Journal of Forensic Sciences And Criminal Investigation
ISSN: 2476-1311

Mini Review
Volume 18 Issue 2 - March 2024
DOI: 10.19080/JFSCI.2024.18.555986

J Forensic Sci & Criminal Inves

Magical Nanoparticles - Finger Print Detection in Forensic Pharmacy

B Nagashubha*, M Kiran Sai, K Dharani, Charitha B and Y Padmanabha Reddy

Department of Pharmaceutics, Raghavendra Institute of Pharmaceutical Education and Research – Autonomous, India

Submission: March 07, 2024; **Published:** March 29, 2024

***Corresponding author:** B Nagashubha, Department of Pharmaceutics, Raghavendra Institute of Pharmaceutical Education and Research – Autonomous, Anantapuramu, 515721, Andhra Pradesh, India, Email: naga.shubha531@gmail.com

Abstract

Nanotechnology is an enabling, essential technology, allowing us to do new things in roughly every possible technological discipline. The employment of nanoparticles has recently shown nice potential in manufacturing succeeding generation of finger mark development techniques, Micro- chip technology, nano-manipulators, nano-imaging tools etc. These techniques area unit supported nanomaterials that area unit ready to provide either improved performance over typical techniques or modify to gather info from a crime scene that may not otherwise are potential ever. This review mainly focuses on Nanoparticles are used in detection of long lasting degraded and aged fingerprints in crime science.

Keywords: Nanotechnology; Forensic investigation; Fingerprints; Nano imaging

Introduction

Fingerprints have served as a unique form of identification for centuries, with their use documented as early as Babylonian clay tablets for business transactions [1]. Traditionally, fingerprint powders adhere to fingerprint residue, highlighting the unique patterns used for individual identification. However, these powders often stain the underlying surface, making it difficult to capture clear fingerprint images for accurate analysis [2]. To address this challenge, forensic science is increasingly exploring nanotechnology for fingerprint development. Unlike traditional powders, engineered nanoparticles offer the potential to enhance fingerprint visibility without interfering with the underlying surface [2]. This can significantly improve the quality of fingerprint images, leading to more accurate identification and clearer evidence in forensic investigations.

Beyond fingerprint development, nanotechnology holds broader promise in forensic science. It can potentially play a crucial role in collecting and analyzing various types of evidence at crime scenes, potentially improving the accuracy and efficiency of forensic investigations [3].

Benefits of Nanoparticles

Nanoparticles' small size, versatility, and ability to tailor their surface properties make them highly attractive for fingerprint detection. This tailored surface modification allows for targeted interaction with specific components within fingerprint residue, leading to enhanced discrimination between fingerprints and background noise [5,6]. Additionally, their unique optical properties can further improve sensitivity and reduce detection limits, particularly when utilizing luminescence to eliminate background interference [6].

Several types of nanoparticles have been explored for this purpose, including:

i. Metal oxides [7]
ii. Gold [8]
iii. Silver [9]
iv. Silicon oxide [10]
v. Semiconductors [11] such as quantum dots

These nanoparticles can be utilized in two main forms:

i. **Dried powders:** This method relies primarily on physical adhesion. An example is oleylamine-stabilized gold nanoparticles, which effectively detect fingerprints due to their attraction to fingerprint residue [12]. However, this method suffers from limited selectivity and potential health and safety concerns.

ii. Suspensions [aqueous or organic solvent]: This approach encourages physico-chemical and chemical interactions with the residue. Examples include gold nanoparticles functionalized with aliphatic chains suspended in petroleum ether [13] and gold colloids enclosed by citrate ions in aqueous solution [14].

Traditional Methods

Powder dusting method

Since the late 19th century this method is more generally useful methods for detection of latent fingerprint on non-porous substrates. The fingerprint powder particles are physically adhered to the aqueous or oily components present in the latent fingerprint residues [15,16] ex: metallic powder, and fluorescent powder.

