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MANIPULATION OF MATTER AT NANOSCALE

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***Abstarct*— Nanotechnology is the engineering of functional systems at the molecular scale. Nanotechnology is the manipulation of matter at a molecular or atomic level in order to produce novel materials and devices with new extraordinary properties. However, nanotechnology is not a new discipline. It is rather the merging of multiple scientific disciplines (biology, physics, chemistry, medicine and engineering) and the combination of knowledge to tailor materials at the nanoscale; approximately in the range of 1-100 nanometers (10^{-9} m). Nanotechnology is closely related to Nanoscience, the basic theoretical and experimental study of matter at the nanoscale before applying the acquired knowledge for device manufacturing. But the question is why Nanotechnology is so innovative and revolutionary? The answer lies in quantum mechanics. The behavior of matter changes significantly when the surface area to volume ratio increases so dramatically. Classical physics no longer control the behavior of the material which is now under the control of quantum laws. This fact gives the nano-structured material new abilities and properties that may be more favorable than the ones of the bulk material version. A good example is that some polymers, although being insulators in the bulk form, they become semiconductors at the nanoscale. Nanotechnology is the engineering of functional systems at the molecular scale. This covers both current work and concepts that are more advanced. In its original sense, 'nanotechnology' refers to the projected ability to construct items *from the bottom up,* using techniques and tools being developed today to make complete, high performance products.**

***Key words*—atom,quantum,nanoscale,lighter,faster.**

I INTRODUCTION

Basic definitions

Definition – What is nanotechnology? Truly revolutionary nanotechnology products, materials and applications, such as nanorobotics, are years in the future (some say only a few years; some say many years). What qualifies as "nanotechnology" today is basic research and development that is happening in laboratories all over the world. "Nanotechnology" products that are on the market today are mostly gradually improved products (using evolutionary nanotechnology) where some form of nanotechnology enabled material (such as carbon nanotubes, nanocomposite structures or nanoparticles of a particular substance) or nanotechnology process (e.g. nanopatterning or quantum dots for medical imaging) is used in the manufacturing process. In their ongoing quest to improve existing products by creating smaller components and better performance materials, all at a lower cost, the number of companies that will manufacture "nanoproducts" (by this definition) will grow very fast and soon make up the majority of all companies across many industries. Evolutionary nanotechnology should therefore be viewed as a process that gradually will affect most companies and industries.

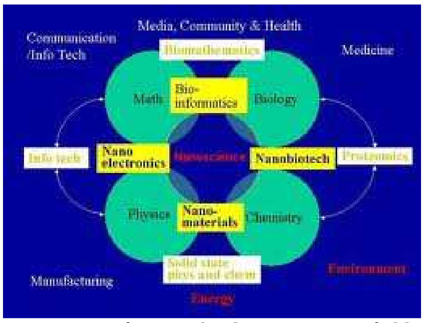

Fig 1 Impact of nanotechnology on various fields.

Example: The biological and medical research communities have exploited the unique properties of nanomaterials for various applications (e.g., contrast agents for cell imaging and therapeutics for treating cancer). Terms such as biomedical nanotechnology, nanobiotechnology, and nanomedicine are used to describe this hybrid field. Functionalities can be added to nanomaterials by interfacing them with biological molecules or structures. The size of nanomaterials is similar to that of most biological molecules and structures; therefore, nanomaterials can be useful for both in vivo and in vitro biomedical research and applications.

"Nano" – From the Greek word for "dwarf" and means 10-9, or one-billionth. Here it refers to one-billionth of a meter, or 1 nanometer (nm). 1 nanometer is about 3 atoms long. **"Nanotechnology" –** Building and using materials, devices and machines at the nanometer (atomic/molecular) scale, making use of unique properties that occur for structures at those small dimensions. How small is a nanometer? (and other small sizes) Start with a centimeter, A centimeter is about the size of a bean. Now divide it into 10 equal parts. Each part is a millimeter long. About the size of a flea. Now divide that into 10 equal parts. Each part is 100 micrometers long. About the size (width) of a human hair. Now divide that into 100 equal parts. Each part is a micrometer long. About the size of a bacterium. Now divide that into 10 equal parts. Each part is a 100 nanometers long. About the size of a virus. Finally divide that into 100 equal parts. Each part is a nanometer. About the size of a few atoms or a small molecule. Most consider nanotechnology to be technology at sub-micron scale: 1-100's of nanometers. Exact definition of nanotechnology is not clear

