Visualization of latent fingerprints using evaporated metal thin-films.

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Abstract

The commonly used detection and preservation of latent fingerprints methods employ dry powders or wet chemistry principles to visualize the samples in the field and also for laboratory analysis. This research examines a rarely-used technique to visualize latent fingerprints with a secondary purpose of preservation as the sample fingerprints may be exposed to extreme conditions. The method employs physical vapor deposition of silver deposited on glass, plastic, paper and metal substrates. Varying thicknesses of silver ranging from 1.0 nm to 10.0 nm are deposited on substrates and examined for optimal spectral, transmittance and reflectance signals. Subsequent analysis repeats the spectral examination of latent fingerprints contained on the surfaces after the vapor deposition and addresses the optical properties and visualization methods of fresh and weathered latent prints.

Objective:

This project will focus on testing the viability of using resistive evaporation to deposit metals on the surface of substrates containing latent materials and specifically to clearly visualize fingerprints found on those substrates. The objectives of this project are to:

- Perform Ag PVD on Cu, Al, plastic, paper, glass 1.0nm to 12 nm in 0.5nm increments to establish visual and spectroscopy baseline data.
- Perform Ag PVD on Cu, Al, plastic, paper, glass, 1.0nm to 12 nm in 1.0nm increments with eccrine and sebaceous fingerprints to determine optimal PVD thickness visualization.
- Determine advanced aging degradation of samples by heating and immersion in water and lipids and to determine if the Ag layer enhances the lifetime of the latent fingerprints.

Method

Silver (Ag) is used as the metal to be deposited on the surface of the material of interest. Varying thickness of Ag will be deposited with equal intervals of 0.5nm from 1nm to 12nm. PVD will be used to deposit the highly pure, solid coating material (in this case, silver-Ag). Physical Vapor Deposition (PVD) techniques are used to deposit metals on the surface of the materials of interest. It is a process performed at high vacuum at temperatures between 150° C and 500C (Oerlikon et al. 2014). The highly pure, solid coating material (in this case, silver-Ag) is evaporated by heat and sublimated on the surface of the materials as a thin, highly adherent coating. It is evaporated by heat in vacuum and sublimated on the surface of the materials as a thin, highly adherent coating. This is what a PVD looks like:

The color of the thin metal film is different for every thickness and material used therefore a spectroscope will be used to measure this color spectrum. The percentage transmittance will be recorded for the film thickness in the Visible light wavelength range for every thickness of silver deposited.

Figure 2: (thin films of Ag deposited and their color intensities observed, with thickness starting from the left with 1.0nm, 3.0nm, 5.0nm, 7.0nm and 10.0nm respectively)

Figure 1 shows a few slides of the different intensities and colors formed with varying thickness of Ag.

PVD was used to deposit these thin films on glass slides and as the thickness increases, the color observed was darker. Same range of the thickness of Ag will also be deposited on plastic and Copper slides and the color intensities of those will be compared to that with glass. The human eye cannot precisely determine the exact intensity changes in colors that are visible; therefore, spectroscopy is employed to measure color intensities. Spectroscopy is a term used to refer to the measurement of radiation intensity as a function of wavelength, and in this case the wavelength observed is in the visible light spectrum. Percentage transmittance for 1nm, 3nm and 5nm thickness of Ag was recorded and the graph for that is shown in Figure 2 below. In this graph, it's apparent that as the thickness of Silver deposited increases, the peak shifts to the right and becomes flatter. This gives us an idea that there is a mean peak of percentage transmittance at a certain wavelength and that would be explained in greater detail with more samples tested on a range of Silver thickness.

