FLUORESCENT SILICA NANOPARTICLES FOR LATENT FINGERPRINT DEVELOPMENT AND ANALYSIS

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Abstract

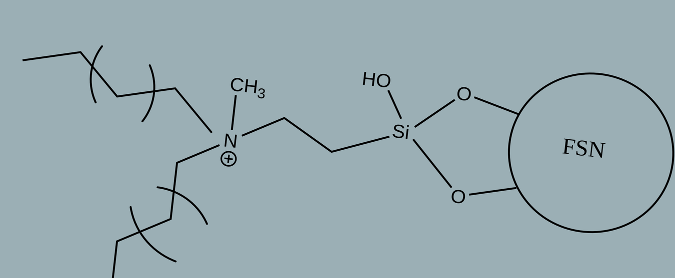
Fluorescent silica nanoparticles (FSN) were prepared by incorporating rhodamine 6G dye into mesoporous silica nanoparticles and used to develop and analyze latent fingerprints. The surface of the particles was modified to create particles that are best suited to develop prints on glass, plastic, and aluminum surfaces. Fingerprints can be lifted from their surface of origin and preserved or chemically analyzed. A method to lift and analyze trace evidence by TLC MS on the lifted print was developed. As a proof of concept, Thiamine was added to a print and detected on the lifted print. Not only can fingerprints be lifted and analyzed, they can also be re-dusted subsequent to lifting and still produce a distinguishable print.

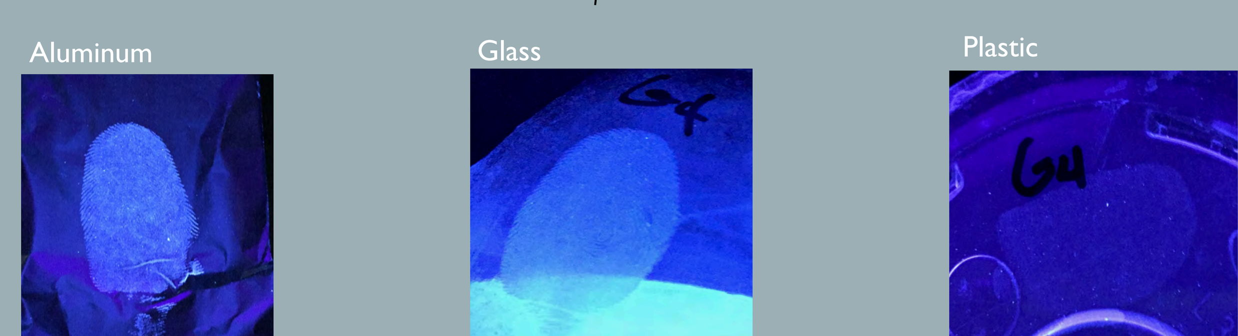
Results and Discussion

Functionalization and Surface Analysis

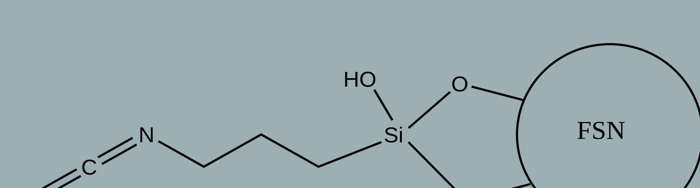
The surface of FSNs can be modified using siloxane chemistry. It was determined that hydrophobically modified particles and isocyanate functionalized particles were the most effective. The hydrophobically modified particles were created by reacting native FSN with N,N-Didecyl-N-Methyl-N-(3-Trimethoxysilylpropyl) Ammonium Chloride, while the isocyanate functionalized particles were prepared by reacting native FSN with 3-Isocyanatopropyltriethoxysilane. Both were tested on prints on different surfaces and compared. The hydrophobically particles were more effective and could adhere better to the oils of a print than the isocyanate particles on glass surfaces. However, isocyanate particles were more effective on plastic and aluminum. This was tested on aluminum soda cans, glass bottles, glass slides, tin foil, plastic, etc. and all tests showed the same results.

