbon nanotubes. The carbon-carbon bond length in grapheme is about 0.142 nanometers. Graphene sheets stack to form graphite with an interplanar spacing of 0.335 nm, which means that a stack of three million sheets would be only one millimeter thick. Grapaene nanoelectronics is an emerging area of research. Graphene differs from most conventional three-dimensional materials. Intrinsic graphene is a semi-metal or zero-gap semiconductor. It is interesting to note that the conductivity of the graphene sheet is anisotropic tensor and it can be controlled by applying electrostatic and magnetostatic biasing field. This property introduces the possibility of developing new applications which cannot be obtained by conventional conducting materials of fixed conductivities. This anisotropic tensor conductivity of magnetically biased graphene sheet can be used to introduce Faraday rotation. Thus magnetically biased graphene sheet can be used to rotate the polarization of a normally incident plane wave [1]. Main drawback associated with CNT transmission lines in microwaves is that their impedance is greater than 10kΩ. Thus these materials are difficult to match with the 50kΩ required by microwave circuit equipment.

Therefore, graphene may be a viable solution to replace the single wall CNT thin film, which consists of thousands of nanotubes, the total number of which is difficult to control. Graphene is not only a unique material for its electrical properties devices but also find astounding applications in the area of Nano Electromechanical (NEMS) devices due to its huge Young modulus. Graphene is a very efficient RF-NEMS switch for microwave applications [2].

Graphene Transistors and Active Components In THz applications of graphene, a single graphene barrier is a switch with a very high on off ratio, which has a large differential negative resistance beyond 1 THz in the I-V characteristics of a graphene barrier. The negative differential resistance can be used to generate monochromatic signals of high frequencies, up to the THz region. It is possible to introduce stimulated emission from graphene sheet at terahertz frequencies by Plasmon excitation of the graphene. The graphene strip in this case acts as the plasmon cavity. The Plasmon in population inverted graphene can experience extremely large gain through the process of stimulated emission at terahertz frequencies. The large gain values and the small plasmon wavelengths can lead to compact terahertz plasmon lasers and amplifiers that are only a few microns in size [3].

III. FIBER OPTIC NANOTECHNOLOGY

Whenever we deals with optical fibers, we typically think of optical propagation through waveguides of dimensions greater than or similar to the optical wavelength. Nanotechnology has spawned new areas of research for fiber optics, namely fiber optic nanophotonics. Nano photonics or Nano-optics is the study of the behavior of light on the nanometer

scale, and of the interaction of nanometer-scale objects with light. Nanophotonics is an exciting new field of nano-science that deals with the interaction of light with matter on a micro/nanometer size scale. It is a field in which photonics merges with nanoscience and nanotechnology, providing challenges for fundamenta research and creating opportunities for new technologies and applications. Metals are an effective way to confine light to far below the wavelength. This was originally used in radio and microwave engineering, where metal antennas and waveguides may be hundreds of times smaller than the freespace wavelength. For a similar reason, visible light can be confined to the nano-scale via nano-sized metal structures, such as nano-sized structures, tips, gaps, etc. This effect is somewhat analogous to a lightning rod, where the field concentrates at the tip.
Hollow Core Fiber One of the more promising avenues for nanotechnology in fibers has been use of photonic band gap effects to confine light in a hollow core fiber. Such designs provide a number of intriguing optical properties, including: ultralow optical nonlinearity, excellent power handling capabilities, low latency, and even the prospect of ultralow loss. These unique properties cannot be achieved in conventional solid optical fiber. Importantly, they point to a host of exciting application opportunities in telecommunications and high optical power delivery, as well as in new areas such gas based linear/nonlinear optics and particle guidance [12]

Photonic Crystal Fiber In a different design space, adding holes to the cladding of solid-core fibers allows modification of modal properties and offers great flexibility in fiber design. This has been exploited in many directions, such as (a) to decrease the mode-field size to enhance nonlinear effects, such as for super continuum generation, (b) to increase the mode-field size to avoid nonlinear effects for applications such as high power fiber lasers, and (c) to reduce the bend loss of fibers for telecommunications applications, such as in-home wiring [12].

Microscale And Nano Scale Photonic Devices Beyond altering waveguide propagation, nanotechnology has also created a platform for the manipulation of light in devices and novel structures. Perhaps the simplest example is miniaturization of optical fibers, i.e., optical micro- and nanowires. Such nanowires were fabricated by adiabatically tapering a fiber and preserving the original fiber dimensions at the input and output, thereby allowing ready splicing to standard fibers and fiber components. Tapers allow facile coupling and nanowire manipulation without the expensive instrumentation typical of the nano world [12].