Cyanoacrylate fuming method

The Cyanoacrylate fuming method, also known as the Super Glue fuming technique, is a popular choice for revealing latent fingerprints on non-porous surfaces. Developed around the late 20th century, it relies on a quick chemical reaction. Cyanoacrylate ester monomers, in their gaseous form, are introduced to the fingerprint residue. These monomers readily bond with initiators like water, acid, or alkali present in the residue. The bonded monomers then react further with each other in the vapor phase, forming a white, durable polymer that coats the raised ridges of the fingerprint, making them visible [15,16].

Silver nitrate method

The silver nitrate method, dating back to the late 19th century, is a traditional technique for revealing latent fingerprints on porous surfaces like paper and wood [15,16]. This method relies on a chemical reaction between silver nitrate and chloride ions present in fingerprint residue. This reaction forms silver chloride, which appears white. Upon exposure to light, especially ultraviolet [UV] light with shorter wavelengths [around 254 nm], the silver ions in the chloride are reduced to elemental silver, resulting in a black stain that reveals the fingerprint ridges. While a straightforward and effective technique for specific surfaces, the silver nitrate method has limitations. Firstly, it is recommended for fingerprints no older than a week. Secondly, a potential drawback is the reduction in contrast due to unwanted background staining from the reaction. Additionally, research by Trozzi et al. [17] explored using an ethanol-based 3% silver nitrate solution for developing latent fingerprints on water-repellent materials like waxed paper [17]. This approach aimed to improve surface wetting and accelerate the process by reducing the dissolving rate of sodium chloride [NaCl] within the fingerprint residue. Overall, the silver nitrate method offers a simple solution for developing latent fingerprints on specific surfaces, but it has limitations in age of fingerprints and potential for background interference.

Ninhydrin method

Ninhydrin is a widely used technique for developing latent fingerprints on porous surfaces like paper, cardboard, and wood. Developed in the mid-20th century, it reacts with amino acids in fingerprint residue to produce a deep purple color [Ruhemann's purple], making the invisible fingerprint visible. Ninhydrin's popularity stems from its ease of use, effectiveness, low toxicity, and ability to develop even aged fingerprints. However, achieving optimal results requires skill and experience due to the specific reaction conditions.

Problems of Traditional Methods

i. Low Contrast

ii. Low Sensitivity

iii. Low Selectivity

iv. Low Toxicity

Advanced Technology [20]

Before dealing with these nanoparticles there are several methods for the detection of finger marks in 21st era of advanced deoxyribonucleic acid technology, fingerprint proof could also be thought-about old-style forensics, however it's not as obsolete as some criminals might imagine. Advanced process technology currently makes developing, collecting, and characteristic fingerprint proof easier and faster. In some cases, even making an attempt to wipe fingerprints clean from a criminal offense scene might not work. Not exclusively has the technology for assembling fingerprint proof improved, however the technology wont to match fingerprints to those within the existing info has been considerably improved (Figure 1).

Advance fingerprint identification technology

In 2011, law enforcement agencies implemented the Advanced Fingerprint Identification Technology [AFIT] system, significantly enhancing their fingerprint processing capabilities. AFIT boasts several key improvements:

i. Increased accuracy: The system boasts matching accuracy exceeding 99.6%, compared to the previous 92%, according to the law enforcement agency.

ii. Enhanced processing capacity: AFIT significantly increases daily fingerprint and latent print processing capabilities.

iii. Improved system availability: The system offers increased uptime and reliability.

iv. Reduced manual review: With AFIT, the need for manual fingerprint reviews has decreased by 90%, saving valuable resources and streamlining the process.

How to cite this article: B Nagashubha, M Kiran S, K Dharani, C, Y Padmanabha R. Magical Nanoparticles - Finger Print Detection in Forensic Pharmacy. J Forensic Sci & Criminal Inves. 2024; 18(3): 555986. DOI: 10.19080/JFSCI.2024.18.555986

