Chapter 25
Nanotechnology and Its Applications in Forensic and Criminal Cases

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ABSTRACT

When Dr. Richard Feynman first gave the good news in 1959 that nanotechnology was on its way to change or perhaps transform the world of technology, many people might have considered his concepts too futuristic to be realized. Criminals, on the other hand, would not have known how effective nanotechnological tools would become in solving crimes in a few decades. Among some of the medical applications of the technology are drug production, diagnostics, and production of medical as well as forensic tools and devices. Forensic science can be described as the sum of scientific tests or techniques used in the investigation of crimes. This chapter is, therefore, aimed at introducing and discussing nanotechnology as applied in forensic science along with instrumentation used in performing nano-analysis. The future prospects of the technology as employed in forensic science and toxicity of nanomaterials are also dealt with in this chapter.

INTRODUCTION

Nanotechnology can be defined as an ever-expanding area of science that focuses on the tiniest parts, or rather particles of structures, namely those with a size of approximately 1-100 nanometers. Compared to standard materials, nanostructures are far stronger, more stable, and have a larger surface area per unit. Of note, nanostructures begin exhibiting quantum effects below 10 nanometers. This is a size where it becomes possible to control the various physical or chemical properties of a nanostructure. The specific wavelength of emitted light is one of those properties that can be kept under control.

By dealing especially with the manipulation of individual molecules, nanotechnology designs and produces various functional materials, devices, and systems. This technology has many practical applications in such fields as electronic engineering, physical sciences, materials sciences and biomedical sciences. It has recently been made use of in detecting and analyzing nanoscale medical as well as chemical samples, which would, other-

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wise, not be collected or go unnoticed. Detecting trace amounts of gunshot residues, heavy metals, explosives, DNA on fingerprints or palm-prints are obvious examples that might give an insight into the impressive array of what nanotechnology can achieve.

Forensic science, on the other hand, can be described as the sum of scientific tests or techniques used in the investigation of crimes. With a view to achieving this aim, it tries to identify, personalize and evaluate evidence. The science has received wide coverage in the media during the past few decades. Such TV programs as Crime Scene Investigation (CSI) and Naval Criminal Investigative Service (NCIS) have certainly contributed to the popularity of this science. Many reasons may be mentioned to explain why forensic science is arousing so much of the layman's interest. While one of them is advancements in analytical techniques, no doubt the other is improvement in analytical detection levels of commonly used techniques. This is where nanotechnology has recently burst onto the scene. Its role in the identification of latent fingerprints, in particular, is a major development in forensic science. Latent fingerprinting is performed by making use of bodily excretions, such as sweat, and secretions from sebaceous glands discovered at the scene of crime. These residues or imprints become visible by means of optical techniques and/or various chemical agents like powders. Use of the latter is a common method and is the one that most people are acquainted with thanks to the media. When it comes to providing clearer imprints by means of nanoscale powder particles, nanotechnology can be considered as a pilot scheme. Nevertheless, the results obtained so far are very encouraging. To illustrate, it was reported by a group associated with Sydney University that nanoscale (20 nm) powder of ZnO did not only make it possible for clearer and more fluorescent prints to come into sight, but it also worked in wet conditions. Some good news is also coming from other researches in which particles like cadmium sulfide (CdS) of only 10 nm are used to produce ultraviolet (UV) fluorescent and better fingerprints. As for ROAR particles, a United Kingdom based company, there are attempts to utilize nanoparticles to create a print on which bodily secretions can be differentiated from such chemicals as explosives, drugs and the like that the subject might have touched.

Nanotechnology has created new opportunities whereas a forensic investigator is able to examine evidences like source of ink, fingerprints, gunshot residues, etc. in a very small amount and reach conclusions (See Figure 1). It makes evidences more reliable and more effective in connecting criminals and crime scenes.

NANO-ANALYSIS AND ITS USE IN FORENSIC SCIENCE

Forensic science is responsible for identifying, evaluating and finding connections between pieces of evidence and perpetrators. To achieve this goal, a forensic scientist is forever in search of new technologies applicable to this field. Nano-analysis is becoming a common technique thanks to the advances in nanotechnology. Some of these analyses techniques are Scanning Electron Microscopy, Transmission Electron Microscopy, Atomic Force Microscopy, Dynamic Light Scattering, and Raman Microscopy. 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 properties of nanomaterials to detect and collect evidence, which would not have been possible by previous techniques. DNA extraction from palm-prints, fingerprints, gun residues, explosives and heavy metals are some of the novel approaches that ease the way for forensic scientists to provide conclusive evidence.

Electron Microscopy

Using electron beams, Electron Microscopy (EM) magnifies and enables detailed analyses of nanomaterials. A sub-nano scale resolution is