IV. NANO SUPERCONDUCTIVITY

Nanotechnology combined with superconductivity could pave the way for 'Spintronics'. As the ever-increasing power of computer chips brings us closer and closer to the limits of silicon technology, many researchers are betting that the future will belong to "Spintronics": a nanoscale technology in which information is carried not by the electron's charge, as it is in conventional microchips, but by the electron’s intrinsic spin. If a reliable way can be found to control and manipulate the spins, these researchers argue, Spintronics devices could offer higher data processing speeds, lower electric consumption, and many other advantages over conventional chips--including, perhaps, the ability to carry out radically new quantum computations. After the introduction of giant magnetronics i.e. the dependence of the electrical resistance on the magnetization orientation of neighboring layers, “spin valve” had been introduced with two metallic magnetic layers separated by a nonmagnetic spacer. Shortly thereafter, room temperature magnetic-field sensors had been made from spin valves which were superior to previous state-of-the-art devices. Out of a field treating the effects of magnetic fields on electronic transport was rapidly born a field focusing on spin-dependent electronics, which came to be called “Spintronics”. The new field of Spintronics is born in the intersection of magnetism, electronic transport, and optics. It has achieved commercial success in some areas and is advancing toward additional applications that rely on recent fundamental discoveries. The field is sufficiently broad that there is no single central obstacle to the application of these fundamental physical principles to new devices [11].

V. BIOMEDICAL APPLICATIONS

Advances in nanofabrication techniques are opening a wide array of highly sophisticated biomedical applications for magnetic nanoparticles. These different applications are used in vitro and in vivo, depending on the relationship between size, shape composition of magnetic, nanoparticles, magnetic fields and biological systems [10].

In Vitro Applications Of Magnetic Nanoparticle For in vitro applications of magnetic nanoparticles, several biotechnological approaches have been developed in the past. An molecular biological diagnostic procedure which becomes more and more important is bio magnetic separation. In this approach magnetic nanoparticles bound to a ligand (i.e. antibodies) can be used to target cells, DNA or bacteria. After binding of the ligands the targets can he separated by the use of **an** external magnetic field. A medical approach of the bio magnetic separation technique which becomes standard is Magnetic cell separation for in vitro diagnosis in cancer patients. Disseminated tumor cells in the peripheral blood of cancer patients can he detected by the use of super paramagnetic Nano-spheres and an automated magnetic cell separation [14] [15].

In Vivo Applications Of Magnetic Nanoparticle For in vivo application magnetic nanoparticles are incorporated or coated by different materials to receive biocompatibility. Several approaches were developed for in vivo diagnostics and therapeutics. A continual challenge in medicine is to deliver therapeutic agents to specific body compartments without harming healthy tissue. Therefore different carriers like magnetic micro particles, magneto-liposomes or magnetic iron oxide nanoparticles are used. Magneto-liposomes, colloidal particles consisting of a lipid layer are also recognized as useful drug delivery carriers due to their controllable size and membrane properties, their large capacity for carrying various agents and their biocompatibility. Furthermore thermo sensitive magneto-liposomes can be also used for local hyperthermia in cancer treatment. Whole body hyperthermia in combination with chemotherapy is a very common approach in cancer treatment. Another possibility to achieve local hyperthermia with magnetic particles is the use of magnetic iron oxide particles which can be heated up to over 40 degrees centigrade by an alternating magnetic field after intralesional injection. Super paramagnetic iron oxide particles were also used as contrast agent in Magnetic Resonance Imaging for lymphography in tumor bearing rabbits. A new class of particles i.e. lipid coated micro bubbles. Micro bubbles are spherical cavities stabilized by different coatings like phospholipids or synthetic polymers [10].

VI. CONCLUSION

Nanotechnology introduces a new revolution in a wide variety of RF, Microwave, Optical and Biomedical applications. These applications include passive and active circuit components, antennas, filters, transmission lines, resonators. Different nanostructures represent new excellent candidates for these applications with extra features compared with conventional materials. These nanostructures can be divided into two main categories; carbon-based nanostructures and non-carbon nanostructures. Carbon-based nanostructures like carbon nanotubes and graphene sheets have interesting electrical properties which make carbon seems to play the same role of silicon. On the other hand, non-carbon nanostructures like gold, silver or zinc oxide nano particles have important properties of focusing fields in optical and infrared range. These properties are known as plasmoincs properties due to the interaction of electron gas in the crystals of these materials with electromagnetic fields in this spectrum range. These nanostructures can be used individually as in the case of field effect transistors, nano-antennas or nano-transmission lines. The success of particle development and the application in biomedical system is a factor of the interdisciplinary work that is involved. The collaboration in the fields of material science, magnetic characterization, physics, medical electronics, chemistry, cell engineering and testing as well as clinical trials are necessary to gain new successful research results.

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