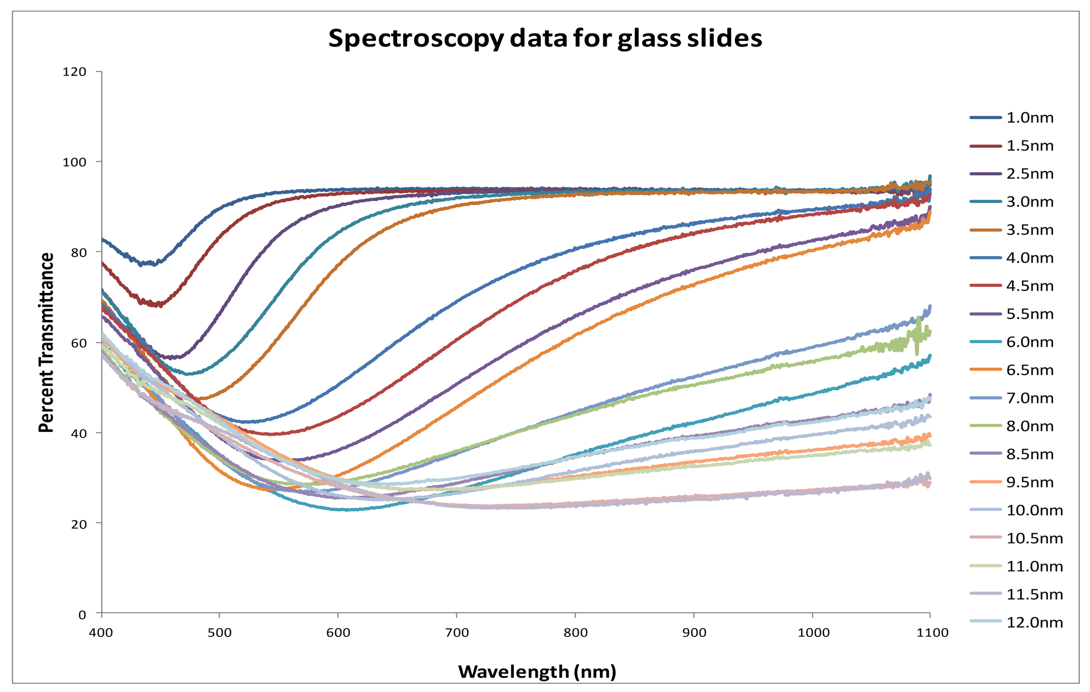


Figure 3: Percentage transmittance observed for 1.0nm, 3.0nm and 5.0nm thickness of Silver metal deposited

In Figure 3, it is apparent that the wavelength of the fingerprint observed is in the visible light spectrum since its color is visible by the human eye. However, spectroscopy is employed to measure the exact intensity of the color observed. Using that it will be easier to determine what thickness of Silver will give the greatest intensity of the color observed and makes it easier for the detection of fingerprints.

Results

The spectroscopy data for glass slides showed that it 's peak transmittance is at 5nm and that is where the fingerprints are to be clearly seen. For Copper slides, since the metal itself is colored, brown, therefore it's peak transmittance is in the 10nm thickness of silver:

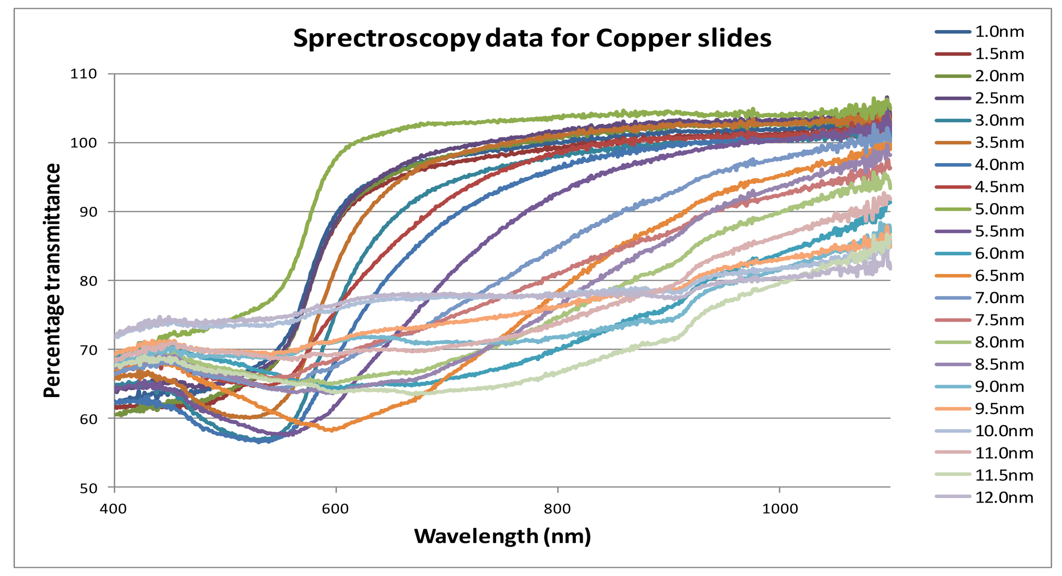
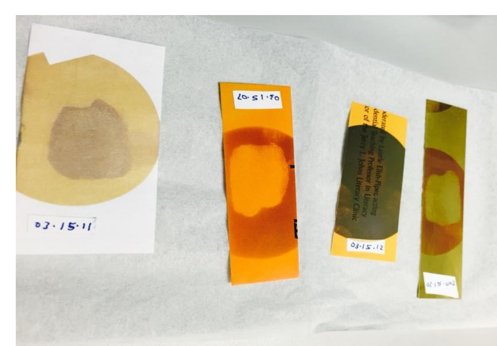


Figure 3: Percentage transmittance observed for glass slides from 1-12nm

The Silver metal was deposited on the slides with fingerprints on it and microscopic images were observed of these slides:



Conclusions:

The final product of this project will be the evidence that detection using an evaporated metal film is a highly efficient way to detect latent fingerprints. Observing the graph shown above, as thickness increases, the peak transmittance decreases and shifts towards the right. Therefore, by observing the trend, it is likely that the mean peak of all the regular intervals from 0.5 to 12nm will be in the middle of the visible light spectrum.

Acknowledgments

I would Like to thank my mentor Dr. Martin Kocanda for putting in so much time and effort in this project with me and helping me every step of the way. I would also like to thank the NIU Research Rookies program for funding this Research and supporting me in this Research every step of the way.