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Nanotechnology in Forensics and Its Application in Forensic Investigation

Srividya B*

*Department of Pharmaceutical Analysis, Yalamarthy Pharmacy College, Andhra University, Vishakapatnam, India

Review Article

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***For Correspondence**

Department of Pharmaceutical Analysis, Yalamarthy Pharmacy College, Andhra University, Vishakapatnam, India.

E-mail: vidyacps@gmail.com

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ABSTRACT

Nanotechnology is an important and powerful tool in most of the areas including medicine, imaging, and energy sciences. It is a rapidly growing region of research with monstrous potential in a few fields, running from medical care to production and physical science. Nanotechnology has a potential to make significant positive contribution in forensic science in Crime detection. The various uses of nanotechnology in the field of forensics are discussed in this review. In forensic nanotechnology minute chip materials are used instead of bulky instruments, which reduce the methods of analysis to make investigation, accurate, precise, timely and appropriate. This talk aims to highlight some of these applications of Nanotechnology in Forensic Science.

INTRODUCTION

Nanotechnology is the managing of matter at a molecular or atomic level. It deals with materials, devices, or other structures possessing at least one dimension sized from 1 to 100 nanometres. The size of nanometer is about 3-5 atoms wide. It includes both man made things and natural things. By using nanotechnology we can produce the devices or materials which extraordinary properties. It is useful in wide areas like biology, engineering, chemistry and physics. Nanotechnology have wide variety of application in different fields like medicine, engineering and electrical field [1-7]. Nanotechnology due to its multipurpose use and advantages in all areas, it referred to as a universal purpose technology since its foremost version will have its impact on relatively on all field, industries and all areas of civilization [7-9].

Nano-forensics, a completely new area of forensic science associated with the development of nano-sensors, nanotechnical methods for real-time crime scene investigation and terrorist activity investigations, determining the presence of explosive gases, biological agents and residues [10-14].

Forensic Science is a broad field of subspecialties which use techniques adapted from the natural sciences to obtain criminal or other legal evidence [14-18].

Nanotechnology is beginning to have an impact on the handling of evidence at crime scenes, its analysis in the laboratory and its presentation in the court room. Application of nanotechnology is likely to enhance the capacity to toxic materials, forensic evidence in tissue, materials and soil [19-22].

Forensic Nanotechnology

Forensic science mainly deals with identification, evaluation, investigation of the crime, finding connections between pieces of evidence and perpetrators. Nano-forensics, is a new area of forensic science which is highly advanced associated with the development of nano-sensors for crime investigations and inspection of terrorist activity by determining the presence of explosive gases, biological agents and residues [22-26]. Nano-analysis is commonly used in the nanotechnology detection of crimes. Some of these analyses techniques are Scanning Electron Microscopy, Transmission Electron Microscopy, Atomic Force Microscopy, Dynamic Light Scattering, and Raman Microscopy [27-29]. These techniques assist forensic scientists in 2 ways: 1) by making it possible to analyze nano-scaled samples and 2) by making use of the specific effects of nanomaterial to identify and collect evidence, which would not have been possible by previous techniques. DNA extraction from palm-prints, fingerprints, gun

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residues, explosives and heavy metals are some of the novel approaches that ease the way for forensic scientists to provide conclusive evidence [30-34] (Table 1).

Table 1. Nanotechnology and Forensic science.

Nanotechnology		Forensic science
Nanoparticles		Finger mark development
Nanosensors	Forensic Nanotechnology	DNA sequencing
DNA Nanotechnology		Forensic toxicology
Nanolithography		Drug identification
Scanning probe microscopy		Fibre and hair analysis
Nanorobotics		Trace evidence analysis

Applications of Forensic Nanotechnology

Forensic toxicological analysis

Nano technology is most effectively used in the discipline of forensic toxicology for examination of different toxic materials from numerous important forensic evidences like hair, blood, saliva, vitreous humor and even from remains of body skeleton and samples of evidences of fingerprints. Gold nanoparticles, silver nanoparticles and Titanium oxide nanoparticles are commonly used to enhance the detection limit [35-39]. The body fluid vitreous humour, in which Lidocaine hydrochloride is detected. The nanosensor which is developed with this innovative approaches may be used as a, immediate spot test and a major substitute for on the field test, low-cost, active, stable and certain time screening methods for forensic toxicological drug screening. Forensic nanotechnology was effectively applied to real specimens to illuminate the applicability of the nano sensors for toxicological analysis [45-48].

