Recent Research Projects

INTERNATIONAL ASSOCIATION FOR IDENTIFICATION

Minneapolis, MN

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U.S. Department of Homeland Security

United States
Secret Service

Developing Latent Prints on Coated Papers

U.S. Department of Homeland Security

United States Secret Service

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Introduction

- On occasion, the U.S. Secret Service receives counterfeit currency coated with an unknown material.
- This coating tends to inhibit the development of latent prints using traditional reagents.
- The coating is typically added to counterfeit currency in an attempt to disrupt the ability of "counterfeit detection pens" from detecting the currency as non-genuine.
- The coating is typically hairspray (e.g., brands like Aquanet).

Introduction

- Amino acid reagents in primarily non-polar solvents do not appear to be able to develop prints on these coatings.
- The hypothesis was to see if amino acid reagents in polar solvents (like acetone) could penetrate through the coating and develop latent prints.
- Two sets of latent prints are possible – those placed on the paper prior to the coating (most likely the prints of the counterfeiter) and those placed on the surface of the note after the coating was applied.

Materials & Method

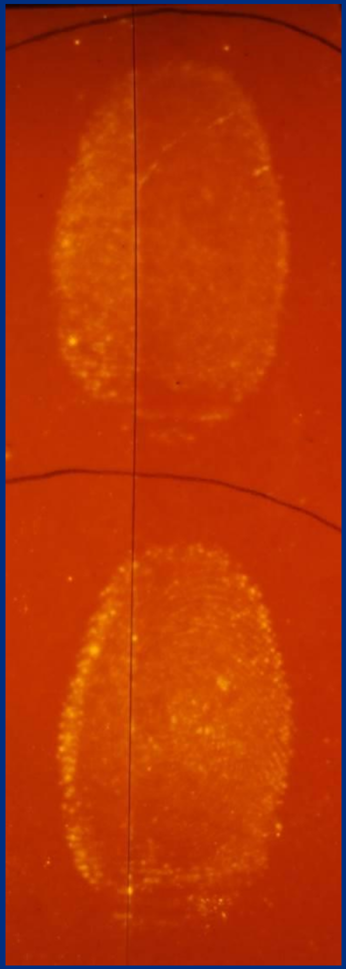
- Substrate types included:
- There were XX sample donors (x female/ x male)
- A total of 600 number of samples were prepared for all of the different experiments

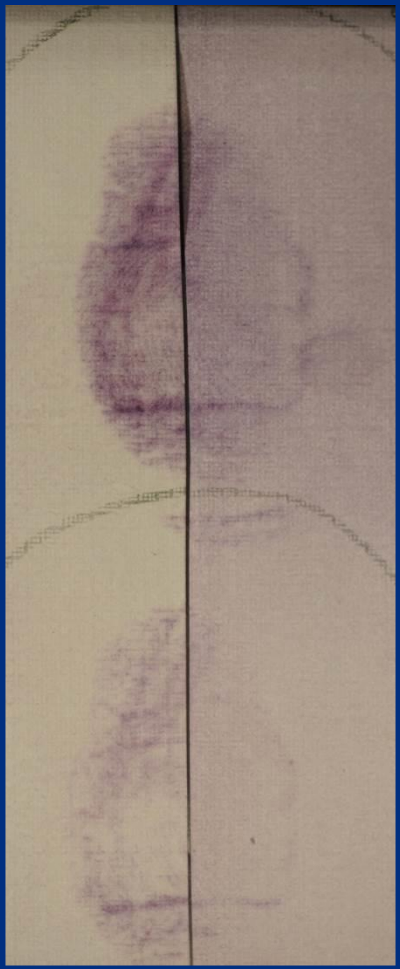
Experimental

- Two scenarios were explored for the reagent:
  - Preparation of a 0.6% w/v solution of ninhydrin in pure acetone.
  - Preparation of an acetone pre-wash solution to be used prior to the standard petroleum ether-based 0.6% w/v solution of ninhydrin.
- Two scenarios were explored for the print placement
  - Half of the prints were placed on the paper substrate prior to the application of Aquanet hairspray.
  - The other half of the prints were placed on the paper samples after the Aquanet hairspray had been applied and dried (i.e., on top of the coating).

Results – Prints Under the Coating

- The sample on the left shows (l) prewash of acetone + IND-Zn (petroleum ether-based) and (r) IND-Zn (petroleum ether-based).
- The sample on the right shows (l) prewash of acetone + ninhydrin (petroleum ether-based) and (r) ninhydrin (petroleum ether-based).