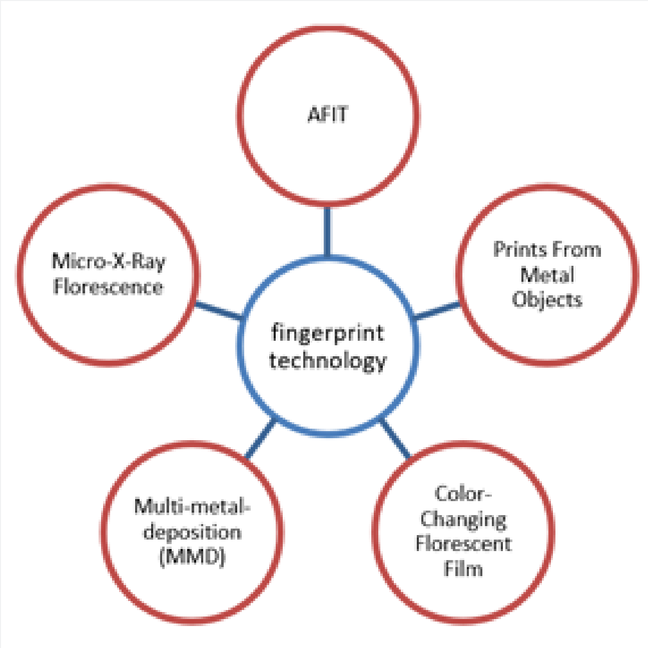

Figure 1: Different methods for detection.

These advancements demonstrate the positive impact of AFIT on law enforcement efficiency. The improved accuracy, processing speed, and reduced reliance on manual review allow for faster and more reliable identification, potentially aiding in solving crimes and improving public safety.

Prints from metal objects

In 2008, researchers at the University of Leicester in the UK made a breakthrough in fingerprint detection. They discovered a novel method to enhance fingerprints on metal objects, ranging from small shell casings to large machine guns. Their discovery hinges on the unique electrical properties of fingerprint residue. The researchers found that these chemical deposits act as electrical insulators, blocking the flow of current even though they are incredibly thin, measuring only nanometers in thickness. Utilizing this principle, the researchers devised a method to deposit a colored film using electrical currents. This film preferentially deposits in the areas devoid of fingerprints, creating a negative image of the fingerprint known as an electrochromic image. This innovative technique holds significant potential in forensic investigations, enabling the recovery of fingerprints from metal surfaces that were previously difficult or impossible to analyze (Figure 2).

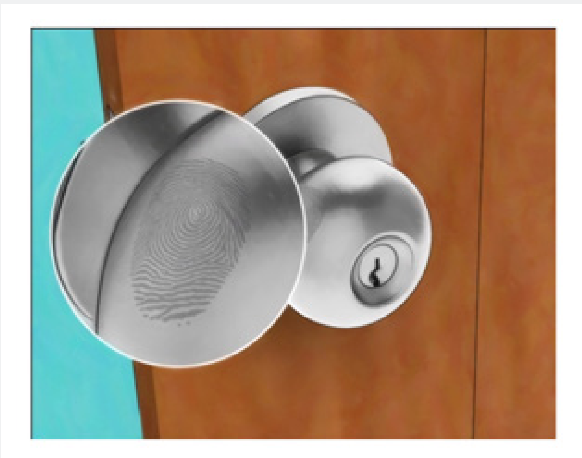

Figure 2: Fingerprints on metal objectives [21].

 How to cite this article: B Nagashubha, M Kiran S, K Dharani, C, Y Padmanabha R. Magical Nanoparticles - Finger Print Detection in Forensic Pharmacy. J Forensic Sci & Criminal Inves. 2024; 18(3): 555986. DOI: 10.19080/JFSCI.2024.18.555986

Colour-changing florescent film:

Building upon their 2008 discovery, Dr. Hillman Robert and his colleagues at the University of Leicester further refined their fingerprint enhancement technique. They incorporated fluorophore molecules into the electrically deposited film. These molecules fluoresce under visible and ultraviolet light, providing an additional tool for forensic scientists. This innovative addition allows for the development of latent fingerprints in various colors using both electrochromic and visible light imaging. Moreover, fluorescent film offers a third color option, which can be adjusted to create high-contrast fingerprint images for improved analysis and identification. This advancement significantly enhances the potential of this technique in recovering valuable fingerprint evidence from challenging surfaces like metal objects (Figure 3).

Figure 3: Color-Changing Florescent latent fingerprints.

