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THE SIGNIFICANT ROLE PLAYED BY NANOPARTICLES IN DEVELOPMENT OF FINGERPRINTS

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INTRODUCTION

Fingerprints are one of the most significant pieces of evidence found in the Scene of Crime (SoC) as they are unique, permanent, and can be classified by analyzing friction ridge skin found on the tip of our fingers. When in contact with a surface, it leaves a Latent Print (LP) due to the secretions of apocrine, eccrine, and sebaceous glands.

Different techniques are employed for the development of latent fingerprints found in the SoC, physical methods: dusting powder - black, magnetic, fluorescent powders, and chemical methods - iodine, cyanoacrylate fuming, silver nitrate.

Currently, a new method employed for fingerprint analysis uses nanoparticles whose sizes range between 1 to 100 nanometers as it produces high-quality images with clear ridge characteristics, increased contrast against the background, and visibility. They have properties like low size, large surface area, and optical properties that favor the interaction of fingerprint residues with porous and non-porous surfaces. The major advantage is it helps in the detection of both fresh and aged fingerprints.

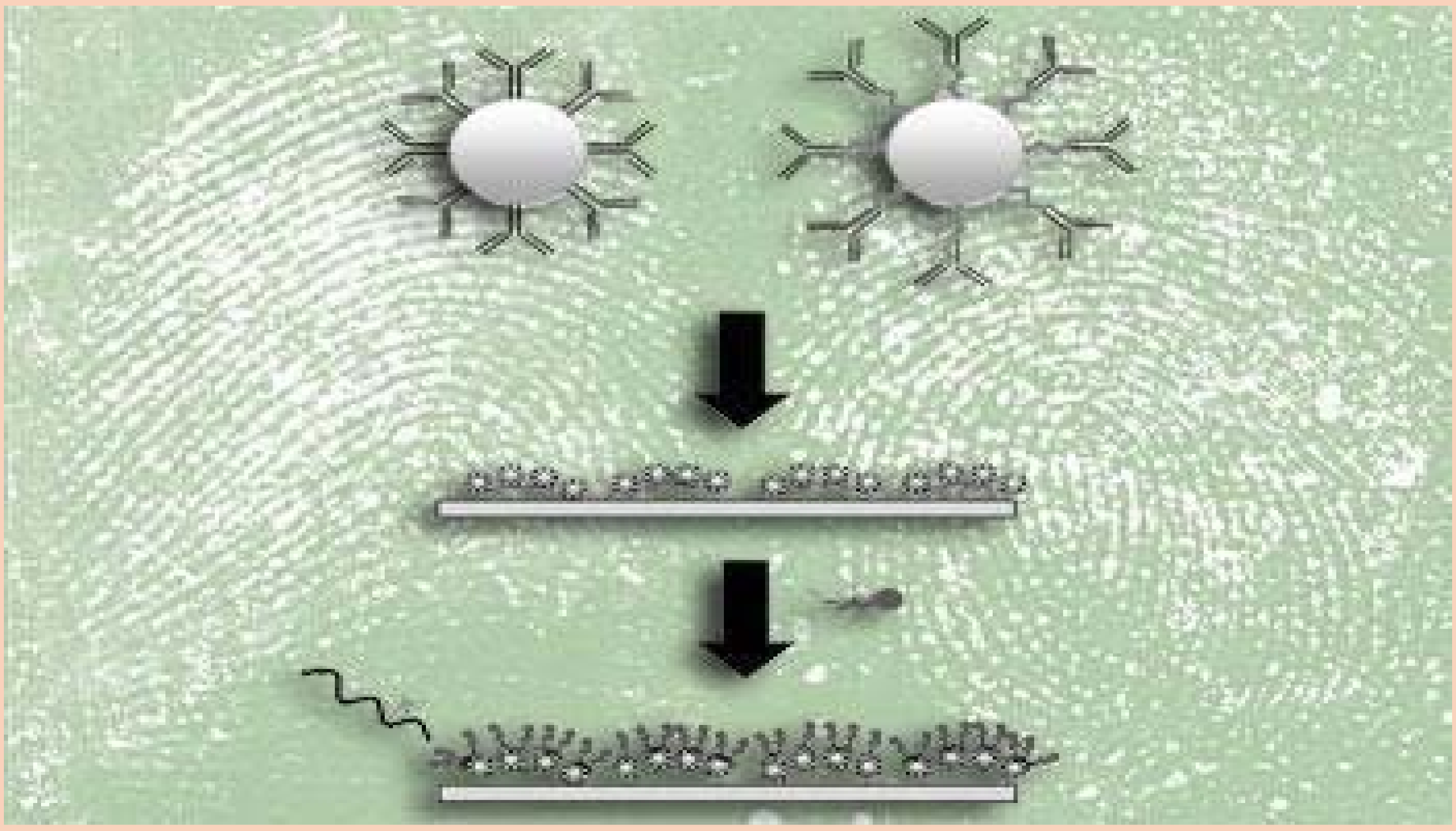

IMAGE: Nanoparticles adhering to the fingerprint residue
SOURCE: https://d2cbg94ubxgsnp.cloudfront.net/Pictures/480xA-ny/2/8/7/124287_fingerprint-350-for-tridion_tcm18-200397.jpg