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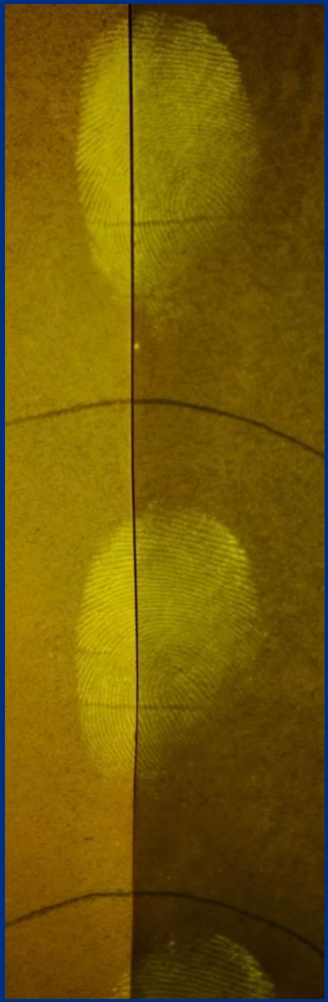
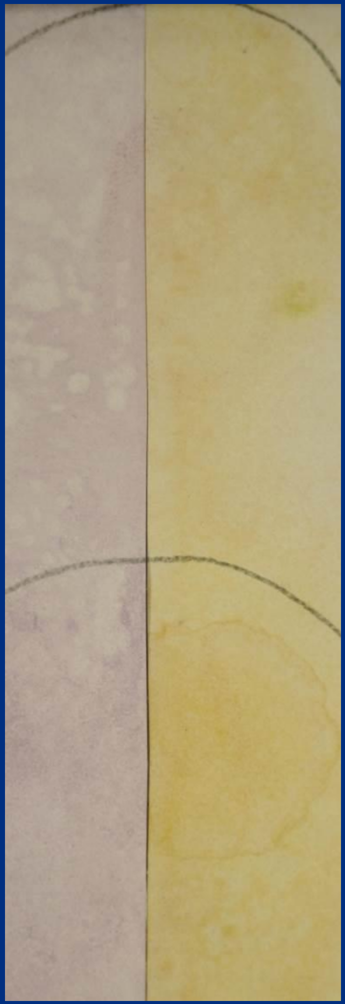
Results – Prints on Top of the Coating

- The sample of the left shows (l) prewash of acetone + IND-Zn (PE-based) and (r) IND-Zn (PE-based).
- The sample on the right shows (l) prewash of acetone + ninhydrin (PE-based) and (r) ninhydrin (acetone-based).





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Conclusions

- Thus far, there does not appear to be much of an advantage to using an acetone prewash prior to petroleum ether-based formulations of either ninhydrin or IND-Zn.
- The preliminary results also show that there does not appear to be an advantage to preparing the amino acid reagents in acetone rather than the mixture of 5% ethanol/95% petroleum ether.
- A better understanding how the coating interacts with the fingerprint residue is needed – does the coating destroy prints below it and absorb/"dissolve" prints placed on top of it?

Developing Latent Prints on Stone Papers

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Introduction

- Some manufacturers have recently introduced a class of writing and printing papers that is often referred to as “stone” papers.
- These stone papers are composed of some sort of polymeric material (e.g., polyethylene) and calcium carbonate.
- These papers are designed to be more durable (e.g. ,tear-resistant), water resistant, and environmentally friendly.
- Some paper products allow for writing to occur when the paper is wet.
- So called “stone” papers have been evaluated for their impact on handwriting analyses, but to date nothing has been published to provide guidance on how to process this new type of paper.

Materials & Methods

- Substrate Paper types
  - Rite in the Rain Loose Leaf Paper
  - Rite in the Rain Laser Paper
  - Rite in the Rain Inkjet Paper
  - Viastone Inkjet Paper
  - Oxford Stone Notebook Paper
- 400 samples per paper type (2000 total)
- Donors (male/female)

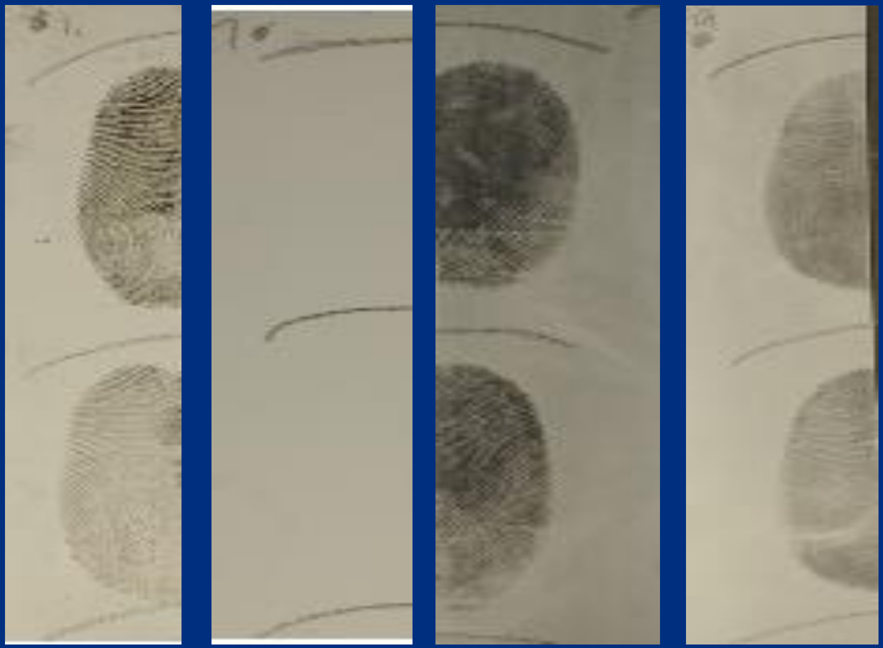
Materials & Methods

- The following processes were used on the stone paper samples.