Micro-X-ray florescence

Researchers at the University of Golden State, collaborating with Los Alamos National Laboratory, have developed a novel method for fingerprint imaging based on a 2005 discovery. This technique, named the Leicester method, utilizes micro-X-ray fluorescence (MXRF) to detect fingerprints. MXRF works by identifying sodium, potassium, and chlorine elements present in fingerprint residue salts. These elements are mapped based on their location on the surface, revealing the friction ridges, the unique line patterns used for fingerprint identification, wherever the salts are deposited. This essentially allows the method to "see" fingerprints based on the elemental composition of the residue. This new technique offers a promising alternative to traditional fingerprint detection methods and has the potential to be particularly useful for detecting faint or partial prints where conventional techniques might struggle (Figure 4).

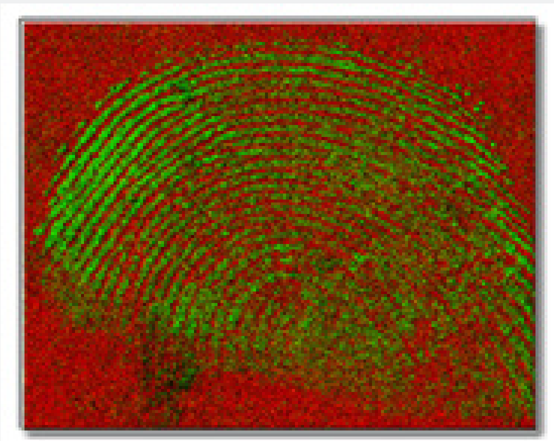

Figure 4: Transmitted X-ray Intensity & Silver distribution.

How to cite this article: B Nagashubha, M Kiran S, K Dharani, C, Y Padmanabha R. Magical Nanoparticles - Finger Print Detection in Forensic Pharmacy. J Forensic Sci & Criminal Inves. 2024; 18(3): 555986. DOI: 10.19080/JFSCI.2024.18.555986

Mapping area: 17 mm x 17 mm & X-ray beam diameter: 10 µm

Micro-XRF analyzers [22]: The Fluorescence micro-analyzers combine the fast, non-destructive elemental analysis of energy dispersive X-ray Fluorescence [EDXRF] with the potential to pinpoint individual particles with diameters down to 10 nanometres in size. Programmed sample scanning provides comprehensive images of constituent distribution, over areas as large as 10cm*10cm.

Multi-metal-deposition [MMD] [23]

MMD was familiarized by Saunders to the forensic field; it is an actually delicate method for picturing latent fingermarks on both porous & non-porous surfaces. This method is a 2-step chemical process [wet] for the detection of latent fingermarks with the help of gold and silver. The procedure contains dipping the fingerprint in gold aqueous solution at small pH values monitored by treatment with physical developer for contrast enhancement.

Magical Nanomaterials

These above motioned methods are commonly used for the detection of fingerprints but here comes magical nanomaterials which are used for the detection of finger prints and at the same time we can improve the long lasting capacity of the prints.

Long lasting luminescent technology

Researchers Develop New Fingerprint Detection Technique with Persistent Luminescence, A novel fingerprinting method using nanomaterials promises long-lasting luminescence, generating sharp images of invisible fingerprints. This technique holds potential to surpass traditional methods in forensic investigations.

Currently, forensic investigators rely on various reagents like black powder, dyes, and fluorescent molecules to reveal fingerprint patterns. However, choosing the optimal reagent depends on the surface type (porous, non-porous, dark, or colored)) and can be challenging. Additionally, traditional methods often struggle with background interference, especially when dealing with surfaces that glow under ultraviolet light, masking the fingerprint details.