Forensic DNA analysis

Forensic DNA analysis is carried in murder cases, rape cases and other crime cases. DNA analysis of blood stains, hairs, fibres semen can be carried out. Microfluidic devices are the recent advanced devices used for forensic DNA analysis. The advantages of these devices are shorter examination time, risk of contamination is less, it is directly applicable at the crime scene. Another most important technology is microfluidic chip technology has already proven to be useful and effective within medical applications, such as for point-of-care use [49-54].

Forensic DNA typing

In forensic DNA typing, good quality of PCR (polymerase chain reaction) extraction is very crucial. To extract of excellent quality of PCR ready DNA samples from indicative fluids of the body and specimens of sketal remains which are bought for Forensic analysis, silica based magnetic nanoparticles, magnetic nanoparticles, and copper nanoparticles are used. To isolate DNA, the magnetite nanoparticles with carboxylic compounds are used as adsorbents for PCR amplification [55-59].

Forensic fingerprint visualization

Finger marks are the evidences remained by the ruptured ridges of the finger. These finger marks are enable to identify a person. Commonly three types of fingerprints are observed in the crime scenes i.e., plastic, patent and latent. Mostly latent type of the finger prints are seen in the crime scenes which are not visible or invisible to the naked eye which require further processing. Generally fingerprint powders are used to develop latent fingermarks [60-65]. Generally in the crime scene, the sweat residues are left by the finger on the things or objects. The finger print powder are scattered on the area which will get sticked to the sweat residues left by the finger, which will give predictable patterns, which makes latent print to coloured or fluorescent for easy identification. Aluminium flake, carbon black is the best materials which have been generally used in latent fingerprint development [66-70].

Nanopowders have been developed which are used in conjunction with SALDI-TOF2-MS will develop the ginger print and used for detection [71-74].

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The new methods of nanotechnology in finger print analysis made easy to unmask the new evidence in the crime cases. By using the gold nanoparticles, researchers were able to researchers were able to target amino acids on non-porous surfaces, which will allow better analysis of latent fingerprints. [75-79].

Nano-Fingerprint Residue Visualization: Microscopy: The body creams and sunscreen lotions can be detected by using residual Titanium dioxide or Zinc oxide nanoparticles and while sweat can be detected due to its inorganic components

Forensic explosive detection

Terrorist activities have been increased globally, which has drawn the attention for the detection of hidden explosives. Nano materials provide a active potential to create sensors for detection of explosives. Systematic and efficient detection of explosives which were hidden in vehicles, luggage and vehicles. Tracing of explosives is a very costly and highly complicated task [80-85]. Nanostructures are used as sensors for detection of different chemical and biological compounds including explosives. The Ultra small devices have high sensing capability.

To trace the explosives, advanced nanosensor concept devices like electronic noses, nanotube and nanomechanical devices are used detect the conventional bombs, plastic explosives and grenades [13-18]. Dogs can recognise different types of odours including explosives, at present, dogs have been trained for detecting out hidden explosives which is too costly and time taken. So at present, the electronic nose technique is used so that dogs can trace easily without any disadvantages. An electronic nose is usually possessed of a chemical sensing system such as an artificial neural network [86-91].

Post blast explosive residues analysis

Nanotechnology is also useful in post blast explosive residue analysis. The fragmentation of explosives occurs in bomb blast incidents and very traces of explosive residues remain at the spot of the blast Nano techniques can be executed for detection of unfragmented explosives [92-96].

Gunshot residue analysis

Nanotechnology can be applied for detecting the analysis of gunshot residue. Some of the microscopic particles of gunshot residues are often present on the hands of a shooter, following discharge of a firearm. It may be present on his clothes, or on any of the things with the shooter. High-resolution SEM imaging is used in the GSR analysis to locate residue particles, and X-ray spectrometry to determine their composition of the elements. [96-100].

CONCLUSION

This review explained the significance of nanotechnology in the field of Forensic science and application of nanotechnology in the various stages of forensic investigation. The different techniques of nanotechnology in different stages of criminal investigation have been discussed.

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