Process
Crimescope
LASER
RUVIS
UV
Cyanoacrylate Fuming
Cyanoacrylate Fuming + Black Magnetic Powder
Cyanoacrylate Fuming + Black Powder
Cyanoacrylate Fuming + Black Wetwop™
Cyanoacrylate Fuming + LASER
Cyanoacrylate Fuming + RAM
Cyanoacrylate Fuming + Basic Yellow 40
Cyanoacrylate Fuming + RUVIS
Cyanoacrylate Fuming + Sticky-side Powder™
Cyanoacrylate Fuming + Sudan Black
Cyanoacrylate Fuming + UV
Black Magnetic Powder
Black Powder
Black Wetwop™
Sticky-side Powder™
1,2-Indanedione-$ZnCl_2$
1,8-Diazafluoren-9-one (DFO)
Ninhydrin
Physical Developer
Sudan Black
VMD

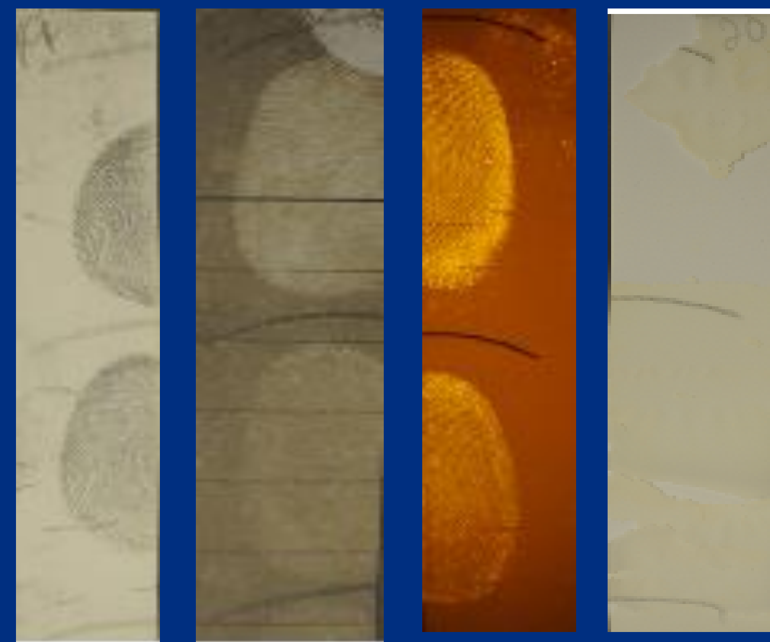
Results

- The sample on the left is laser paper treated with Wetwop™. The image in the middle/left is of laser paper treated with Sticky-side powder™. The image in the middle/right is of laser paper treated with magnetic powder. The image on the right is of laser paper treated with CA fuming + magnetic powder.



Results

- The image on the left is of Viastone paper processed with PD. The image on the middle-left is of Oxford paper treated with VMD. The image on the middle-right is of Laser paper treated with IND-Zn. The image on the right is of Viastone paper treated with DFO. Note the damage and delamination that has occurred.



Results

Process	Substrate
RUVIS/CA+ RUVIS	Laser
Wetwop	Laser, Loose-leaf, Oxford
Magnetic Powder	Laser, Loose-leaf, Oxford, Viastone
CA + Magnetic Powder	Laser, Loose-leaf
Black Powder	Laser, Viastone
CA + Black Powder	Laser, Viastone
Physical Developer	Ink jet, Viastone
Vacuum Metal Deposition	Laser, Oxford, Ink jet, Viastone
DFO	Laser, Oxford, Ink jet, Loose-leaf
IND	Laser, Oxford, Ink jet, Loose-leaf

Conclusions

- The stone papers evaluated in this study did not behave as expected when treated with latent print reagents.
- Instead of acting as non-porous surfaces (as one might expect for polymer-based paper), the stone papers reacted more as porous substrates.
- Optical methods, cyanoacrylate, Sticky-side powder™, Sudan black, and dye stains performed poorly.
- With the exception of the Viastone inkjet paper, the amino acid reagents (IND-Zn in particular) performed the best.
- Physical developer performed the best on Viastone inkjet paper (the other organic solvent-based reagents de-laminated the paper).

Impact of Latent Print Reagents on Ink Analysis

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Ink Composition

- Ballpoint Inks (dyes, glycol-based, organic solvents)
- Non-ballpoint Inks (dyes, water-based)
  - Roller ball, felt tip, plastic tip, fountain pen
- Gel Inks (pigments/dyes, water-based and some organic solvents)

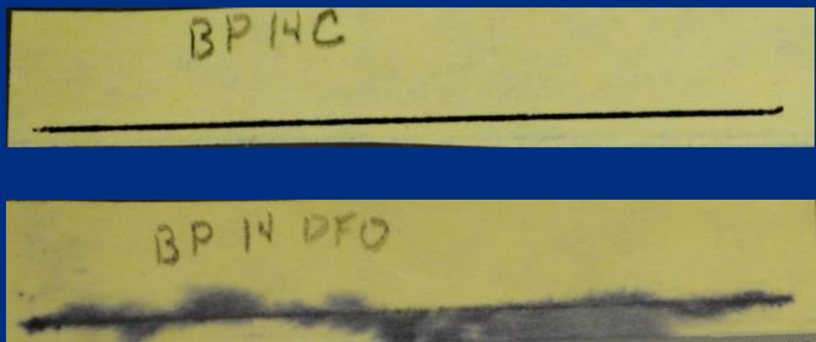
Latent Print Reagents

- Indanedione-Zn
- Ninhydrin
- DFO
- Physical Developer (PD)
- DFO + ninhydrin + PD
- Indanedione-Zn + ninhydrin + PD

Imaging

- Visible
- Infrared fluorescence
- Infrared luminescence
- Short wave UV (365 nm)
- Long wave UV (254 nm)

Physical Changes



(l) Change of BP 14 on yellow legal paper caused by processing with DFO (top-control, bottom-processed)