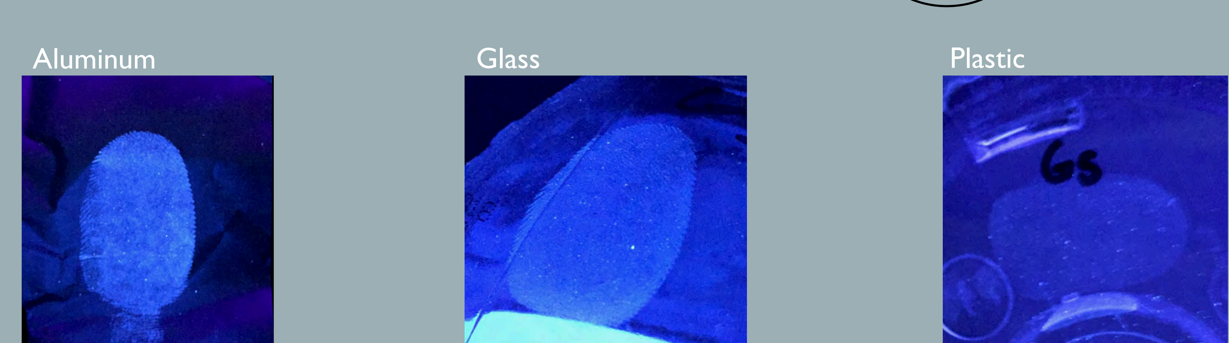
Hydrophobically Modified





Isocyanate

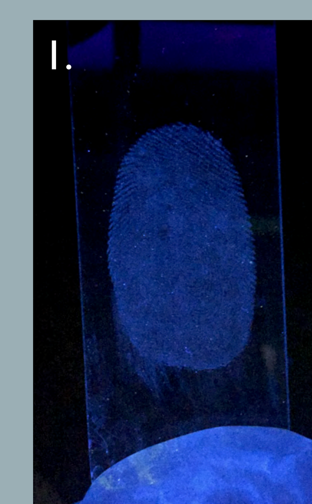




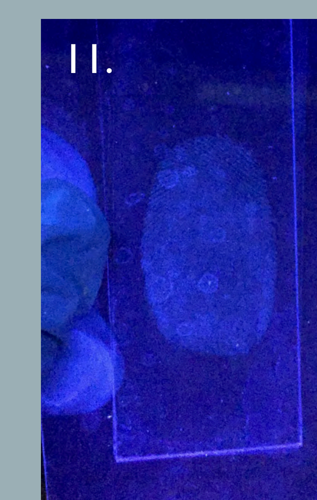
Fingerprint Preservation

Prints can be lifted for preservation purposes or chemical analysis. Clear packing tape was used to preserve a print's ridge detail and patterns. This was the most effective as it was still clearly transparent under UV light. Other tapes, like Scotch, we found to be difficult to see in both natural and ultraviolet light due to the film on the non-adhesive side.

Fingerprint Preservation



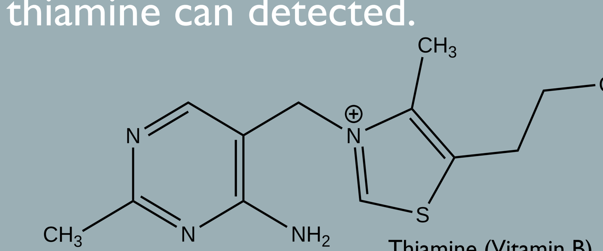
Before lifting and preserving, a fingerprint was dusted with the hydrophobically modified particles seen on the left in picture I.

