The Effects of Cyanoacrylate Fuming on the FTIR Classification and Comparison of Polymers

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Abstract

Cyanoacrylate fuming is a common method used in forensic science to develop and preserve latent fingerprints on evidence either in the field or at the laboratory; however, the chemistry of cyanoacrylate during the fuming process may also react with polymers found commonly in trace evidence samples. Polymer samples were collected from six different sources: tool paint, spray paint, architectural paint, automobile paint, glitter, and synthetic fibers. All samples were fumed with cyanoacrylate at least once and analyzed using a Thermo Nicolet Continuum FTIR microscope instrument. Comparisons of the fumed sample IR spectra were then compared to their non-fumed IR spectra. Future research can be done in developing a non-destructive clean-up method to remove the cyanoacrylate from trace polymer samples.

Introduction

This research project's goal was to determine if the cyanoacrylate fuming process hinders the ability of forensic trace examiners to accurately classify and compare polymer trace evidence.

Six studies were done to fully evaluate the effects cyanoacrylate fuming has on paint and polymer samples:

1) Sample Size Determination
2) Single Fumed Sample Comparison
3) Double Fumed Sample Comparison
4) Inter-layer Penetration Comparison
5) Library Search Evaluation
6) Reproducibility Evaluation

The combination of all the studies conducted will help the field of forensic science to better understand and predict limitations the cyanoacrylate fuming process imposes upon the infrared spectroscopic data of paint and polymer classifications and comparisons.

Materials and Methods

Sample Size Determination
Eighteen paint samples from the same source were collected and the masses were averaged.

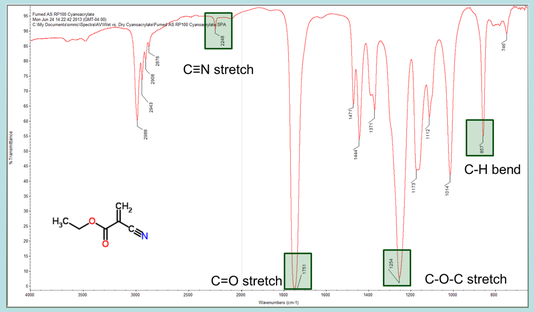
Single Fume Comparison, Double Fume Comparison, Inter-Layer Penetration Comparison, and Reproducibility Evaluation
Polymer samples from various sources were fumed at least once for 45 minutes using Adhesive Systems RP 100 Cyanoacrylate. Each sample was run on a Thermo Nicolet 6700 FTIR. The fumed sample IR spectra were compared to both their non-fumed sample IR spectra and the known fumed cyanoacrylate IR spectra.

Library Search Evaluation
Full library searches in the Thermo Scientific OMNIC Software Suite were performed for all known sample spectra.

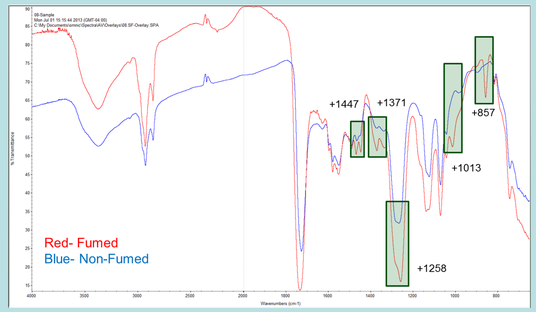
Results

Sample Size Determination
The average mass determined for the 1mm x 1mm sized samples was ~40 mg.

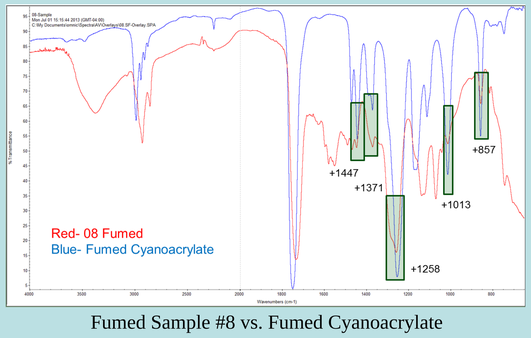
Single Fumed Sample Comparison



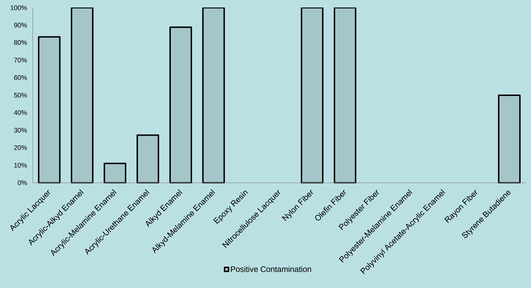
Fumed Cyanoacrylate IR Spectrum



Fumed Sample #8 vs. Non-fumed Sample #8



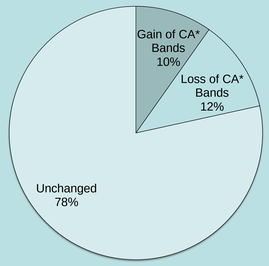
Fumed Sample #8 vs. Fumed Cyanoacrylate



Cyanoacrylate Contamination via Polymer Classification

Contaminated Sampled with "Halo" Effect of Cyanoacrylate

Double Fumed Sample Comparison



Double Fumed IR Spectra vs. Single Fumed IR Spectra (CA* = Cyanoacrylate)

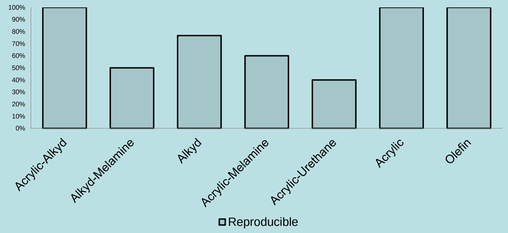
Inter-Layer Penetration Comparison
No layers below the topcoat on multilayered samples were contaminated with cyanoacrylate

Library Search Evaluation

Sample ID	Classification	Control Difference?	Control Library Match %	Single-Fumed Library Match %	Double-Fumed Library Match %
48	Polyester Fiber	No	97.59	98.64	96.46
49	Acrylic Fiber	Yes	99.21	82.34	84.47
50	Nylon Fiber	Yes	98.29	95.3	97.38
51	Rayon Fiber	No	98.57	97.78	98.32
52	Olefin Fiber	Yes	98.68	97.46	96.12

Known Synthetic Fibers' Library Search Results

Reproducibility Evaluation



Reproducibility of IR Spectra via Polymer Classification

Conclusion

The attraction of cyanoacrylate to certain classes may be dependent on chemical composition, electrostatic attraction, or steric effects. A definitive conclusion cannot be made on this phenomenon from the IR data alone found in this project, but further studies should be conducted into discovering the specific initiation sites that promote polymerization of cyanoacrylate on different classes of paints and polymers.

Double fuming has little to no impact on the IR spectra because during the original fuming process the polymerized cyanoacrylate saturates all the initiation sites and the side chains terminate when they come into contact with air.

Fumed cyanoacrylate also has no penetration ability into multilayer paint, and only moderately affects the library search parameters of acrylic polymers.

Reproducibility of paints/polymers that have undergone cyanoacrylate fuming is dependent both on the class of polymer and the sampling method used.

Additional comparison studies using x-ray fluorescence (XRF) and scanning electron microscopy (SEM) should be conducted to better understand the method of polymerization initiation of fumed cyanoacrylate. Also, developing a cleanup method to remove cyanoacrylate without disrupting the evidence would be beneficial. It would allow latent print examiners to fume evidence in order to preserve potential fingerprints without disrupting potential trace evidence.

References and Acknowledgements

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