Chapter 10
Nanomaterial-Based Bio-Detection

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ABSTRACT

Analysis of body fluids is an important aspect of forensic investigation; therefore, rapid and sensitive detection is required for their analysis as well as characterization. This chapter presents an overview of the applications of different nanomaterials with respect to the biological material detection. If we talk about forensic biological samples, we especially need to handle them with care, because such samples from crime scenes are always in traces. This chapter briefly discusses the use of functional nanoparticles for the detection of biological materials. Genetic material obtained from crime scenes is one of the most important pieces of evidence in forensic investigations, and the chapter focuses on the application of functional nanomaterials for their detection.

INTRODUCTION

Nanomaterials are in the midst of rapid development owing to their potential applications in almost all scientific fields (Cao & Wang, 2004). With daily technological advancements, novel properties of nanomaterials and nanotechnology are being discovered, studied, and utilized in medicine, diagnostic, forensic, pharmaceutical, clinical, industrial, agricultural, environmental monitoring and safety purposes (Perfézou et al., 2012; Zhang et al., 2009). Several nanomaterial types have already been synthesized

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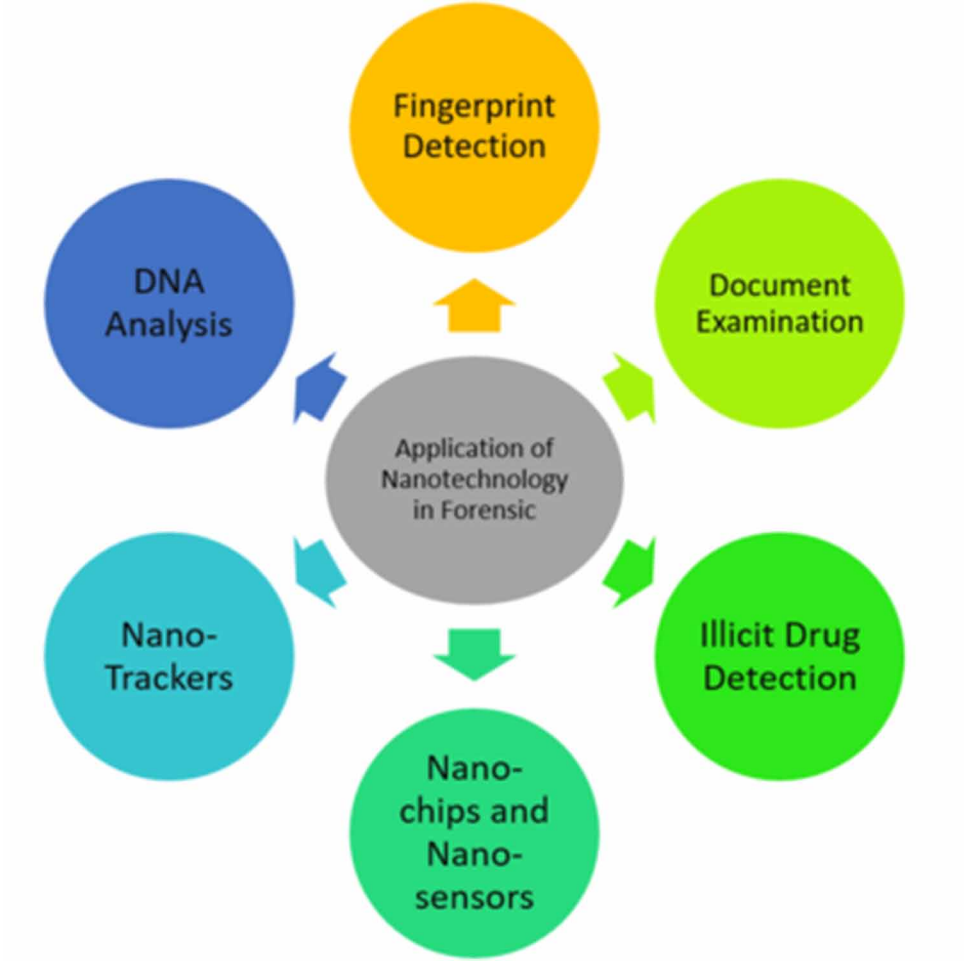
Figure 1. Application of nanotechnology in forensics



and utilized for such purposes; among which carbon nanoparticles, magnetic nanoparticles, silver nanoparticles, carbon nanotubes, quantum dots, graphene, and hybrid nanocomposites are widely used because of their optical, thermal and structural properties (Chen & Chatterjee, 2013; Yang et al., 2015).

Owing to the complexity of forensic analysis procedures, it is necessary to develop highly efficient and rapid technological methods that can provide accurate results with limited available evidence. Most of the time, the evidence secured from a crime scene is either partially degraded, impure, or in trace amounts (C. Liu et al., 2019). Furthermore, securing and preserving this evidence is always at risk of compromise as it requires a great deal of accuracy. In this regard, nanotechnology, illustrated in Figure 1, has gained a high level of interest in the forensic field because it offers rapid results and ease in complex analytical procedures (Hagarová, 2020).

Many conventional methods that are widely used in forensic applications have significant downfalls. For instance, manual extraction and isolation of DNA from biological samples leads to denaturation (Abdulrahman & Ghanem, 2018). The latent fingerprinting powders used in fingerprint development most often lead to overlapping of granules, resulting in distorted results. However, the detection and isolation