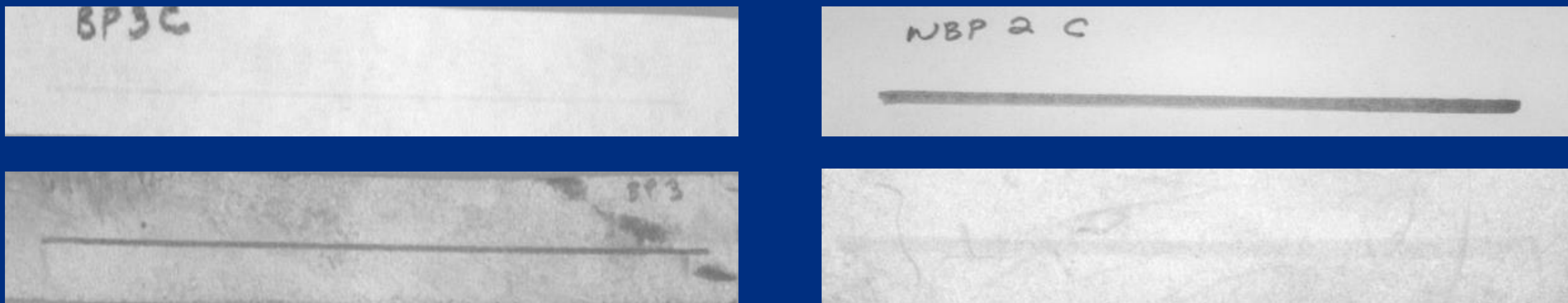
(r) Physical change of NBP 18 on white photocopy paper caused by processing with DFO (top-control, bottom-processed)

Optical Changes

(l) Optical change of NBP 8 on white photocopy paper caused by processing with indanedione (top-control, bottom-processed)

(r) Optical change of NBP 26 on white photocopy paper caused by processing with PD (top-control, bottom-processed)

Infrared Reflectance Changes



(l) Change IRR value for NBP 29 on white lined paper caused by processing with indanedione- Control: 1000 nm, IND: 715 nm (top-control, bottom-processed)

(r) Change IRR value for NBP 2 on white photocopy paper caused by processing with PD- Control: 1000 nm, PD: 1000 nm (top-control, bottom-processed)

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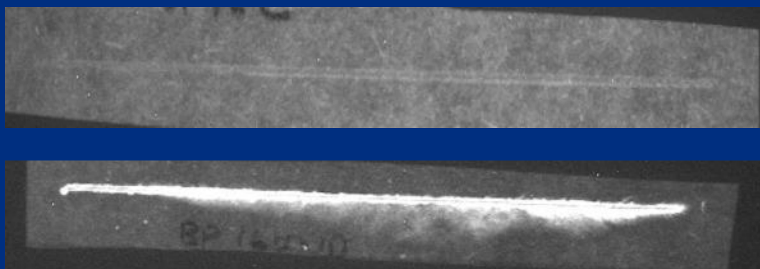
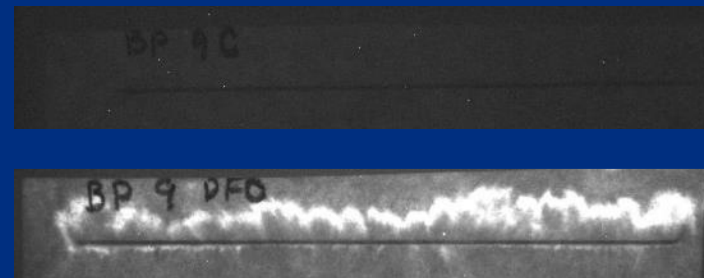
Infrared Luminescence Changes





(l) Optical change of BP 16 on yellow legal pad paper caused by processing with IND (top-control, bottom-processed)

(r) Optical change of BP 9 on white lined paper caused by processing with DFO (top-control, bottom-processed)

Conclusions

- Visible and optical changes observed
- DFO caused most damage
- Ninhydrin caused least amount of damage
- PD changed the coloring of substrate
    - Effected more NBP than BP

Processing Business Envelopes with Polystyrene Windows

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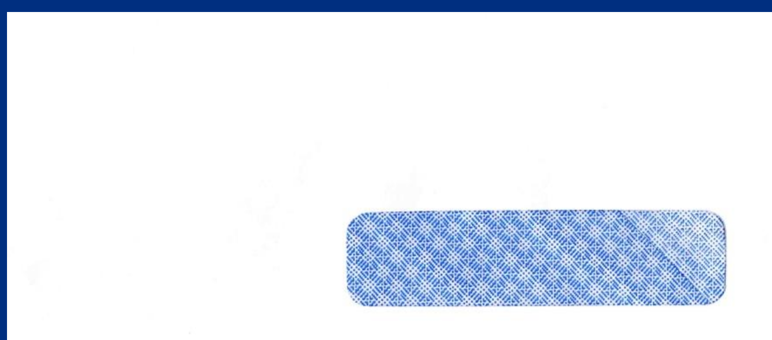
Research Objective

- Debate over whether which process to use on mixed substrates (recommendation was to use cyanoacrylate fuming prior to AA visualizing reagents)
- USACIL policy on non-porous items (David Perkins/William Thomas)



Editorial

Cyanoacrylate Fuming Prior to Submission of Evidence to the Laboratory

(The opinions or assertions contained herein are the private views of the authors and are not to be construed as reflecting the official views of the Department of the Army or the Department of Defense.)

Background

The U.S. Army Criminal Investigation Laboratory-Europe (USACIL-Europe) provides forensic laboratory services to all Department of Defense investigative elements and selected allied forces law enforcement agencies throughout Europe. As a result of serving such a large geographical area, much of the evidence examined at the laboratory is transported or sent registered mail over considerable distance. Consequently, the potential loss of evidence from handling, packaging, and shipping always has been of concern to laboratory personnel.

