Binary Collision with Energetic Ions of Carbon Nanotubes

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Abstract— From various sources on processing technologies, its expect that processing accuracy will reach the order of nano-meters in the twenty-first century. This speaks strongly for an urgent need to develop and improve nanotechnology methods in several special branches of the industry like: nanoelectronic, magnetic storage and other essential computer network devices. The field of enhancing carbon nanotube-structure science and technology has been growing very rapidly in the past few years, since the realization that creating new materials and devices so that nano-scale building blocks could access new and improved properties and functionalities. Irradiation of carbon based nanotubes creates new fields in material sciences [1]. One of the most attractive candidates for futer-generation electronics field are carbon based nanotubes (for example single-walled carbon nanotubes (SWNTs): like other transistors also this tube) because flowing current along the tubes can be controlled by an external electric field [2].

Carbon nanotubes (CNTs) are very interesing technological branch. Due to their low dimensionality, nanometer size and remarkable electronic, mechanic and magnetic properties (nanotubes are promising structures for many purposes in several fields of physics, materials science or biomedicine) [3]. Channeling of energetic ions through solids is a phenomenon which should be accounted for in the present day semiconductor technology, as it gives rise to deeper implantation and less lattice disorder. The channeling effects are particularly important for materials with high crystallization and anisotropic atomic structure [4] (for example 4×10^{16} ions/cm^2).

1. INTRODUCTION

While many aspects of the field existed well before nano-structure science and technology became a definable entity in the past decade, it has only become a coherent field of endeavor through the confluence of three important technological streams [5]: 1. New and improved control of the size and manipulation of nano scale building blocks 2. New and improved characterization (spatial resolution, chemical sensitivity, etc.) of materials at the nano scale 3. New and improved understanding of the relationships between nano-structure and properties and how these can be engineered Hence using nano-technology in electronic devices may solve some of problems like: 1. The size of the devices 2. The performance of the devices 3. The fabrication problems of the devices 4. The price problems, Fabrication, Marketing Nano-technology was initially proposed to provide a concrete target accuracy for fabrication processes which involve ultraprecision surface and finishing (ultra- fine mirror cutting, various kinds of energy beam processing using photon electron, and ion beams). Materials-processing in nano-technology thus consists mainly on: 1. High-precision cutting with diamond tools of low wear 2. Fine lapping and fine polishing using fine abrasives.

The invention of nano-technology was the legendary proposal of the Nobl Prize winner wonderful and respectable scientist Richard Feynman from 1957; "There is a lot of space at the bottom". Some of the most important key fields of nano technology are [6]:

1. Electronics and communications, quantum structure electronic devices for memory and data storage, displays, optoelectronics, photonic crystal structures, (longer term) quantum information technology. Nano-sized magnetic particles facilitate small mass storage devices with capacities at multi-terabit levels, such as single electron memory [7].
2. Tissue engineering, medical implants and devices.
3. Instrumentation, tools and metrology, tools for top down manufacture e.g. high resolution and soft lithography, nanometrology.
4. Sensors and actuators; integrated nanosensor systems capable of collecting, processing, and communicating massive amounts of data with minimal size, weight, and power consumption [6, 7].
5. Nanostructured materials, smart composites, catalysis, biosensors; because biosensors are under intense development for a wide range of applications, from medical diagnostics and environmental developments [8].
6. Nanomaterials for functional interfaces.

The top-down approach, which uses techniques like photo-lithography and etching, has already been used to make so-called micro-electromechanical systems (MEMS); such systems are commercially available and have components on length scales of several microns (the acceleration sensors in airbags being a well-known example) and what to do now is shrink these systems even further to create true nano-electromechanical systems, or NEMS [9].

As dimensions reach the atomic scale, the manufacturing processes are trying to manipulate individual molecules Forces (like van der Waals and London force, which is due to a net electrostatic attraction between the electron distribution of one atom and the positive nucleus of the other) and interactions between individual molecules then become significant, and new paradigms have to come into play, Bottom-up techniques involve manipulating individual atoms and molecules (bottom-up nano usually implies controlled or directed self-assembly of atoms and molecules into nano structures) . Faster computers, advanced pharmaceuticals, controlled drug delivery, biocompatible materials, tissue repair, surface coatings, better skin care and protection, catalysts, sensors, optical communications, magnetic materials and devices — these are just some sectors of the economy where nanotechnology will have an impact.