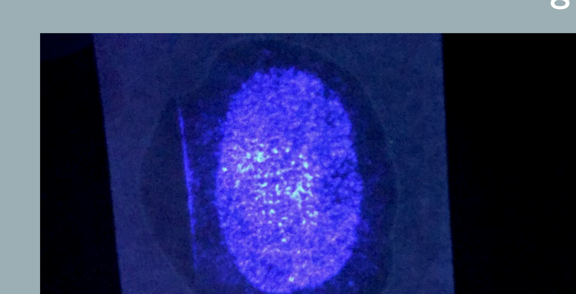


A thin piece of clear packing tape was then used to lift the print from it's original surface and placed on a new clean glass slide. As shown in picture II, the details of a print can then be preserved for further analysis.

Chemical Analysis of Lifted Fingerprints

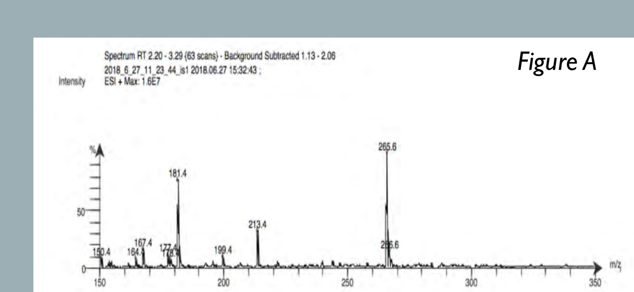
FSN dusted prints can be lifted onto chromatography paper and then analyzed by TLC-mass spectrometry (TLC-MS). To demonstrate that trace amounts of chemicals within fingerprints can be detected using this strategy, thiamine was used as a model compound. A gloved thumb was pressed into thiamine then printed on a selected surface. After dusting the surface with FSN, the print was lifted onto chromatography paper and analyzed by TLC-MS. Thiamine was detected within multiple areas of the print. Serial dilutions of thiamine were then made to determine the lowest amount of thiamine the instrument could detect. The results indicate that nanograms of thiamine can detected.





A lifted fingerprint under ultraviolet light

Thiamine TLC-MS Analysis



The most concentrated dilution was 230µg/mL. On Figure A, 265.6m/z is the highest peak, and it has the highest percentage of relative intensity. This mass to charge ratio is in conjunction with thiamine's molecular weight, 265g/mol.

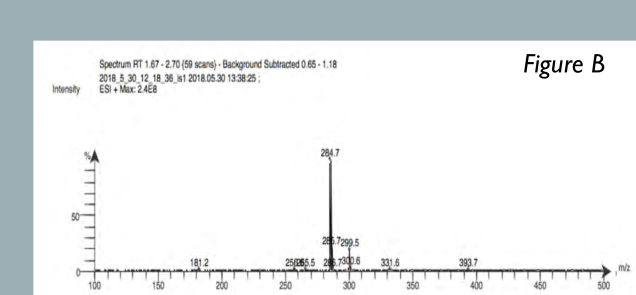


Figure B is a mass spectrum of a normal lifted fingerprint with only hydrophobically modified particles. There is little to no relative intensity at 265m/z (where thiamine would be).