The USACIL-Europe latent print examiners, speculating that latent print evidence was being accidentally wiped off non-porous surfaces prior to arrival at the laboratory, began to promote the use of CA fuming by investigative personnel in the field as a means to help prevent this potential loss. They heavily publicized the probable advantage of CA fuming to make latent prints more durable and less susceptible to damage. Beginning in December, 1985, almost every quarterly laboratory bulletin sent to contributing agencies contained an article which emphasized the envisioned advantage of CA fuming non-porous evidence prior to submission. The latent print examiners also stressed the presumed potential of CA fuming in the field when speaking to investigators on the telephone, in person, or at training opportunities.

In March, 1987, the laboratory initiated an extensive program that attempted to increase the use of CA fuming in the field. Training teams were sent out to instruct a number of contributing organizations on the proper construction of CA fuming chambers and the proper methods of CA fuming. Laboratory representatives also attended meetings and conferences with senior investigative personnel and their supervisors and stressed the positive impact that CA fuming in the field can have. Additionally, the laboratory conducted a number of

J. Forensic Ident
41 (3), 1991 \ 157

Research Objective

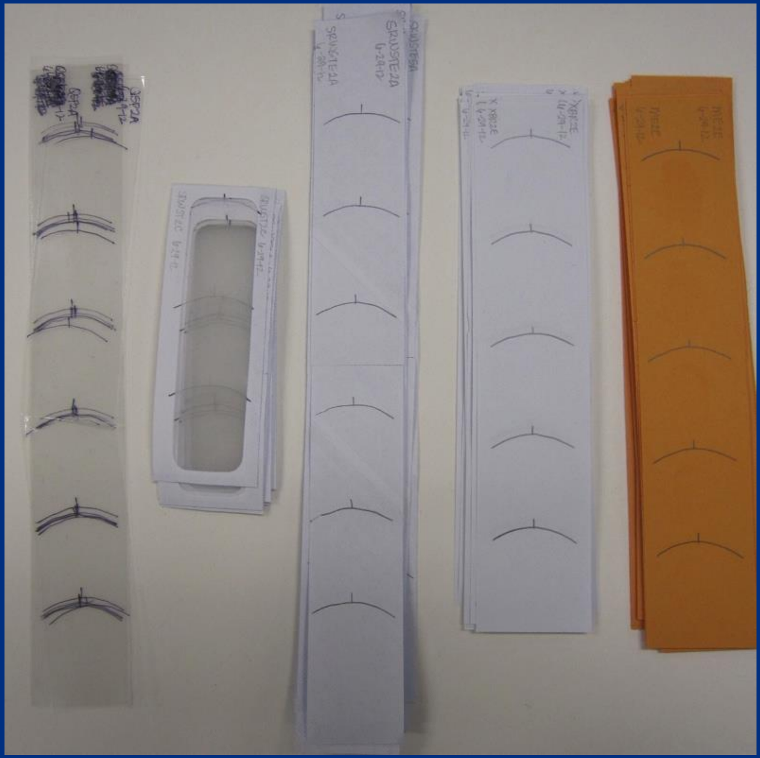
- Determine the best sequential processing approach to processing business envelopes with polystyrene windows
- Determine if any component of either reagent can damage the polystyrene window (experiment 1)
- Determine whether the first approach should be porous or non-porous reagents (experiment 2)
  - Determine whether cyanoacrylate inhibits ninhydrin or 1,2-indanedione-zinc reactions with amino acid residues
  - Determine if ninhydrin or 1,2-indanedione-zinc inhibits cyanoacrylate formation on amino acid residues

Materials & Methods

- Substrates
  - paper (868)
  - plastic (492)
- Latent Print Samples
  - 5 depletions per depletion strip
- Latent print type
  - eccrine
  - sebaceous
- Donors
  - 6 total (3 male, 3 female)
- Latent print ages
  - recent (< 4 months)
  - old (> 4 months)
- Reagents/Processes
  - Indanedione-Zn
  - Ninhydrin
  - Loc-Tite Hard Evidence
  - Lightning Powder magnetic black powder

Materials & Methods

- Substrates
  - Quill Sheet Protectors
  - Staples Right Window Security Tint plastic windows (no. 10)
  - Xerox Business Recycled paper
  - Staples Right Window Security Tint Envelope paper (no. 10)
  - Manila Envelope paper



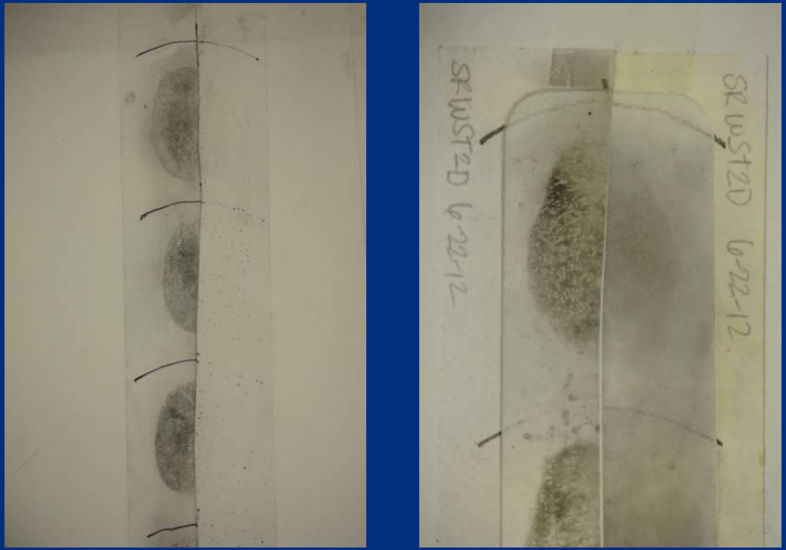
Experimental Results (1)

- The most significant damage was caused by ethyl acetate (and to a lesser extent glacial acetic acid)
- These components caused the plastic windows to become cloudy and in some cases (ethyl acetate) caused the window to dissolve completely.