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Why is Small Good?-Because it is Faster Lighter, Can get into small spaces, Cheaper, More energy efficient,

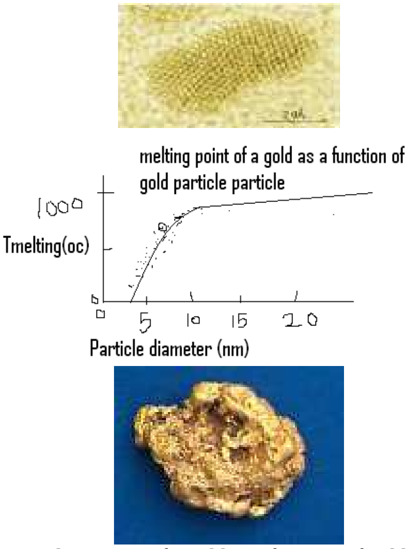

Fig-2 melting point of a gold as a function of gold particle

II GRAPHS SHOWING EXPERIMENTAL RESULTS

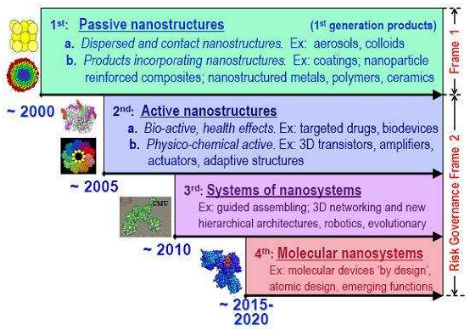

Fig 3, nanotechnology can refer to measurement or visualization at the scale

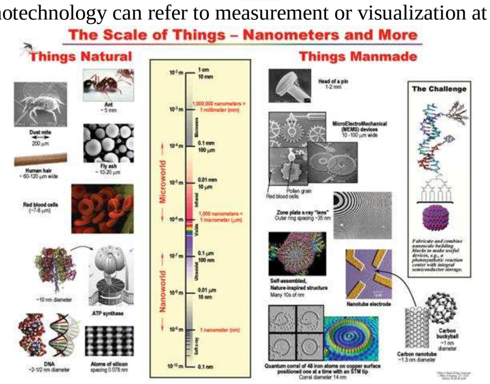

Fig 4 , Introduction to Nanotechnology Structures. Now that you have an idea of how small a scale nanotechnologists work with, consider the challenge they

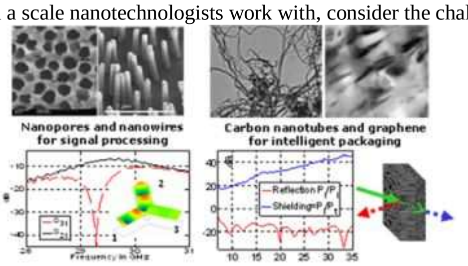

Fig 5 ,Micro and Nano Technologies and Systems

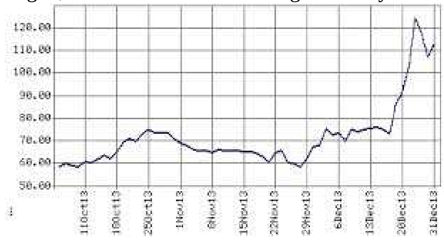

Fig 6, 3 Month Graphene Nano Share Price Graph

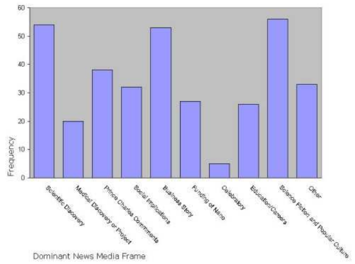

Fig 7, Nanotechnology in the news

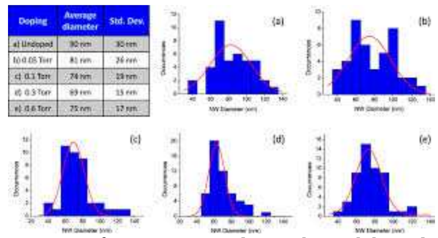

Fig 8, Gaussian fitting is reported in each graph by red curves.