Addressing this limitation, researchers at Wuhan University developed a new approach. They synthesized Ternary oxide ($Zn2GeO4$) nanorods doped with Gallium (Ga) and Manganese (Mn), similar to materials used in medical imaging. These nanorods displayed persistent luminescence, glowing even after the UV light source is turned off. The researchers modified the nanoparticle surface to bind with amino acids present in fingerprints. They then tested the technique on a card and a tin can with fingerprints. After applying the nanoparticle solution, rinsing, and exposing the samples to UV light, only the green glow from the nanoparticles remained, revealing fingerprint details like ridges, whorls, and other patterns. Compared to traditional black powder, this method revealed significantly clearer ridge details. Additionally, it successfully detected fingerprints left 60 days prior, a challenge for conventional techniques due to fingerprint decomposition over time. While promising, widespread adoption of this method might face hurdles. Dr. S.S. Anthony, an expert in analytical chemistry, acknowledges the potential for overcoming challenges like background interference and detecting prints on complex surfaces. However, he highlights the difficulty of introducing new protocols into established forensic labs. Nonetheless, researchers remain optimistic, with a forensic institute in Beijing already expressing interest in exploring the potential of this new fingerprint detection tool (Figure 5).

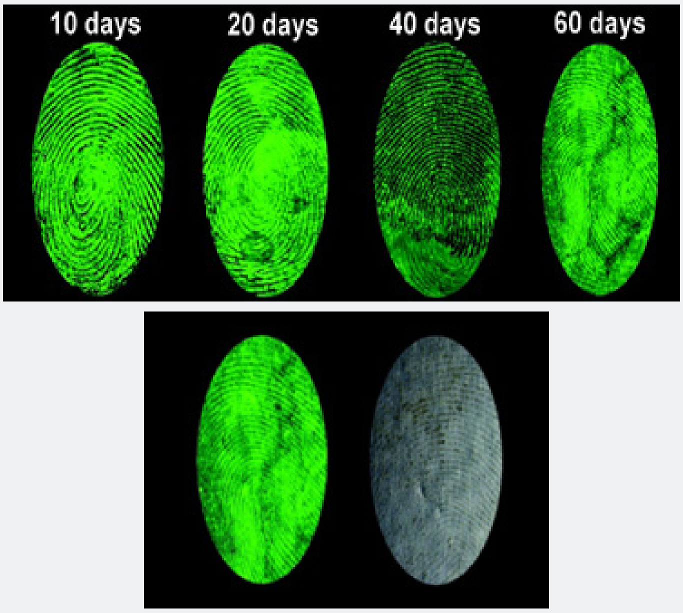

Figure 5: Long lasting fingerprint images.

How to cite this article: B Nagashubha, M Kiran S, K Dharani, C, Y Padmanabha R. Magical Nanoparticles - Finger Print Detection in Forensic Pharmacy. J Forensic Sci & Criminal Inves. 2024; 18(3): 555986. DOI: 10.19080/JFSCI.2024.18.555986

Immune-labelling methods

In this method detection of presence a drug in an exceedingly fingerprint could indicate that a personal has acquire contact thereupon drug, however this is often not enough to prove the employment of that drug as a result of it can't be excluded that the drug was deposited on the latent smirch at an exact time when it had been generated. A successful solution to solve this difficulty was proposed by Russell et al. that involved using gold nanoparticles functionalized with antibodies [25] (Figure 6).

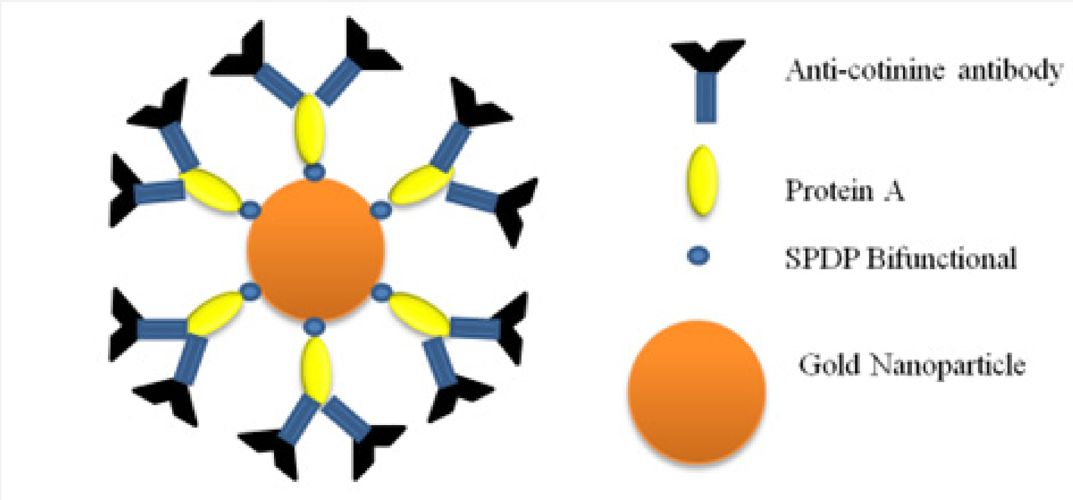

Figure 6: Demonstration of the antibody–Nanoparticle conjugates.

