REVIEW ARTICLE

Applications of Nanotechnology in Forensic Investigation

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ABSTRACT- Nanotechnology as a new area of research, which involves the revealing of cases and evidences before the court of interest whenever it is obligatory. This area of research has its own significant interest as the advances in the field of nanotechnology are being incorporated in the field of forensic science. Only large collections of strains from all over the world and high quality sequence data will provide the basis for meaningful results in microbial forensic investigations. International and interdisciplinary cooperation will improve our capabilities to rapidly identify the agents, elucidate the source, and provide these results as evidence in court. Since the last few decades, fingerprints from pollen have become the dominion of many forensic scientists throughout the world, and have proven to be the main ingredient of one of the most powerful techniques in trace and contact evidence- Forensic Palynology**.** Nanotechnology will be likely to play a major role in the future in the field of forensic science to deliver more selective and more sensitive ways to detect and reveal cases along with infallible evidences.

Key-words- Detection, Evidences, Forensic Science, Investigation, Nanotechnology

INTRODUCTION

Nanotechnology is a rapid growing field, which set new horizons in the field of science and technology. It has been applied to various fields of science, including electronics, engineering, physical sciences, materials sciences, biomedical sciences and many others. Nanotechnology has great prospective to benefit the society and forensic science; however those nanoparticles with unknown novel properties can also cause risks to the environment [1,2].

An important advantage of using nanotechnology in the field of forensic science as it reveals the hidden evidences, which can prove to be helpful for the forensic scientists to give an outcome to their investigation. New developments in forensic science apart from the use of advanced analysis techniques the involvement of nanotechnology has played a major role in putting the accused behind the bars without leaving any inquiry marks behind [3-6].

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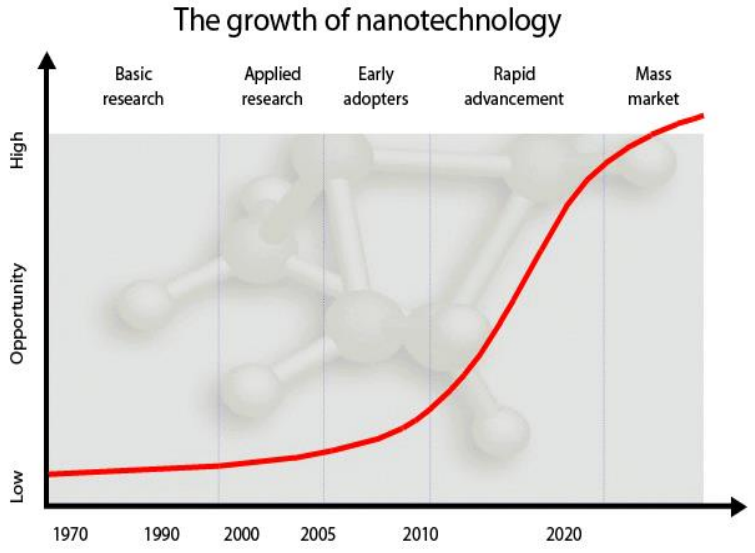

Fig. 1: Future time line growth of Nanotechnology

There are several areas of forensic science to investigate: Latent fingerprint development, illicit drug identification, alcohol measurement in drunk drivers, explosives detection, nerve gas detection, saliva detection, inorganic pigments identification in hit-and run car accidents, and many more which finds a prominent involvement of snanotechnology for time bound investigation and accurate

results [6,7].

Nanotechnology at present has found its ways in the field of illicit drug identification too. Although the development of investigation in this field is slow. Nanotechnology has proved to give unbiased results once the investigating body has his hands full of evidences and once he involves nanotechnology in his investigation the outcome will be accurate and unbiased and within a short span of time [7-9].

The novel methods or the conventional methods which were involved in the past or at present also for investigating a crime scene like the smidgen method which used to reveal the finger prints or the use of fluorescent x-ray tubes can be replaced with the help of new scientific techniques like Microbial Forensics, Forensic Palynology as well as the Nanotechnology [10-12].

Nanoparticles today have begun to get incorporated in the process of polymerase chain reaction-amplification due to their unique ability to create physical and chemical properties based on what may be present on the surface [12-14].

The word PCR refers to the polymerase chain reaction which is a common method of creating copies of DNA-fragments. Polymerase chain reaction rapidly amplifies a single DNA-molecule into billions of molecules [13,14].

When pcr technique combines with nanotechnology can prove to be very much beneficial for the crime scene investigators as the PCR technique can help the investigators to examine each and every fragment of the specimen which is obtained at the crime spot. For example, if a hair strand is obtained than with the help of PCR the investigating body can produce sufficient copies of it to carry out further forensic analysis [15-17].

