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Nanotechnology and Forensic Science

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Abstract- Nanotechnology is a fundamental, enabling technology, allowing us to do new things in almost every conceivable technological discipline.

Introduction

Nano means small but of high potency, and emerging with large applications piercing through all the discipline of knowledge, leading to industrial and technological growth. As the prefix nano indicates extreme smallness. In other words nano-sized structure needs to be magnified over 10 million times before we can easily appreciate its fine detail with the naked eye. Nanotechnology is already having its impact on products as diverse as novel foods, medical devices, chemical coatings, personal health testing kits, sensors for security systems, water purification units for manned space craft, displays for hand-held computer games, and high-resolution cinema screens. Nanotechnology is expected to have an impact on nearly every industry. Over the last few years nanotechnology has emerged as the science of all things small, more specifically, 'nano'. Nanotechnology is a catch-all phrase for materials and devices that operate at the nanoscale. In the metric system of measurement, "Nano" equals a billionth and therefore a nanometer is one-billionth of a meter. The nanometre scale runs from 1 to 100 nm.To put that scale of measurement into perspective, a nanometre is 1/80,000 of the diameter of a human hair. To appreciate the size, a human red blood cell is over 2,000 nanometers long, virtually outside the nanoscale range! Materials of this size display unusual physical and chemical properties caused by many factors including the increase in surface area compared to volume which occurs as particles get smaller.References to nano materials, nanoelectronics, nano devices and nanopowders simply mean the material or activity can be measured in nanometers. Nanotechnology is a multidisciplinary science that has its roots in fields such as colloidal science, device physics and supra molecular chemistry. Nanotechnology refers to technologies in which matter is manipulated on the atomic and molecular scale to create novel materials and processes. It is not just the study of the very small; it is the practical application of that knowledge. There are two main routes of entry to the nano-world. Molecular manufacturing involves the manipulation of individual atoms (working from the bottom up); and ultra-miniaturization results in smaller and smaller devices (building from the top down). The development of nanotechnology as the latest mega trend in science and engineering which will bring a wave of radical innovation and perhaps, because of its potentially broad impact, spark new industrial revolution in various application areas. Nanotechnology has the potential to change every part of our lives. It affects all materials: ceramics, metals, polymers, and biomaterials. New materials are the foundation of major technological advances. In the coming decade nanotechnology will have an enormous impact. Future advances could change our approaches to manufacturing, electronics, IT and communications technology making previous technology redundant and leading to applications which could not have been developed or even thought

about, without this new approach. Current commercial applications include:

Sunscreens which use nanosized zinc oxide particles to absorb and reflect UV rays. This makes lotions transparent and smooth as opposed to sticky and white which will therefore make it more appealing to the consumer.

Self cleaning windows are coated with a material which has unique chemical properties. When the sun shines on these windows, a chemical reaction is triggered which breaks down dirt. Rain, instead of forming droplets, will spread evenly over the panel and wash away the broken down dirt. The thickness of this layer is controlled at the nanoscale.

Stain repellent fabrics are made by immersing rolls of woven cotton fabric in liquids containing trillions of nanotech fibres. The cotton is then dried in an oven, binding the tiny fibres to the cotton threads. The cotton appears to be unchanged but is, in fact, impermeable to liquid.

Bouncy tennis balls are coated in nanosized material. A molecular barrier is formed by the tiny particles that trap air molecules making the balls extra bouncy.

Forensic Applications

Forensic Science Laboratory (FSL) is multi disciplinary institutions doing highly specialized sophisticated analytical work. The prime role of FSL is to provide unbiased scientific evidence to investigating agencies and in turn to the judiciary system. Criminal activities have come to stay for long. The nature of crime has drastically changed. It has neither geographical boundaries, nor technical limitations. Terrorists activities, Drug trafficking eco-crimes, high profile crimes, Robbery hit and run cases, building collapse, petroleum products adulteration are some of the latest forms of crimes. Security issues today are many. They include protecting citizens and state from organized crime, detecting unsolved crimes and preventing terrorist acts. In many cases, forensic evidence is key to obtain a conviction and often only very small quantities of forensic material are found on a suspect.

Nanotechnology plays an important role in addressing current concerns. It can be applied to forensic trace evidence analysis, include-

i) Post Blast Explosive residues Analysis – In bomb blast incidents fragmentation of explosives occurs and very traces of unfragmented explosive residues remain at the spot. Nano techniques can be applied for identification of unfragmented trace explosives.

ii) Gun shot residue analysis- Microscopic particles of gunshot residues are often present on the hands of a shooter, following discharge of a firearm. Nanotechnology can be applied for detecting the GSR. For example, in a murder case the accused was found with only two particles of gunshot residue in his coat pocket.

iii)DNA Analysis- In murder, rape cases DNA analysis of blood stains, hairs, fibres simen can be carried out.

iv)Physical clue materials- Paint and other protective coatings such as lacquer, enamel varnish frequently recovered in hit and run, burglary and forced entry cases, label comparison in cheating cases can be analysed by applying nano-techniques.

v)Fire and arson cases- In those cases very traces of petroleum hydrocarbon residues are needed to be analysed

vi)Cyber Forensics, Tape Authentication and speaker Identification- Audio, video tapes are having nano coatings and by identifying the nano coating material the authentication of tapes can be determined.

The ion beam analysis is a group of techniques which can be used to study forensic materials. Ion beam analysis can be applied to solve research problems in forensic science. Ion beam

analysis: In particular, the technique can be used to identify forensic specimens such as gunshot residues, explosives residues, fingerprints, soils and inks, with the ultimate aim of linking a suspect to a scene of a crime by comparing the elemental composition of forensic material found on the suspect to the composition of forensic material at the crime scene In forensic investigations it is essential to analyse the samples in such a way that they are not destroyed. It is a non-destructive technique. It is also essential to get as much information out of the samples as possible. Ion beam analysis has a very high sensitivity to trace quantities of most elements in the periodic table compared with other non destructive techniques. It is a modern analytical technique involving the use of milli electron volts(MeV) ion beams to probe the composition and obtain elemental depth profiles in the near-surface layer of solids. All IBA methods are highly sensitive and allow the detection of elements in the sub-monolayer range. The depth resolution is typically in the range of a few nanometers to a few ten nanometers. Ion Beam Analysis (IBA) is based on the interaction, at both the atomic and the nuclear level, between accelerated charged particles and the bombarded material. When a charged particle moving at high speed strikes a material, it interacts with the electrons and nuclei of the material atoms, slows down and possibly deviates from its initial trajectory. This can lead to the emission of particles or radiation whose energy is characteristic of the elements which constitute the sample material. The spectrometric analysis of this secondary emission may lead to the detection of specific elements in diverse samples as well as the determination of the concentration of these elements, the determination of the nature, thickness, position or concentration gradient of several layers of elements or compounds and the nature of the secondary emission detected determines the type of analysis which would produce the optimal results. Ion beam analysis methods include, Particle Induced X-ray Emission Analysis, Particle Induced Gamma-ray Emission Analysis, Nuclear Reaction Analysis & Rutherford Back Scattering Analysis.

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