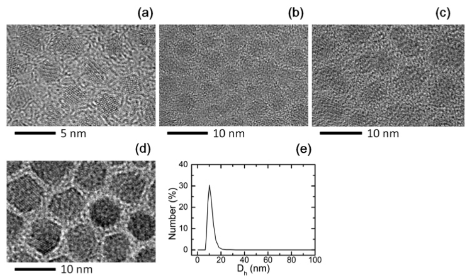

Fig 9 ,e) A typical DLS graph of the Fe3O4 nanoparticles in (d).

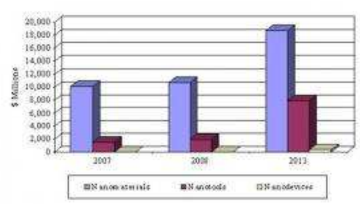

Fig 10, GLOBAL NANOTECHNOLOGY MARKET, 2007-2013

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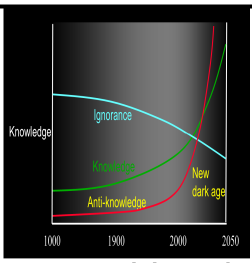

Fig 11, Knowledge Graph

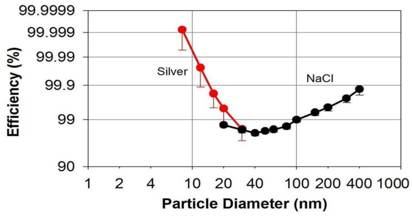

Fig 12, Efficiency graph

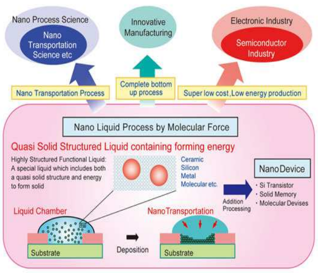

fig 13, research for fabrication of nano electronic devices .

Fundamental concepts: Nanotechnology is the engineering of functional systems at the molecular scale. One nanometer (nm) is one billionth, or 10−9, of a meter. By comparison, typical carbon-carbon bond lengths, or the spacing between these atoms in a molecule, are in the range 0.12–0.15 nm, and a DNA double-helix has a diameter around 2 nm. On the other hand, the smallest cellular life-forms, the bacteria of the genus Mycoplasma, are around 200 nm in length. By convention, nanotechnology is taken as the scale range 1 to 100 nm following the definition used by the National Nanotechnology Initiative in the US..**Two main approaches are used in nanotechnology.** In the **"bottom-up"** approach, materials and devices are built from molecular components which assemble themselves chemically by principles of molecular recognition. In the **"top-down"** approach, nano-objects are constructed from larger entities without atomic-level control.

(i)Bottom-up approaches These seek to arrange smaller components into more complex assemblies. DNA nanotechnology utilizes the specificity of Watson–Crick basepairing to construct well-defined structures out of DNA and other nucleic acids. Approaches from the field of "classical" chemical synthesis (inorganic and organic synthesis) also aim at designing molecules with well-defined shape (e.g. bis-peptides

(ii)Top-down approaches These seek to create smaller devices by using larger ones to direct their assembly. Many technologies that descended from conventional solid-state silicon methods for fabricating microprocessors are now capable of creating features smaller than 100 nm, falling under the definition of nanotechnology. Giant magnetoresistance-based hard drives already on the market fit this description, as do atomic layer deposition (ALD) techniques.

(iii)Functional approaches These seek to develop components of a desired functionality without regard to how they might be assembled. Synthetic chemical methods can also be used to create synthetic molecular motors, such as in a so-called nanocar.

(iv)Biomimetic approachesBionics or biomimicry seeks to apply biological methods and systems found in nature, to the study and design of engineering systems and modern technology.