The conjugated with gold Nanoparticles with help of macro-protein "A" and SPDP [N-succinimidyl 3-[2-pyridyldithio] propionate] act as a bi-functional linker. The functionalized Nanoparticles having secondary protein fragment, which were labelled with a fluoresceine, was used to fluorescently label the spot. The high-resolution image was obtained employing a visible light stereomicroscope [26,27]. Some new research work in this field has significantly improved the immuno-labelling image of fingermarks. Spindler et al. completed research on enantio-selective anti-L-amino acid, on non-porous surfaces to detect latent fingermarks. Anti - L - amino acids & anti bodies by direct electrostatic adsorption or by a covalent amide- bonding to the gold [Au] Nanoparticles forms the conjugation. These conjugated Nanoparticles 16nm in diameter and are very effective in detection of degraded and aged finger marks [28].

Small particle reagent (SPR) methods [29]

Newly, research has synthesized innovative Zinc Oxide Silica Core-Shell Nanoparticles [ZnO-SiO2] the fingermarks were developed by using the conventional heating method. Small particle reagent [SPR] method has been successfully useful on semi-porous and non-porous in dry conditions and non-porous surfaces in wet conditions to make visible latent fingerprints.

iMMD [30]

This is Innovative technique that integrates the benefits of the straight MMD method with the help of immunoassay technique [iMMD]. Compared to the straight MMD method, iMMD is faster [less than a one hour], facile, cheap to operate and can deliver extra chemical information than just identification.

Quantum dots utilized in powder dusting method [31]

Quantum dots (QDs) can be used in the powder dusting method similar to traditional powders. They adhere to the water-based (aqueous) or oil-based (oily) components in latent fingerprint residues. This adhesion happens through physical attraction and electrostatic forces, much like traditional fingerprint powders. However, QDs exposed to air after adhering to fingerprints can easily oxidize, which weakens their fluorescent signal. This results in a poor "coffee" contrast, making it difficult to see the fingerprint clearly. Additionally, preserving the fingerprint specimen itself becomes challenging due to the oxidation issue. To overcome this limitation, researchers often combine (conjugate) or coat the QDs with specific materials. These coated QDs, called nanocomposites (NCs), offer improved resistance to oxidation, leading to better long-term preservation of fingerprint evidence and potentially clearer visualization under appropriate light sources.

Magnesium aluminate nanoparticles engrafted by Cu^{2+}

Researchers investigated the use of two types of nanoparticles for developing latent fingerprints: Cu2+ nanoparticles and calcium molybdate (CaMoO4) nanophosphors.

i. **Cu^{2+} nanoparticles:** Synthesized using a combustion method, these nanoparticles showed photocatalytic activity under UV light, enhancing latent fingerprints on smooth surfaces like

How to cite this article: B Nagashubha, M Kiran S, K Dharani, C, Y Padmanabha R. Magical Nanoparticles - Finger Print Detection in Forensic Pharmacy. J Forensic Sci & Criminal Inves. 2024; 18(3): 555986. DOI: 10.19080/JFSCI.2024.18.555986

metal and lead crystal. However, the quality was not optimal, lacking clear individual fingerprint characteristics and pores.

ii. **CaMoO4 nanophosphors:** These nanoparticles possess luminescent properties, allowing fingerprint visualization under visible light with improved contrast and background reduction. They effectively detected ridge details on various non-porous surfaces, including CDs, glass slides, and stainless-steel cups

Some Interesting Research Works Conducted

Nanoparticles have emerged as a promising tool for developing latent fingerprints, often in conjunction with a technique called SALDI-TOF2-MS for identification. This approach builds upon the initial use of magnetic powders in 1961 by M. Donell et al. [36].

