Chapter 5
Nano-Trackers (Nano-Sensors) for Forensics Investigation

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ABSTRACT

Sensors are effective instruments for finding illegal drugs. In the past several years, sensor use and development have garnered a lot of interest. The lack of an effective tool that offers the specialist all the necessary features, including cost-effective manufacturing, on-site analysis, instrumental simplicity, and correct findings, might be blamed for this thirst for the creation of new detectors. Nanotechnology has the potential to significantly advance forensic science and criminal investigation. In forensic nanotechnology, tiny chip materials are employed in place of large apparatus, which simplifies the techniques of analysis and improves the accuracy, precision, timeliness, and suitability of investigations. The reader is provided with up-to-date studies and publications as this chapter describes the use of nano sensors in forensics investigation. Additionally, it details the key distinctions between the three major categories of sensors that provide information on the potential applications of these sensing materials in the future.

INTRODUCTION

In every sector, nanotechnology is making a significant impact. Its capability to modify and describe the matter at the level of individual and tiny atoms makes it an extensively utilized method. The word “nano” refers to the “billionth” or a factor of 10-9. The word is derived from the ancient Greek “Nanos,” which means “dwarf.” To put it simply, 1 nm is equivalent to 3–10 atoms. When compared to the typical size encountered every day, it is quite little. As an illustration, 1nm is 1/1000th the breadth of a human

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hair. Nanotechnology is the term used to define the component of science, engineering, and technology research done at a size between 1 and 100 nanometers (Shukla et al., 2016). Due to their tiny size, wide surface area, and improved reactivity, nanotechnology has the potential to be used in electronics, diagnostics, biosensing, imaging, optical devices, and drug administration (He et al., 2020; Malefane, 2020; Pavan Kumar et al., 2020).

New paradigms in science and technology are being established by the rapid advancements in nanomaterials. Due to the integration of advances in nanotechnology into the field of forensic science, this area of research is particularly significant. With verified cutting-edge nano-imaging technologies for visualization, nano-sensors, nano-manipulators and nano-forensic provides a novel viewpoint for investigations into crimes in the present moment (Dahiya et al., 2022).

It is now considered a technology with a universal purpose due to its widespread applicability in practically all fields. As a result, there are many uses of forensic science for this universal technology. A completely new field of forensic research, nano-forensic is a beautiful fusion of forensic science with nanotechnology. Identification, appraisal, crime scene investigation, and establishing links between specific evidences and offenders are the core concerns of forensic science. By detecting the presence of biological agents, explosive gases and residues, nano-forensics is a highly advanced branch of forensic sciences that is connected to the development of nano-sensors for crime investigations and inspection of terrorist activity (Mathur et al., 2016; Gopi et al., 2016). In the identification of crimes using nanotechnology, nano-analysis is frequently employed. Transmission electron microscopy, scanning electron microscopy, dynamic light scattering, atomic force microscopy and Raman microscopy are a few of these analysis methods (Lloyd-Hughes et al., 2015).

Nanoforensic and other technologies have important uses for DNA analysis, explosive detection, drug testing, and fingerprint analysis (Kaushik et al., 2017). These methods help forensic investigators in two ways: first, by enabling the analysis of nanoscaled samples, and second, by utilising the unique properties of nanomaterial to locate and gather evidence that would not have been possible with earlier methods. The use of modern techniques such as DNA extraction from fingerprints, gun residues, explosives, and heavy metals makes it easier for forensic experts to provide irrefutable evidence (Arif et al., 2015; Singh et al., 2015).

Due to the significance of forensic science to the legal system, errors cannot be allowed in this discipline. The materials used for analysis must exhibit great specificity and precision, just like fingerprint detection, bodily fluids, DNA, drugs, poisons, and explosives (Mahbub et al., 2020). A list of laboratories have financed in preferring analytical methods and nanostructures to provide findings with the necessary precision (Shaw et al., 2017; Rawtani et al., 2019). As in one of case relevant to fingerprint detection (Rawtani et al., 2019; Chávez et al., 2021) or drug detection being carried out by biosensors and the deployment of nanosensors enables their usage at scene of crime (Montagner et al., 2018; Teymourian et al., 2020) and explosives (Moram et al., 2020).

Among the primary fields concerning by assessment as well as analyzing sample taken from a human corpse and the scene of death is forensic microbial nanotechnology. The range of forensic microbiological techniques is expanding as a result of the advancement of microbial nanotechnology, and related approaches are also growing in popularity. Nowadays, forensic microbial nanotechnology techniques are used as aids in a number of fields, likewise the diagnosis of the deceased, the calculation of the postmortem period, and the characterization of the cause, mechanism, and mode of death. Research defining new approaches in forensic sciences have been driven by advancements in microbial nanotechnology, including next-generation sequencing, amplicon metagenomics as well as mass-spectrometry-based

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