C39 Visualization of Latent Fingerprints Using Columnar Thin Films

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After attending this presentation, attendees will have gained knowledge and insight into a new latent fingerprint development technique that does not rely on mechanical or chemical interactions, but instead on surface topology of latent fingerprint ridge detail. Information on optimization of conformal-evaporated-film-by-rotation (CEFR) development for latent fingerprint visualization on multiple substrates as well as comparisons to traditional techniques using split fingerprints and depletion studies will be presented.

This presentation will impact the forensic science community by allowing for an additional option for latent fingerprint development where traditional methods are not ideal or inapplicable. Forensically relevant surfaces for which either typical development methods are ill-suited or multiple techniques are necessary will now have an additional one-step technique available for forensic investigators to utilize.

Similar to vacuum metal deposition, columnar thin film (CTF) technology is a form of physical vapor deposition under vacuum conditions: thermal evaporation of a source material and subsequent condensation of the vapor create a thin film on a substrate that rotates above the vapor flux. Nano-scale CTFs have been employed in optical applications and in materials engineering for more than a century. Typically, surface defects, such as dust or debris, are highly problematic as once a thin film begins to develop on a substrate, the defect results in a non-uniformity, with the underlying defect propagating through the growing film. This phenomenon is, however, ideal for replicating latent fingerprint ridge detail as the topography or surface texture is essentially copied as the film grows. This results in observable contrast between the fingerprint ridge detail and the underlying substrate.

A systematic study was carried out in order to determine the optimal deposition parameters necessary to visualize the best contrast and clarity of developed fingerprint ridge detail. The clarity of development was such that level three details could be resolved. CTF formation was found to rely on: base vacuum pressure during deposition, the average angle of the vapor flux relative to the substrate plane, substrate rotation rate, evaporant material deposition rate, and final film thickness.

Subsequent to the determination of optimal development parameters, the new technique was applied to forensically relevant substrates for which current development techniques are either undesirable or inapplicable. Surfaces such as brass, stainless steel, and various plastics, woods, and adhesive tapes underwent CEFR development using multiple evaporant materials. The evaporant materials utilized included: chalcogenide glass, gold, germanium oxide, nickel, and magnesium fluoride. Each evaporant material was employed on each substrate to determine optimal development conditions for differing surfaces. Split fingerprints were also placed on each substrate, with one half of each print being developed using the optimized CEFR technique, and the other half being developed with traditional techniques such as regular, magnetic, and fluorescent powder dusting, cyanoacrylate fuming, or other techniques recommended for that surface.

The optimal vacuum conditions were determined to be: base pressure of 0.1 mTorr, vapor flux angle of 10 deg, rotation rate of 3 rps, deposition rate of 1 nm/s, and a variable final film thickness of 50-1000 nm depending on the combination of the evaporant material and the substrate under investigation. Multiple evaporant materials were found to be optimal, depending on the underlying substrate. Chalcogenide glass, gold, and nickel all produced development with high contrast and clarity on the substrates investigated, while germanium oxide and magnesium fluoride did not produce optimal results.

Current research is still investigating and assessing the advantages of CEFR technique over traditional fingerprint development techniques on various surfaces, as well as the sensitivity of the technique compared to traditional techniques. The optimal base vacuum pressure found greatly reduces the requirements of a vacuum evaporation chamber necessary for this technology, which allows for increased use of this technique for on-scene development of latent fingerprints in the field. This also greatly reduces equipment cost and increases availability of the new development technique to crime laboratories and law enforcement agencies.

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Latent Fingerprints, Conformal-Evaporated-Film-by-Rotation Technique, Columnar Thin Film

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