III TOOLS AND TECHNIQUES OF NANO TECHNOLOGY

Typical AFM setup. A microfabricated cantilever with a sharp tip is deflected by features on a sample surface, much like in a phonograph but on a much smaller scale. A laser beam reflects off the backside of the cantilever into a set of photodetectors, allowing the deflection to be measured and assembled into an image of the surface.There are several important modern developments. The atomic force microscope (AFM) and the Scanning Tunneling Microscope (STM) are two early versions of scanning probes that launched nanotechnology. There are other types of scanning probe microscopy. Although conceptually similar to the scanning confocal microscope developed by Marvin Minsky in 1961 and the scanning acoustic microscope (SAM) developed by Calvin Quate and coworkers in the 1970s, newer scanning probe microscopes have much higher resolution, since they are not limited by the wavelength of sound or light. The tip of a scanning probe can also be used to manipulate nanostructures (a process called positional assembly). Feature-oriented scanning methodology suggested by Rostislav Lapshin appears to be a promising way to implement these nanomanipulations in automatic mode. However, this is still a slow process because of low scanning velocity of the microscope. Various techniques of nanolithography such as optical lithography, X-ray lithography dip pen nanolithography, electron beam lithography or nanoimprint lithography were also developed. Lithography is a top-down fabrication technique where a bulk material is reduced in size to nanoscale pattern.Another group of nanotechnological techniques include those used for fabrication of nanotubes and nanowires, those used in semiconductor fabrication such as deep ultraviolet lithography, electron beam lithography, focused ion beam machining, nanoimprint lithography, atomic layer deposition, and molecular vapor deposition, and further including molecular self-assembly techniques such as those employing di-block copolymers. The precursors of these techniques preceded the nanotech era, and are extensions in the development of scientific advancements rather than techniques which were devised with the sole purpose of creating nanotechnology and which were results of nanotechnology research.

IV EXAMPLES

Example-1: There are numerous natural nanomaterials around us and in this example, two very common materials, gelatin and milk, are two of these nanomaterials. Milk, as we know, is white and its appearance is connected to the presence of numerous proteins which are selfassembled in specific nanostructures, called casein micelles, 50–300 nm in size. When milk is heated and an acid such as vinegar is added, this molecular organisation is disrupted and milk agglomerates and a 'curd' precipitate forms. Interestingly, if the same procedure is carried out using cold milk, only thickening occurs, no precipitate is formed. This is due to the fact that the stability of casein micelles in milk is due to both electrostatic and hydrophobic interactions: therefore, depending on the degree of disruption of these interactions different effects are obtained. Overall, the experiment will show how appearance (colour, odour) and function of a material such as milk is profoundly connected to its molecular supra-organisation (nanostructures). By altering this organisation, new materials are obtained (in the example of milk processing, these are cheese, yogurt, etc.). This is a fundamental concept of nanoscience.

RESULT: Existence of natural nanomaterials: gelatin and milk as examples of natural colloids. Light interaction with colloids .Protein self-assembly into nanostructures Relationship between the 'macro' properties (colour, smell, taste, consistency) of milk and its molecular structure and how these can be manipulated to obtain different products (cheese, yogurt, etc.)

THIS EXAMPLE TEACHES ABOUT NANOTECHNOLOGY? TWO FUNDAMENTAL CONCEPTS. Structure means appearance: materials in the 'real' natural world, such as milk, appear as they do because of the fine nanostructures they possess. Milk is white because it contains colloidal nanoparticles (micelles). If the structure of these micelles is altered, some of the 'macro' properties of milk such as the **colour** and **odour** will be changed. **Structure means function:** natural materials have very specific functions which are dictated by the fine supra-organisation of their molecules (nanostructures). If this structure is altered, a material with a new function can be produced. In cheese production, altering the casein micelles through specific processes (e.g. chymosin treatment or lactic acid bacteria fermentation) leads to different products (cheese, yogurt, etc.).