2. CARBON NANO TUBE

Continuously improving device performance in the silicon industry has been largely achieved by downsizing device dimensions. However, this approach will soon meet scientific and technical limitations. CNTs are attractive as a solution to the forthcoming fabrication barrier. They are about 1 nm in diameter, a few micrometers in length, and are attractive semiconducting materials with a band gap of 0.5 to 1.0 eV, high mobility and large current carrying capability, and a direct band gap It is well documented that carbon nanotubes (CNTs) have excellent electrical properties both as metals and semiconductors. They can act as one-dimensional ballistic conductors at room temperature as well as Field effect transistors (FETs) with performance comparable to that of silicon FETs. Basic logic circuits have been formed by coupling such devices [10]. Moreover, nanotubes have extraordinary mechanical strength and high thermal conductivity. Recently, new functionalities of nanotube devices have been demonstrated experimentally, e.g. gate-controlled IR electroluminescence from FETs and singlewall carbon nanotubes are outstanding candidates for novel electronic applications [11].

3. ION IMPLANTATION

Experiments on the irradiation of carbon nanotubes with energetic particles poses many interesting properties. These effects may potentially be used in various practical applications, such as nanoelectronicdevices (The CNs are characterized by a high Youngs modulus and varied electronic properties) [12, 13].

Carbon nanotubes (CNTs) are one of the possible building blocks for electronic devices in the transition phase from traditional silicon-based microelectronics towards the fewnanometer regime. Remaining problems in integrating CNTs to the existing technology is the low reactivity of the CNT walls which leads to low conductance between CNTs and the other components. Because recent studies have shown that ion irradiation can be used to modify both the electrical and structural properties of CNTs, we propose that it could also be possible to use ion irradiation with low energies to enhance the conductance of these connections [14].

Table 1: Calculated wave.

f_v	[THz]	0.24	0.48	0.72	0.96
-	-	1.2	2.4	12	24

Ion implantation is one of the main processes used for the fabrication of modern integrated microelectronic devices, and it allows controlled doping of the active regions [15]. The stopping of high velocity light ions in matter usually assumes two major simplifications in stopping theory: (1) the ion is moving much faster than the target electrons and is fully stripped of its electrons, and (2) the ion is much heavier than the target electrons [16].

Also important study done in channeling of heavy ions with keV energies through the wallof carbon nanotubes (for more see) [1, 4, 12, 13].

4. MODELING ENERGY AND WAVE LENGTH

The equation of Heisenberg are used to simplify the behavior of the energy andWave length of an Energetic particles.

$$\triangle\chi \cdot \triangle\tau \geq h \tag{1}$$

in the same manner we can write the above equation in relation to the energy as

$$\triangle\tau \cdot \triangle E \geq h \tag{2}$$

and through substitution of variables and Frequency assumption as a new variable as f_v the equation changed to new relation as

$$\triangle f_v^{-1} \cdot \triangle(\mathbf{e} \cdot \mathbf{V}) \geq h \tag{3}$$

By supplying the Equations (1), (4), (3) with different wave length with different particles for optimal results and in with SWNT and MWNT at constant trigger angle (hitting angle); assuming $\theta = 30$.

5. CHALLENGE OF CHARGE TRANSPORT

The measurement of charge transport in molecules and the determination of their conductance are important goals. Such measurements are experimentally challenging and intriguing because one can test the validity of transport approximations at the molecular level. A conceptually simple configuration would be to connect a single molecule between metallic contacts. Such a metal-molecule-metal configuration would present the molecular embodiment of a system analogous to a quantum dot, with the potential barriers of the semiconductor system being replaced by any existing contact barrier of the molecule-metal interface [17].

6. SUMMERY

The interaction of heavy ions with matter has become the area of intensive concentration both experimentally and theoretically . Effective and successful applications of ion beam technology require detailed qualitative knowledge of different interaction processes. The stopping power or stopping force of any medium for different ions constitute information essential for ion-beam science and its applications. The interaction mechanism of energetic heavy ions with matter are well known at the present time, but no appropriate theoretical or semi-emperical formulations exist to calculate the stopping power of various materials for a variety of different isotopes with varying energies [18]. Irradiation of carbon NTs with energetic particles can be used for nanoengineering, e.g., for creating molecular junctions between the NTs, making NT-based quantum dots and composite materials with enhanced mechanical properties [19].

Single-Walled Carbon Nanotubes (SWNTs) have been attracting substantial interest as potential building blocks of chemical and biological sensors and future integrated circuits.

SWNTs are graphene cylinders with a wall thickness of one atomic layer and a diameter of about one nanometer. They have very exciting properties such as high aspect ratio, large surface area and hollow geometry, high current carrying capacity, superior thermal properties, fast response and good reversibility. These properties present nanotubes as viable candidates for sensing applications, such as gas sensors, pressure sensors, transistors, and thermal sensors [20].

Hence one of the most significant potential applications of single-walled nanotubes is believed to be in the domain of nano-electronics.

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