Y4 Analysis of Upconverting Nanoparticles for Latent Fingerprint Detection

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Learning Overview: The goal of this presentation is to present research conducted with the Security Printing and Anti-Counterfeiting Research Experience for Undergraduates (REU) at the South Dakota School of Mines and Technology. The research focused on testing and optimizing applications of upconverting nanoparticles to improve latent fingerprint detection on difficult substrates.

Impact on the Forensic Science Community: This presentation will impact the forensic science community by providing an investigation into a potential latent fingerprint detection method that, if fully optimized and implemented, could improve the detection of latent fingerprints on fluorescent substrates. This presentation details current application methods, analyzes the utility of alternative application methods, and suggests the direction of future research.

Because of fingerprints' value as forensic evidence in courtrooms around the world, continued research into latent fingerprint development methods remains important. In this study, two novel application methods for $NaYF_4$:Yb,Tm Upconverting Nanoparticles (UCNPs) are considered. UCNPs have previously been investigated for their utility as latent fingerprint-detecting powders given their anti-Stokes properties that can allow for the visualization of fingerprints on colorful, fluorescent backgrounds, which are currently incompatible with many traditional development techniques. Donor fingerprints were deposited on cleaned glass and silicon substrates using a split print method to directly compare the effects of two methods. The UCNPs were prepared in organic solvent dispersions of toluene and chloroform and a soybean oil-in-water emulsion and applied by immersing the substrate, and, in the case of the emulsion, spraying the substrate. The results were subsequently imaged using a 980nm laser and camera, a Scanning Electron Microscope (SEM), an optical profilometer, and a video spectral comparator (VSC).

The UCNP emulsion was found to have little utility as a fingerprint development agent because of the oil residue left on substrate. This residue was difficult to remove and impaired imaging. The toluene dispersion appeared more promising, especially when prepared in a concentration of 1wt% and when washed by immersing in toluene following the application of the dispersion. Additionally, the fingerprints did not appear to dissolve in the toluene when submerged for short periods. With this application and proper imaging, visualization of fingerprint ridges was possible on some of the glass and silicon substrates tested. Further research should concentrate on the formulation and application of organic solvent dispersions to improve the adhesion to the print, reduce background staining, and improve imaging procedures. Additionally, investigating upconverting nanoparticles of varying sizes may also optimize imaging.

Nanoparticles, Latent Fingerprints, Upconversion