This is exactly the concept of nanotechnologies

EXAMPLE-2: There are **hundreds of examples of nanoscience under our eyes daily**, from geckos that walk upside down on a ceiling, apparently against gravity, to butterflies with iridescent colours, to fireflies that glow at night. Liquid crystals (LCs) are an example of **self-assembled molecules** that are sensitive to external factors, such as temperature, and that change their assembly as a consequence of these variations. The effect in some types of liquid crystals is a change of colour. This experiment will show two fundamental concepts: (a) that the way a material behaves at the macroscale depends on its structure at the nanoscale; and (b) that the nanoscale, liquid crystals are self-assembled molecules that organise themselves into nanostructures which have specific optical properties.

RESULT:Understanding of concept of self-assemblyUnderstanding that the way a material behaves at the macroscale is affected by its structureat the nanoscale Learning about liquid crystals and how they work Testing a real thermotropic liquid crystal and see how its colour changes with temperature Creating a liquid crystal thermometer **Therefore, this colour change is a direct consequence of a change in the self-organisation of the liquid crystal molecules.**

The molecules in a liquid crystal are often shaped like rods or plates or some other forms that encourage them to **align collectively along a certain direction**

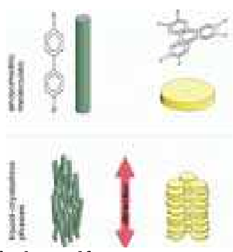

Figure 1: Examples of the self-organisation of anisometric (i.e. with asymmetrical parts) molecules in liquid-crystalline phases:

(left) rod-like molecules form a nematic liquid, in which the longitudinal axes of the molecules are aligned parallel to a common preferred direction (director); (right) disc-like (discotic) molecules arrangedinto molecule-stacks (columns), in which the longitudinal axes are also aligned parallel to the director. As a result of their orientational order, liquid crystals exhibit anisotropic physical properties, just like crystals.

A liquid crystal is formed by the self-assembly of molecules into ordered structures, called phases. An external disturbance, such as a change in temperature or magnetic field, even very small, can induce the liquid crystals to assume a different phase. The molecules in liquid crystal displays, for instance, are reoriented by relatively weak electrical fields. Different phases can be distinguished by their different optical properties (**Figure 2**).

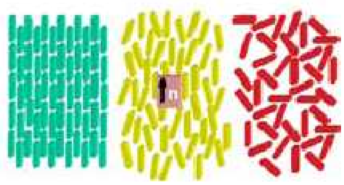

Figure2: Schematic representation of molecules in a solid (left, molecules are well organised);

in a liquid crystal (centre) molecules have a long range distance order); and in a liquid (right) molecules are not

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ordered **Liquid crystals (LCs) are divided into three groups: thermotropic liquid crystals** consist of organic molecules, typically having coupleddouble bonds, and exhibit a phase transition as temperature is changed (**Figure 3, left**),

lyotropic liquid crystals consist of organic molecules, typically hydrophilic (water-loving) and exhibit a phase transition as a function of both temperature and concentrationof the liquid crystal molecules in a solvent (typically water) (**Figure 3, right**),

metallotropic liquid crystals are composed of both organic and inorganic molecules,and their liquid crystal transition depends not only on temperature and concentration but also on the organic-inorganic composition ratio.This example, shows study the properties of a **thermotropic liquid crysta**l meaning that its properties change with changes in temperature..

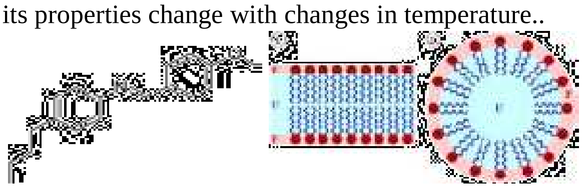

Figure 3:Figure 3: (left) Chemical structure of N-(4-methoxybenzylidene)-4-butylaniline (MBBA);

(right) structure of lyotropic liquid crystal: (1) is a bilayer and (2) is a micelle (the red heads of the surfactant molecules are in contact with water, whereas the tails are immersed in oil (blue).

VI. CONCLUSION

In this paper some examples and it results shows how nano science is used in different fields.how nano technology is superior to previous. Nanotechnology research can contribute to solving future needs for energy technologies, especially in new generations of solar photovoltaics, the hydrogen economy, more efficient conventional energy production and energy saving for industry as well as consumers.

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