Recent advancements showcase the versatility of nanoparticles: chitosan nanoparticles and quantum dots encapsulated in chitosan were used for fingerprints on aluminum [37], while copper-doped zinc sulfide nanoparticles were applied to develop blood fingerprints on various non-porous surfaces [38]. In 2016, Wang et al. demonstrated the use of a simple suspension containing NaYF4:Yb,Er upconversion nanoparticles and a wetting agent for developing fingerprints on diverse substrates [39]. These studies highlight the potential of nanoparticles for sensitive and versatile latent fingerprint development.

Conclusion

This review encourages understanding of the potential of nanotechnology and can make an optimistic community contribution and it'd not only assistance to resolve the crime but also avoid the crime. Within the near future, nanotechnology may support as an advanced and preventive tool within the various field of forensic science like virtual autopsy, crime scene investigation, fingerprint identification, questioned document, ballistics, and toxicology.

References

1. Pitkethly M (2010) Nanotechnology and forensics, mat Today 12(6).
2. Pandya, Shukla (2018) New perspective of nanotechnology: role in preventive forensic. Egyptian Journal of Forensic Sciences (2018) 8: 57.
3. Worley C, Wiltshire S, Miller T, Havrilla G, Majidi V (2006) Detection of visible and latent fingerprints using micro-X-ray fluorescence elemental Imaging. J Fore Sci 51: 57–63.
4. Bécue A, Moret S, Champod C, Margot P (2011) Use of stains to detect fingermarks. Biotechnic & Histochemistry 86: 140-160.
5. Leggett R, Lee-Smith EE, Jickells SM, Russell DA (2007) "Intelligent" Fingerprinting: Simultaneous identification of drug metabolites and individuals by using antibody- functionalized nanoparticles. Angew. Chem Int Ed 46: 4100-4103
6. Bécue A, Cantú AA (2012) Fingermark Detection Using Nanoparticles Lee and Gaensslen's Advances in Fingerprint Technology, (3rd Edtn), Ramotowski RS, Boca Raton, CRC Press, United States pp: 307-379.
7. Choi MJ, McDonagh AM, Maynard P, Roux C (2008) Metal-containing nanoparticles and nano-structured particles in fingermark detection. Forensic Sci Int 179: 87-97.
8. Bécue A, Scoundrianos A, Moret S (2012) Detection of Fingermarks by Colloidal Gold (MMD/SMD) - Beyond the pH 3 Limit. Forensic Sci Int 219: 39-49.
9. Cantú AA (2001) Silver Physical Developers for the Visualization of Latent Prints on Paper. Forensic Sci Rev 13 29-64.
10. Theaker BJ, Hudson KE, Rowell F J (2008) Doped hydrophobic silica nano- and micro- particles as novel agents for developing latent fingerprints. Forensic Sci Int 174: 26-34.
11. Bécue A, Moret S, Champod C, Margot P (2009) Use of quantum dots in aqueous solution to detect blood fingermarks on non-porous surfaces. Forensic Sci Int 191: 36-41.
12. Choi MJ, McDonagh AM, Maynard PJ, Wuhrer R, Lennard C, et al. (2006) Preparation and evaluation of metal nanopowders for the detection of fingermarks on nonporous surfaces. J For Ident 56: 756-768.
13. Sametband M, Shweky I, Banin U, Mandler D, Almog J (2007) Application of nanoparticles for the enhancement of latent fingerprints. Chem Commun 1142-1144.
14. Schnetz, Margot P (2001) Technical Note: Latent fingermarks, colloidal gold and multimetal deposition (MMD) Optimisation of the method. Forensic Sci Int 118: 21-28.
15. Lee HC, Gaensslen RE (2001) Advances in Fingerprint Technology. (2nd Edtn) Boca Raton, CRC Press, United States.
16. Ramotowski RS Lee (2012) Gaensslen's Advances in Fingerprint Technology. (3rd Edtn) Boca Raton, CRC Press; United States.
17. Trozzi TA, Schwartz RL, Hollars ML (2000) Processing Guide for Developing Latent Prints. Federal Bureau of Investigation, United States.
18. Ramotowski RS Lee (2012) Gaensslen's Advances in Fingerprint Technology. (3rd Edtn) Boca Raton, CRC Press; United States.
19. Oden S, Hofsten BV (1954) Detection of fingerprints by the ninhydrin reaction. Nature 173(4401): 449-450
20. Automated Fingerprint Identification System (AFIS) overview - A short history.
21. How to Dust for Fingerprints.
22. X-ray Fluorescence Analyzers [XRF]. Horiba Scientific.
23. Schnetz, Margot P (2001) Technical Note: Latent fingermarks, colloidal gold and multimetal deposition (MMD) Optimisation of the method. Forensic Sci Int 118: 21-28.
24. Melissae Fellet (2017) Luminescent nanoparticles leave a glowing fingerprint. C & EN.
25. Leggett R, Lee-Smith EE, Jickells SM, Russell DA (2007) "Intelligent" Fingerprinting: Simultaneous identification of drug metabolites and individuals by using antibody- functionalized nanoparticles. Angew Chem Int Ed 46: 4178-4181.
26. P Hazarika, SM Jickells, K Wolff, DA Russell (2008) Imaging of Latent Fingerprints through the Detection of Drugs and Metabolites. Angew Chem Int Ed 47: 10167-10170.
27. P Hazarika, SM Jickells, DA Russell (2009) Rapid detection of drug metabolites in latent fingermarks. Analyst 134: 93-96.
28. X Spindler, O Hofstetter AM, McDonagh, C Roux, C Lennard (2011) Enhancement of latent fingermarks on non-porous surfaces using anti-l-amino acidantibodies conjugated to gold nanoparticles. Chem Commun 47: 5602-5604.