- (A) dichloromethane; (B) THF; (C) ethyl acetate; (D) acetone

Experimental Results (2)

- Ninhydrin and 1,2-indanedione-zinc inhibit the formation of cyanoacrylate on non-porous items

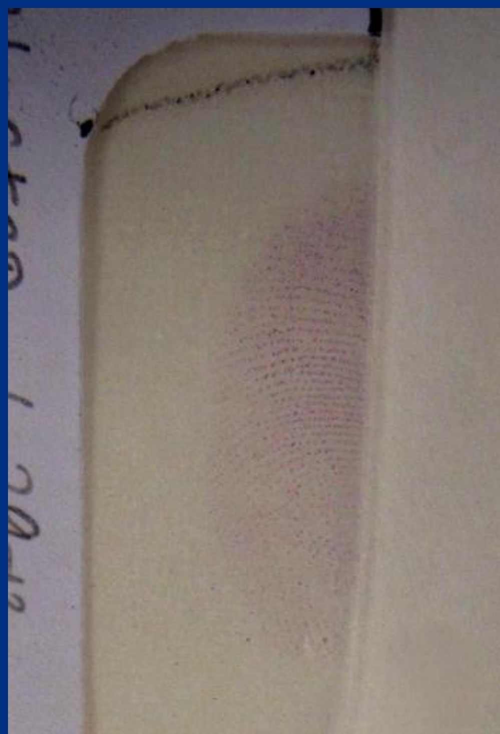


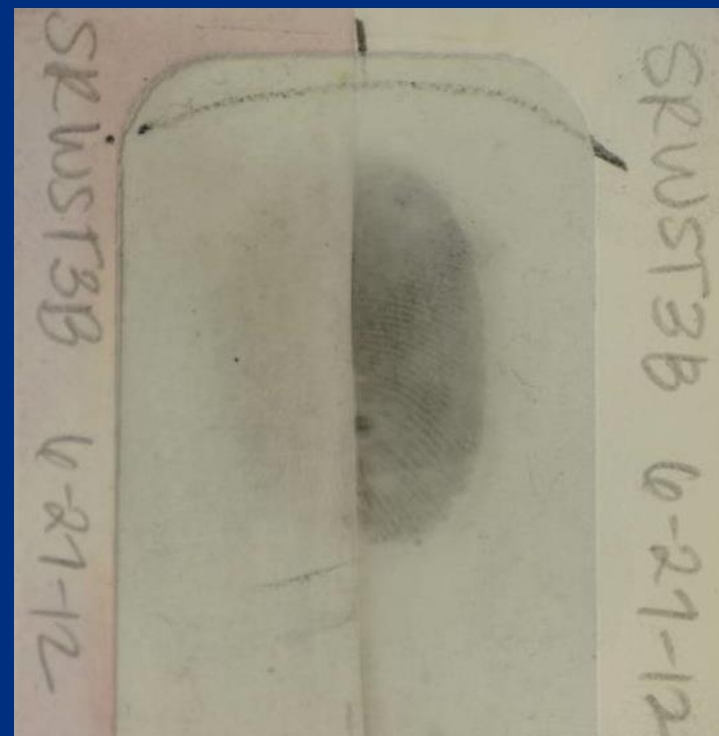
1,2-indanedione-zinc

ninhydrin

Experimental Results (2)

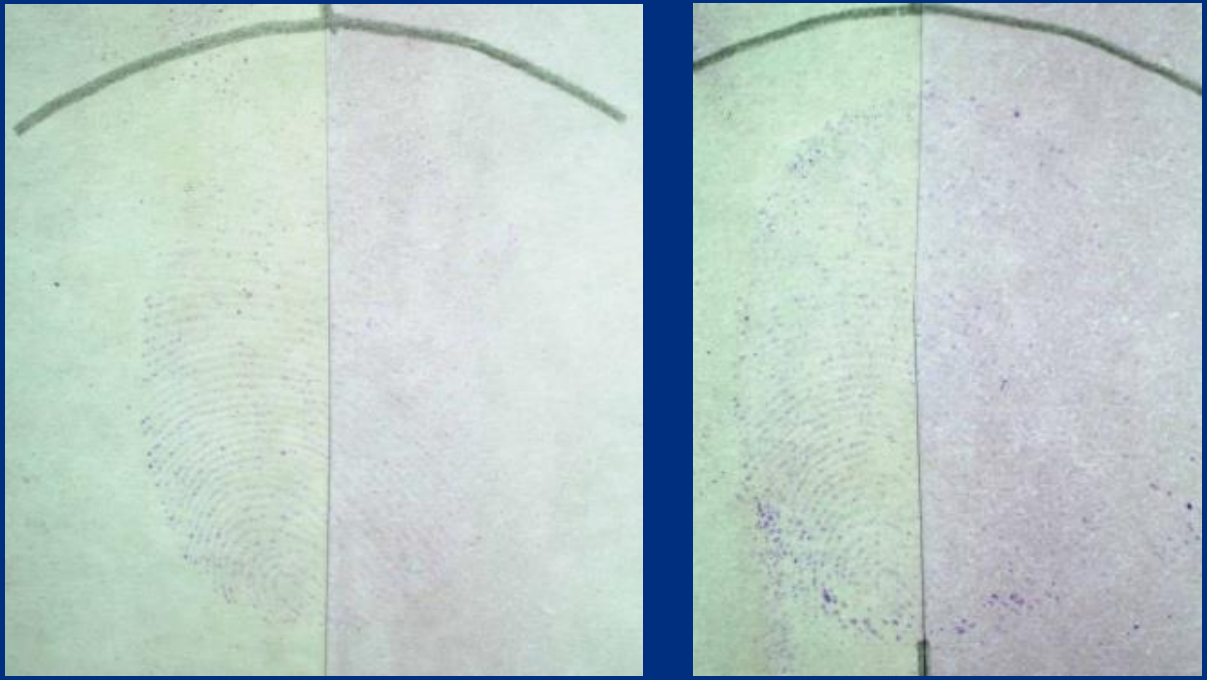
- Ninhydrin developed some ridge detail on a few non-porous items