Further discussing the significance of different nanoparticles in fingerprint analysis:

1. SILVER NANOPARTICLES

Silver nanoparticles have been employed since the 1970s in the UK for the detection of fingerprints. The theory behind development using the Ag-PD method was found in 1983.

- It works on the principle that colloidal silver has an affinity towards the organic components present in the fingerprint residue.
- The Ag-PD technique is known to be the best for the development of latent prints in wet conditions and on porous surfaces.
- Iron salt is used to reduce silver nitrate to colloidal silver that reacts with the organic part of the fingerprint residue to produce a black-silvery image which aids in effective visualization.

2. SILICA NANOPARTICLES

IMAGE: Developing fingerprint using Silica nanoparticle

SOURCE: https://d1otjdv2bf0507.cloudfront.net/image-handler/ts/20200203055752/ri/750/src/images/Article_Images/ImageForArticle_5427_15807274706453894.png

- The development of latent prints using silica nanoparticles creates a good contrast image showing detailed ridge characteristics due to the coating ability of the dye and ease in synthesis.
- Silica nanoparticles are mostly doped with a dye for the development on non-porous surfaces as it prevents photodecomposition, aiding in the long life of the latent print.
- Recent research has found that amphiphilic silica nanoparticles have an affinity towards amino acids in the fingerprint residue, therefore providing a good quality image.

3. GOLD NANOPARTICLES

Gold nanoparticles are unique as they have properties like long shelf-life, resistance to oxidation, chemical inertness, and a strong reactant towards metallic surfaces, which aids in fingerprint analysis.

- They were processed with thiolate cyclodextrin, and along with a dye, they were found suitable for the development of LP on porous and non-porous surfaces.
- Gold nanoparticles were also functionalized with anti-cotinine antibodies, which provided individual identity and a better way to identify drugs from fingerprints.
- When gold nanoparticles were combined with amino acid-binding antibodies and red fluorescent secondary antibodies that adheres to the LP, it aided in visualizing prints almost 12 months old.

4. ZINC OXIDE (ZO) NANOPARTICLES

- ZO nanoparticles are an effective powder for the development of latent prints as they possess fluorescence.
- As per studies conducted, zinc oxide nanoparticles show fluorescence under UV light which helps in better visualization on non-porous surfaces.
- ZO nanoparticles, when combined with silica nanoparticles, produce a good contrast fingerprint on non-porous surfaces like glass, plastic, metal.

5. QUANTUM DOTS (QDs)

- These are semiconductor nanocrystals used for fingerprint development.
- Cadmium Telluride (CdTe) QDs are fluorescent. When combined with non-toxic silica nanoparticles, they give enhanced images with good ridge details and less background staining on non-porous surfaces.

- Highly fluorescent, water-soluble CdTe QDs were processed with Mercaptosuccinic acid (MSA) at a pH of 10. The LP can be processed by immersing the non-porous and porous surface in the QD solution for 1-3 seconds.
- Fingerprints were developed on an aluminum foil surface by a dusting powder made by combining Cadmium Sulfide, which is a highly photoluminescent QD, along with Chitosan mixture and Sodium Sulfide.

CONCLUSION

Fingerprints are the unique evidence found in an SoC due to their ability to individualize and link the perpetrator to the SoC or the victim. The development methods used play a crucial role in obtaining accurate results during fingerprint analysis. The conventional methods used for development may not be efficient enough to obtain prints in wet conditions, aged prints, or detect hidden prints. Development using nanoparticles was proven to be more effective by overcoming certain drawbacks faced previously. Different nanoparticles like gold, silver, zinc oxide, silica, QDs were very effective in development on both porous and non-porous surfaces. They produced fingerprint images of enhanced contrast and less background staining, and their adhering property helped in better visualization. Therefore, development using nanoparticles has proven to be a great asset in the field of forensic science, thereby having a great applicative potential in the future.

REFERENCES:

- Prasad, Prasad, P. Chandravanshi, Lukose, and Agarwal. (2020). The Emerging Role of Nanoparticles in Forensic Fingerprinting. Journal of Seybold Report, 15(9), 2124-2131.
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