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Fluorescent silica-nanomaterials as a developing agent in the detection of latent fingerprints

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Latent fingerprint detection plays a major role in forensic science. Numerous techniques have been developed for the visualization of fingerprints, among which, nanoparticles are potential candidates due to their high selectivity and sensitivity compared to conventional methods. Out of different types of nanoparticles that have been used so far, silica nanoparticles provide a convenient approach due to their synthetic simplicity, biocompatibility, ease of surface modification, and high surface to volume ratio. In this study, fluorescein isothiocyanate (FITC) encapsulated silica nanoparticles were prepared with Stöber and reverse microemulsion methods. FITC was conjugated to 3-aminopropyltriethoxysilane to achieve covalent attachment with the silica matrix, which reduces dye leakage. The nanoparticle surface was modified with carboxyl groups to facilitate binding with proteins and amino acids in the fingerprint residue through peptide bonds. The nanoparticles were characterized using scanning electron microscopy (particle size 742 nm and 139 nm for Stöber and microemulsion, respectively), fluorescence spectroscopy (emission at 521 nm) and X-ray diffraction ($2\theta = 22.66°$). Functionalization and dye doping were characterized using Fourier transform infrared (FTIR) spectra. Two different experiments were done in fingerprint development. Firstly, to study their suitability to develop latent fingerprints on four non-porous substrates (aluminum foil, plastic, stainless steel, and glass slide), the synthesized nanoparticles were applied onto the substrates and illuminated under UV light for visualization. Secondly, they were aged for different time intervals (5 min, 30 min, and 3 weeks after deposition) their ability to develop fingerprints. Luminescent nanoparticle powder works well on aluminum substrate and elicits satisfactory results on other substrates. For aged fingerprints, aluminum foil produces a clear ridge pattern while the remaining substrates produce diffuse fingerprint images. While both types of silica nanoparticles are potential candidates for latent fingerprint development, reverse microemulsion method was the best with a clearer ridge pattern being revealed. Chemically stable covalent attachment between dye conjugate and silica matrix reduces the dye leakage, in the range of 14%-16%. It ensures that FITC-doped silica nanoparticles have a minimum dye leakage during the application and storage process which makes them a potential agent for latent fingerprint development.

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