29. Arshad A, Farrukh M, Ali S, Khaleeq-ur-Rahman M, Tahir M (2015) Development of latent fingermarks on various surfaces using ZnO-SiO2 nanopowder. J Fore Sci 60: 1182-1187.

30. Y He, L Xu, Y Zhu, Q Wei, M Zhang et al. (2014) Immunological Multimetal Deposition for Rapid Visualization of Sweat Fingerprints. Angew Chem Int Ed 126: 12817-12820.

31. De Rosa G, Caraglia M (2013) New Therapeutic Opportunities from Old Drugs: The Role of Nanotechnology? J Bioequiv Availab 5: e30.

32. Wang W, Guihai Chen, Yongping Chen (2013) Nanotechnology as a Platform for Thermal Therapy of Prostate Cancer. J Mol Biomark Diagn 4: e117.

33. Mansoori GA (2013) Diamondoids -The Molecular Lego of Biomedicine, Materials Science and Nanotechnology. J Bioanal Biomed 5: e116.

34. Hadi NI (2012) Electrical Conductivity of Rocks and Dominant Charge Carriers: The Paradox of Thermally Activated Positive Holes. J Earth Sci Climate Change 3: 128.

35. MacDonell HL (1961) Bristless brush development of latent fingerprints. Ident News, 11: 7.

36. Dalrymple B, Duff JM, Menzel ER (1977) Inherent Fingerprint Luminescence—Detection by Laser. J Forensic Sci 22: 106.

37. Dilag J, Kobus H, Ellis AV (2009) Cadmium sulfide quantum dot/ chitosan nanocomposites for latent fingermark detection. Forensic Sci Int 187: 97.

38. Moret S, Becue A, Champod C (2013) Cadmium-free quantum dots in aqueous solution: Potential for fingermark detection, synthesis and an application to the detection of fingermarks in blood on non-porous surfaces. Forensic Sci Int 224: 101.

39. Wang M (2016) Latent fingermarks light up: facile development of latent fingermarks using NIR-responsive upconversion fluorescent nanocrystals. RSC Adv 6: 36264.

How to cite this article: B Nagashubha, M Kiran S, K Dharani, C, Y Padmanabha R. Magical Nanoparticles - Finger Print Detection in Forensic Pharmacy. J Forensic Sci & Criminal Inves. 2024; 18(3): 555986. DOI: 10.19080/JFSCI.2024.18.555986