Chapter 14
Current Challenges and Future Perspective of Nanotechnology in Forensic Investigation

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ABSTRACT

Nanotechnology includes different kinds of nano-materials including the nano-composites, nano-hybrid, and nanostructured materials. There are immense and broader views based on pragmatism and cross-fertilization of nanotechnology. Because of the development in nanotechnology, the progression in technical sector is also increasing. Similarly, the role of nanotechnology is increasing in the field of forensic sciences. There are numerous branches of forensics covered by nanotechnology including the trend of nanotechnology enhancing already existing technologies in forensics. In the upcoming era, advanced nanotechnology in instruments for illicit drug screening and fingerprint detection is increasing because nano-based techniques hold an immense future in fingerprinting and security features. Therefore, this chapter offers an application of nanoparticles in numerous areas of forensics.

INTRODUCTION

In every sector, nanotechnology is making a significant impact. Being able to control and characterise the matter at the level of individual and small atoms makes it a commonly used method (Kesarwani, 2020). It is generally understood to be the investigation, design, production, synthesis, manipulation, and application of useful materials, systems, and devices by controlling matter at the nanoscale. It has

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been utilised in a variety of academic fields, such as electronic engineering, physical sciences, medicinal sciences, and many others (Chen, 2011). The term 'Nano' implies dwarf or little, that specifically relates to a specific size that will be one billionth which is nearly to the one nanometer nm as per calculation. As compared to the other values, it is almost 50,000 times thinner than the thickness of a virus or hair of humanoid, or around 3-5 atoms broad (100 nm). As a result, nanotechnology focuses on newly developed materials with sizes between 1 and 100 nm (Pitkethly, 2016).

Vandan Prasada (2016) presented the limited concept of innovative nano-technique through the lecture presented by him and it was named as "There's Plenty of Room at the Bottom." He proposed things by using different tools that could be operated surely and accurately at the level of atomics employ single atoms and close molecules. Current known nanomaterials include nanoparticles, quantum dots (semiconductor nanomaterials),4 carbon nanotubes, self-assembled peptide nanotubes, and numerous others. As per the definated presented by the United States NNI: "Nanotechnology is the basic knowledge as well as regulation of matters at specific dimensions that is almost 1 to 100 nanometers in size, where exclusive phenomena permit innovative applications." They can be utilised in consumer goods, environmental engineering, communication, medicine, and catalysis (Chen, 2011).

Since nanotechnology will have a significant impact on practically all businesses and all facets of civilization in its advanced form, it is frequently referred to as a universal purpose technology.3 As a result, there are many opportunities for this technology to be developed in forensic investigation (Hazarika, 2008).

Nanotechnology is the term used to designate the study area of science, engineering, and technology carried out at a scale that varies from 1 to 100 nanometers. Due to its small size, vast surface area, and improved reactivity, nanotechnology has the potential to be used in electronics, diagnostics, biosensing, imaging, optical devices, and drug delivery (Prasad, 2020). It is now considered a technology with a universal purpose due to its widespread applicability in practically all fields. As a result, there are several applications regarding this universal technique specifically in the branch of forensic research (Paikrao Hariprasad, 2021).

The newest and fastest-growing area of novelty which deals in the use of nanotechnology is called nano-forensics. With the development of nanosensors, huge, heavy instruments have been replaced by considerably smaller chip-based platforms. This significantly helps with criminal investigations, also identifies unspecified evidence in a quicker examination which is considered as the best way in the process of investigation in more accurate and sensitive way to solve crimes (Pandya, 2018), (Chauhan, 2017).

A completely new field of forensic research, nano-forensic is a beautiful fusion of forensic science with nanotechnology. As mentioned previously, nanoforensics aids in the identification and examination of evidence at the nanoscale level; yet, due to the instrument's detection limit, it is not able to evaluate the crucial evidence. Nano analysis is revolutionising the investigative process by improving the techniques' accuracy, speed, and sensitivity. Applications for fingerprint analysis, explosive detection, drug screening, dangerous substance analysis, and DNA analysis are all prominent uses of - and other technologies (Lodha, 2016).

FORENSIC INVESTIGATION AND NANOTECHNOLOGY

Identification, appraisal, crime scene investigation, and establishing links between specific pieces of evidence and offenders are the core concerns of forensic science. A brand-new, highly developed field