Experimental Results (2)

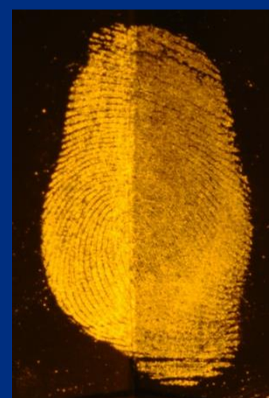
- Cyanoacrylate inhibits ninhydrin reactions on porous items



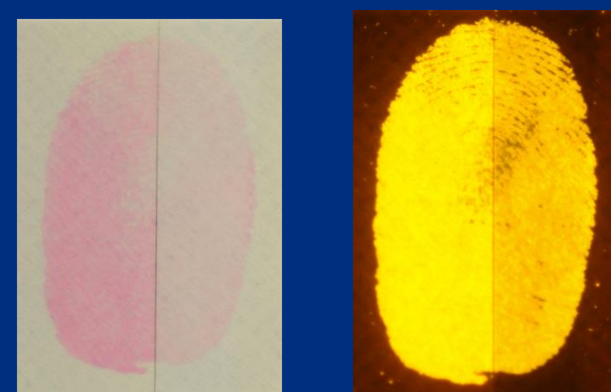
Experimental Results (2)

- Cyanoacrylate partially inhibits 1,2-indanedione-zinc reaction on thicker porous substrates, but appears to enhance the reaction on all other porous substrates examined in this study

Manila Envelope



Xerox Business Recycled



Staples Security Tint Envelope

Experimental Results (2)

- Cyanoacrylate fuming prior to processing with 1,2-indanedione-zinc appears to capture more ridge detail than 1,2-indanedione-zinc alone, as well as making the ridges "crisper"

Control (left)
Variable (right)

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Effect of Acidifying Ninhydrin on Latent Print Development

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Introduction

- The Home Office Manual of Fingerprint Development Techniques recommends acidifying ninhydrin (~0.5% v/v with acetic acid).
- Moore S, Stein WH. Photometric Ninhydrin Method for Use in the Chromatography of Amino Acids. J Biol Chem 1948;176:367-388.
- Lamothe PJ, McCormick PG. Influence of Acidity on the Reaction of Ninhydrin with Amino Acids. Anal Chem 1972;44(4):821-825.
- Researchers determined that the optimum pH value that produced the most Ruhemann's purple product was 5 (although this value fluctuated for different amino acids).
- Is it necessary to acidify the ninhydrin reagent?

Materials & Methods

- The first experiment involved determining whether of not various acidified ninhydrin solutions (0.5%, 1.0%, and 2.0%) produced better results than the non-acidified one (control).
- The second experiment involved studying the stability of these various ninhydrin solutions over a period of 12 weeks.
- The third experiment involved studying envelopes (previously handled and mailed) that had been processed with all four ninhydrin solutions for additional development over a period of 12 weeks.

Materials & Methods

- Substrates included the following types of paper: manila envelope, yellow lined, white lined (red), white lined (blue), photocopy paper (20#), photocopy paper (28#), and graph paper.
- There were 5 fingerprint donors (3 female/2 male)
- The ninhydrin solution was prepared as follows: 0.6% w/v ninhydrin, 200 proof ethanol (5% v/v), and petroleum ether (95% v/v).
- Development conditions were set at 80ºC and 65% RH.

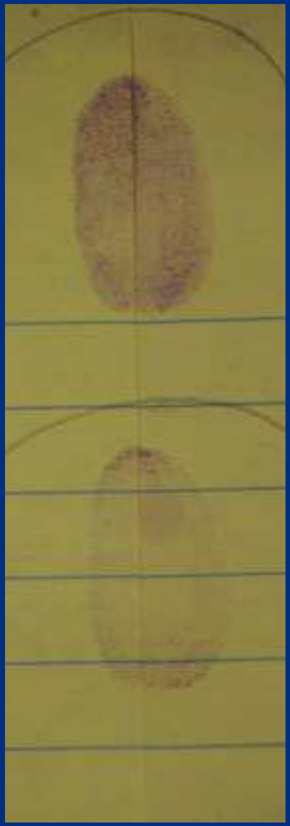
Assessment

- McLaren C, Lennard C, Stoilovic M. Methylamine Pretreatment of Dry Latent Fingermarks on Polyehtylene for Enhanced Detection by Cyanoacrylate Fuming. J Forensic Ident 2010;60(2):199-222.