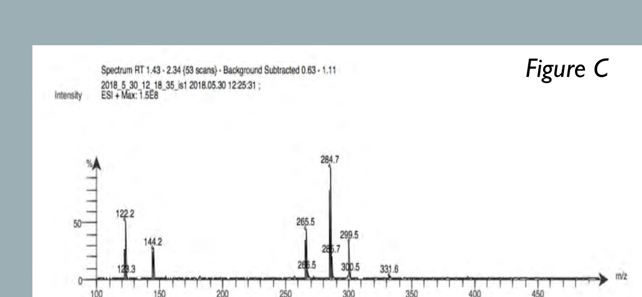
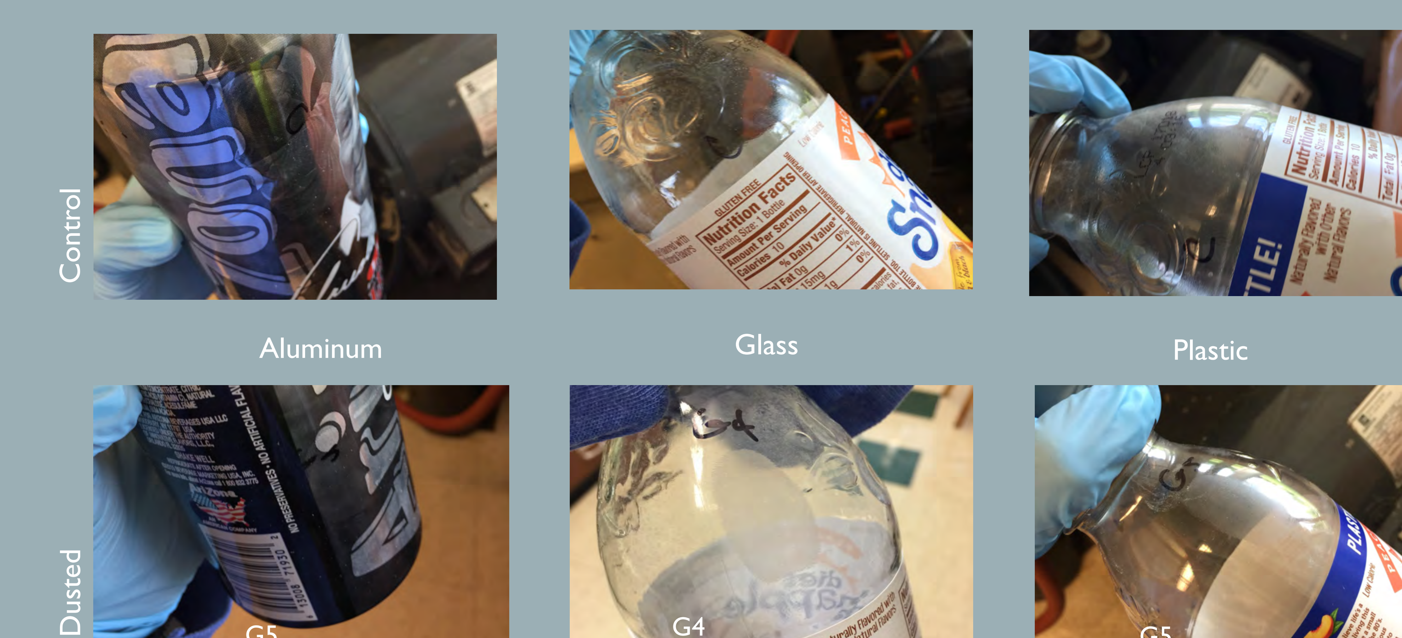


Figure C is a mass spectrum of a lifted fingerprint with hydrophobically modified particles and thiamine. Thiamine's molecular weight is 265g/mol. There is a clear peak at this point 265m/z.

Enhanced Super Glue Fuming

A common technique to develop fingerprints used in forensic science is super glue fuming. A few drops of super glue is added to a metal dish on a hot plate, and left in a chamber for approximately 15-20 minutes along with the various items needing to be fumed. As the dish is heated, super glue particles are released into the chamber and adhere to the oils found in a fingerprint. Fluorescent Silica Nanoparticles also adhere to these oils, so in an effort to seek improvement, they were added to this procedure. A print was dusted previous to fuming with hydrophobically modified particles and placed in the chamber, along with a print with no FSNs for comparison. It was confirmed that with the use of FSNs there was a significant increase in visual clarity seen under both natural and ultra violet light. Prints that were dusted were clear and vibrant, while the control group was barely visible. These results were found on every surface used (aluminum, plastic, and glass) and found with both the hydrophobically modified and isocyanate particles. Certain surfaces worked better with either of the two Generations, further confirming our previous analysis in surface effectiveness.

Control and Dusted Comparison



Conclusions

- Hydrophobically modified FSNs are more effective on glass surfaces
- Isocyanate FSNs are more effective on aluminum and plastic surfaces
- Fingerprints can be preserved using clear packing tape for detail analysis
- The TLC-MS can detect levels of thiamine into the nanograms
- FSNs dusted on prints previous to fuming improve visual clarity in both natural and ultra violet light.

Acknowledgements

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