Nanostructure materials did not first come into existence with the recent emergence of the field of nanotechnology. Many existing materials are structured on the micro- and nanometer scales, and many industrial processes that have been used for decades (e.g. polymer and steel manufacturing) exploit nano-scale phenomena [17,18].

Nanotechnology today is playing a vital role in several fields of investigation whether it is in the field of forensic pathology, forensic ballistics, forensic microbiology and many more, but prominent among all the researchers the area of the involvement of the gold nanoparticles and the usage of silver nanoparticles has gone through miles in this field [19-20]. Today the investigating bodies are using this technique as the new investigating tool for their results and the usage of nanotechnology leaves no stone behind in giving appropriate results.

A significant portion of recent efforts has been devoted to investigating statistical analytical approaches to improve selectivity when dealing with DNA samples from a mixture of sources, or LT DNA. There is a growing consensus that better discrimination can be achieved by adding more standard DNA markers (STR loci) to the existing DNA databases around the world. In order to promote data sharing across a wide number of jurisdictions, a universal standard is yet to be agreed upon by all countries [21,22].

Today in most of the countries the court of interest is relying more on the scientific investigations as compared to the investigations done by the local governing bodies and the evidences which are given by the before the decision governing body. It is worth noting that although numerous scientific improvements are sure to come, the current methods are reliable and valid and their accuracy leaves no stone unturned in proving the results true without any further arguments to go on. Although these techniques are less in practice, but these techniques prove their transparencies well before the community.

Applications of Nanotechnology in Forensic Investigations

The rapid advancement in nanotechnology sets new paradigms in science and technology, but simultaneously increased apprehensions about the health risks of nano-objects. Recently, various types of nanoparticles used in several areas of forensic including paint, inks, security document and to develop the latent fingerprint [23,24].

The technological advancement in the field of forensic science has also changed the character of particulate characteristics, increasing the proportion of nanometer-sized particles “nanoparticles” and expanding the variety of chemicals [24,25].

Forensic Science has a broad range of sub-specialties which use techniques adapted from the natural sciences to obtain criminal or other legal evidence. Nanotechnological advancements in the field of forensic science have involved the use of nanoparticles in the discovery of various aspects which are used in the investigations to reveal out the truth behind the screens.

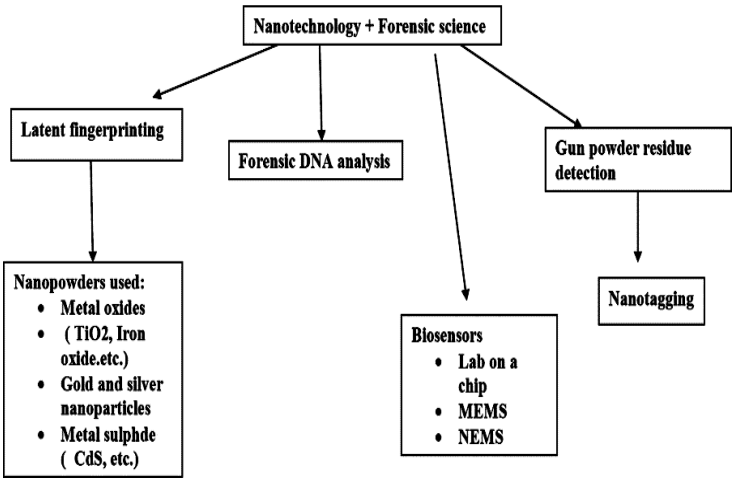

Fig. 2: Applications of Nanotechnology & Forensic Science

Although most of the investigations dealing with forensic science involve the use of certain ailments which sometimes leads to the outcome of moderate results therefore the newly discovered technique involving

nanoparticles is the discovery of latent fingerprinting and the use of nano ink [25].

Latent Fingerprinting- Revealing Invisible Evidences

This method of latent fingerprinting has brought the involvement of nanoparticles on a large extent in the field of forensic science and has made the analysis of the sample much easier and accurate. Before latent fingerprinting was brought into existence the analyst used the sprinkle method in which they used to dip the brush in a fingerprint powder which comprised of black granular, aluminum flake, black magnetic etc. if any prints appear, they are firstly photographed and slowly and gently with the help of adhesive tape the fingerprints are lifted up and slowly with the help of latent lift card they are preserved [26].

However the fingerprint powder can contaminate the evidence and ruin the analysts expectations and hinder the results and due to this contamination the analysts get involved in using other techniques in revealing the results. In order to prevent the contamination occurring due to powder the investigators may examine the area with an alternate light source or apply super glue which is termed as cyanoacrylate before using powder [26].

Analysis involves assessing a print to determine the right answers, which are required by the analyst. If the print is not suitable for comparison because of inadequate quantity of features, the examination ends and the print is reported as not suitable by the analyst to the governing body.