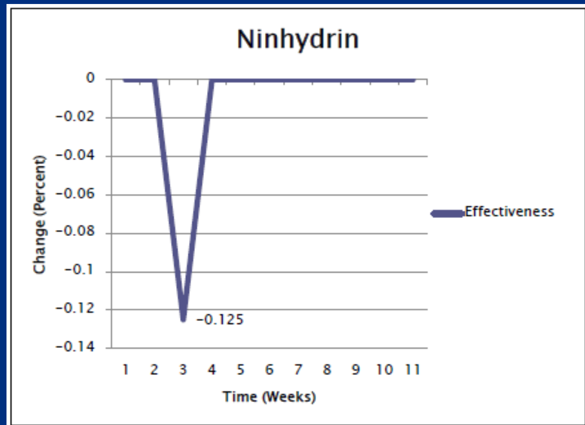
Value	Description
-2	Significant decrease in enhancement when compared to the control
-1	Slight decrease in enhancement when compared to the control
0	No difference in enhancement when compared to the control
+1	Slight increase in enhancement when compared to the control
+2	Significant increase in enhancement when compared to the control

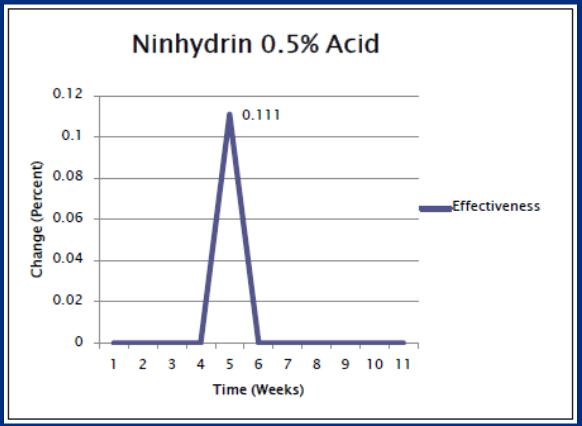
Results – Acidified vs. Non-acidified

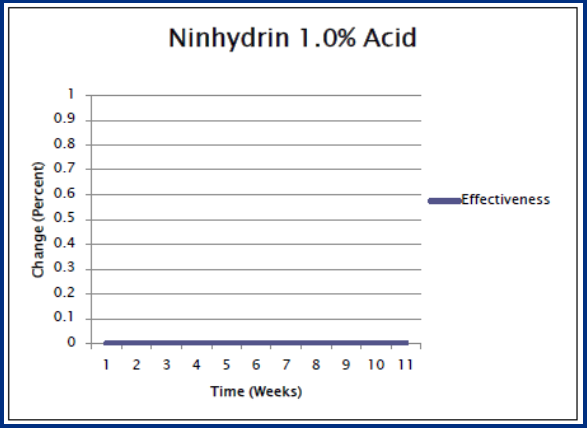
- For the samples processed with 0.5% acidified ninhydrin (out of 215): 206 were graded “0” (96.7%) and 7 were graded “+1” (3.3%) .
- For the samples processed with the 1.0% acidified ninhydrin (out of 211): 201 were graded “0” (95.3%), 1 was graded as “-1” (0.5%), and 9 were graded as “+1” (4.3%).
- For the samples processed with the 2.0% acidified ninhydrin (out of 210): 201 were graded “0” (95.7%), 1 was graded as “-1” (0.5%), and 8 were graded as “+1” (3.8%).

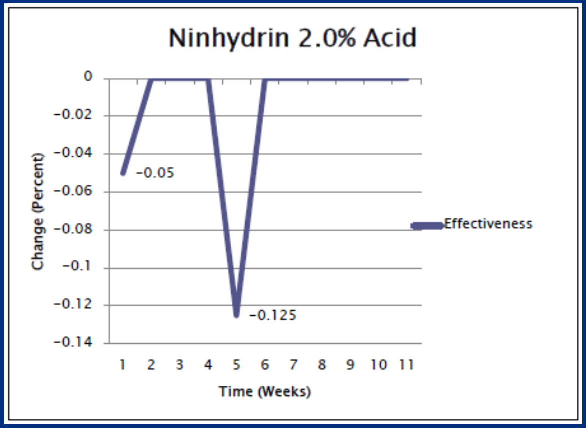


Results – Stability (Reagent Solution)









Results - Envelopes

1 week

6 weeks

11 weeks

Results - Envelopes

1 week

6 weeks

11 weeks

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Conclusions

- Data from experiment #1 indicates that there is neither an increase or decrease in quality of developed friction ridge detail if the solution is acidified.
- Data from experiment #2 indicates that over the course of 11 weeks, all of the ninhydrin reagent solutions remained relatively stable.
- Data from experiment #3 indicates that over the course of 12 weeks, none of the envelopes showed any additional ninhydrin development.
- Anecdotal evidence of additional ninhydrin development days/weeks/months after treatment (usually ambient development).

Acknowledgements

- Andrew Feiter, graduate student, George Washington University
  - Coated Paper Study
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  - Stone Paper Study
- Alexandria Fletcher, Stevenson University
  - Effect of Latent Print Reagents on Writing Ink Analysis Study
- Kelly Miller, West Virginia University
  - Developing Latent Prints on Business Envelopes Study
- David Hooban, George Mason University
  - Effects of Acidifying Ninhydrin on Latent Print Development Study

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