On the other hand if the print is appropriate the analysis indicates the features to be used in the comparison and their tolerances and the amount of variation that is kept under observation.

This technology of latent fingerprinting involving the use of latent nanoparticles has its own significance in the field of forensic science. It has no comparison with the orthodox method of analysis of the crime scene. Latent fingerprinting helps us to reveal the fingerprints which have been washed from the surfaces at the crime scene [27].

Evaluation is where the examiner ultimately decides if the prints are from the same surface and from the same source or not. The variation in the prints obtained from different sources may be due to the quality of samples, lack of comparable areas or insufficient number of corresponding or dissimilar features to be certain [27,28].

Verification occurs only when the evidences are brought before the court of interest and another examiner independently analyzes, compares and evaluates the prints to either support or refuse the conclusions of the original examiner. The examiner may also verify the suitability of determinations made in the analysis phase. Fingerprint analysis is usually performed by the law enforcement agencies or the crime laboratories; however, casework may be sent to private companies if there is a need, such as to reduce backlogs, verify results, or handle the high profile cases [28].

Trace Explosive and Nerve Agents

A significant portion of recent efforts has been devoted to investigating statistical analytical approaches to improve selectivity when dealing with the trace explosives and the nerve agents. In criminal justice cases most of the computerized systems are used to search various local state and national potential explosives. Nanotechnology has its prominent involvement in the field of observing trace explosives and the nerve agents. Research department explosive is an example of an explosive nitrosamine widely used in military and industrial applications.

Micro- X-Ray Fluorescence (MXRF)

Micro-x-ray fluorescence (MXRF) is among the most prominent technology used by the forensic investigator in various examinations. Mostly it is used to detect the presence of any type unrevealed evidences at the crime scene. It is a new visualization technique which rapidly reveals the elemental composition of a sample by irradiating it with a thin beam of X-rays without disturbing the sample.

Formulation of Ink

The forensic examination of inks consists of optical, physical, and chemical examinations. The results from the optical, physical and chemical examinations create the analytical profile of the ink. The results from the optical, physical and chemical examinations create the analytical profile of the Ink. Recently, various types of nanoparticles are developed that can be used in a new generation of anti-counterfeiting inks.

Use of Nano- Celluloid's in Car Bodies

Nanotechnology today has been involved in the manufacturing of different parts as well as the body of the cars too. Among all the car manufacturing companies Toyota was the first to involve the use of nanotechnology in manufacturing the bumpers of the cars. The main motive behind using the nanoparticles is when the nanoparticles combine together the thus the materials thus manufactured are lighter in weight and the strength of the material is three times more than the strength thus obtained before.

A lot of car parts including the dash boards, side panels, will be made of nano-sized particles in the future. For one thing, they will help to reduce the weight of the cars and thus this will increase the fuel economy as well. Similar plastics also show promise for future use in medical applications, such as replacement materials for the artificial heart valves, artificial ligaments, and hip joints.

Future aspects of Nanotechnology in Forensic Science

The integration of these scientific areas shows advantages in the development of nanotechnology in various areas of forensic science, health sciences and various areas of automotive engineering as well. By combining the most advanced chemical and physical technologies with the needs of modern applications of biomedical and forensic research. The growing demand of nanotechnology today

has enabled most of the scientist and analyst to go in the efficient strategic objectives and sound skills in the field of nanotechnology.

Some types of future advancements of nanotechnology in the field of forensic science are as follows

• Design and development of nano-structured materials and new contrast media for the multimodal imaging
• Study of thin films for biomedical applications and energy conversion
• Preparation of molecularly imprinted polymers (MIPS) in the form of nanoparticles and nano-surfaces for analytical applications
• Study of the surface phenomena in the application of the nanostructures to the modern technologies of the molecular separations
• Physico- chemical and characterization of the functional materials investigations on the structure and vibrational properties of functional materials
• Cellular nano-engineering

CONCLUSIONS

Forensic science was mainly focused on fingerprint detection. With the advance in science and technology, forensics has become an increasingly interesting scientific field to explore, and nanotechnology is playing an increasingly important role in this area. An important advantage of using nanotechnology in forensic science has been the long-term storage of developed fingerprints due to its inert nature in addition to the high selectivity and the sensitivity of nanotechnology. There are several areas of forensic science to investigate: latent fingerprint development, illicit drug identification alcohol measurement in drunk drivers, explosives detection, nerve gas detection, saliva detection, inorganic pigment identification in hit-and-run car accidents, and many more. Every technology has its own advantages and disadvantages. With the help of this review, we have made an attempt to point out those areas of Nanotechnology, which was still unseen and untouched. Therefore, before using Nanoparticles for enhancement of blood fingerprint necessary precaution should be taken by Forensic Scientists and researcher to avoid not only false results but also to safe their selves and environments from indirect exposure of these Nanoparticles.

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