Development of Bloody Latent Prints on Dark Surfaces

Amanda L. Atkins, CLPE, CCSI
United States Army Criminal Investigation Laboratory
* This presentation is the original work product of Amanda L. Atkins, United States Army Criminal Investigation Laboratory (USACIL), Forensic Latent Print Examiner. This work is being used for educational and training purposes. It may be reproduced and used for educational purposes only with attribution to the author and USACIL. Further use or distribution is prohibited by Title 17 United States Code Section 107.
The goal of any blood processing technique is:

1. to enhance the ridge detail present
2. to increase the contrast between ridge detail and substrate

Two ways in which chemical enhancement techniques work:

1. Protein dye stain
2. Heme-catalyzed technique
Current Popular Techniques:

- Amido Black – Protein Dye = Dark Blue
- Coomassie Blue – Protein Dye = Dark Blue
- D.A.B. (Diaminobenzidine) – Protein Dye = Brown
- Leucocryystal Violet (LCV) – Blood hemoglobin = Purple (fluoresces @550-600nm)
Problems arise when the substrate on which the latent print rests is black, and current processing techniques will not improve contrast.
Chemicals for Comparison

- Tartrazine
- Acid Yellow 7
- Merbromin
- 2, 2’ Azino-di (3-ethyl-benzthiazoline sulfonic acid (6) or A.B.T.S
- 1, 8-Diazafluoren-9-one or DFO
Tartrazine

20 grams 5-Sulfosalicylic acid
20 grams Tartrazine
1 liter distilled water

- Protein dye = turns a deep yellow
- Can also react with proteins present from other sources
- Fixative is incorporated into the mixture
- Apply by immersing into solution, rinse with tap water
- Can also use a piece of absorbent cloth on top
- Strong white light for visualization
## Pre-mixed Merbromin

<table>
<thead>
<tr>
<th>Part A:</th>
<th>Part B:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Merbromin</td>
<td>Hydrogen peroxide</td>
</tr>
<tr>
<td>Ethanol</td>
<td>Acetone</td>
</tr>
<tr>
<td>Formic Acid</td>
<td></td>
</tr>
<tr>
<td>Acetone</td>
<td></td>
</tr>
</tbody>
</table>

- Catalytic reaction between hemoglobin and oxygen
- Fluoresces yellow with UV or ALS at 650nm
- Time consuming, multi-step process, requires specific equipment, is toxic
- Purchased pre-mixed from crime scene supply companies
DFO/3M Novec™ HFE-7100

- 0.25 grams DFO
- 40 ml Methanol
- 20 ml Acetic Acid

- Porous and non-porous surfaces
- Very sensitive to amino acids
- Visualized with a laser at 532nm = orange color
- Fixed with heat, 20 minutes 100 °C
- If only bloody latent prints are main concern, choose a different chemical
Pre-mixed A.B.T.S.

<table>
<thead>
<tr>
<th>Fixative:</th>
<th>Working Solution:</th>
</tr>
</thead>
<tbody>
<tr>
<td>20 g 5-Sulfosalicylic acid</td>
<td>1.25 g ABTS</td>
</tr>
<tr>
<td>1 liter distilled water</td>
<td>250 ml Citric Acid/Phosphate Buffer</td>
</tr>
</tbody>
</table>

- Used on both porous and non porous surfaces
- Heme catalyzed: heme group in blood + hydrogen peroxide = green color
- Apply by immersing, rinse with distilled water, allow to dry in dark
- Strong white light for visualization
- Multi-step, time consuming process, purchased pre-mixed
# Acid Yellow 7

<table>
<thead>
<tr>
<th>Fixative: 20 grams 5-Sulfosalicylic Acid + 1 liter distilled water</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Working Solution:</strong></td>
</tr>
<tr>
<td>2 g Acid Yellow</td>
</tr>
<tr>
<td>100 ml Acetic Acid</td>
</tr>
<tr>
<td>500 ml Ethanol</td>
</tr>
<tr>
<td>1400 ml distilled water</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Rinse:</th>
</tr>
</thead>
<tbody>
<tr>
<td>100 ml Acetic Acid</td>
</tr>
<tr>
<td>500 ml Ethanol</td>
</tr>
<tr>
<td>1400 ml distilled water</td>
</tr>
</tbody>
</table>

- Protein dye = yellow color, fluoresces under blue/blue-green light (400-490nm)
- Submersion of evidence works best on small items or use saturated absorbent cloth
- White gel lifter may be applied afterwards to lift print
Chemicals for Comparison

- Tartrazine
- Acid Yellow 7
- Merbromin
- 2, 2’ Azino-di (3-ethyl-benzthiazoline sulfonic acid (6) or A.B.T.S
- 1, 8-Diazafluoren-9-one or DFO
- White light
- White gel lifter after Acid Yellow
Black Substrates

Non-Porous:
- Plastic trash bag
- Textured metal
- Linoleum
- Tile

Porous:
- Construction paper
- Leather
- Semi-glossy photographic paper
Methods and Materials

- Human whole blood used, stored in purple top tubes containing EDTA
- Right thumb was used to create all test impressions
- Deposited samples stored ambient room temperature
- Samples were fixed before processing
- Samples were processed after 3 days, 15 days and 30 days
- Digital images were not enhanced with Adobe Photoshop before presenting to examiners
To Be Determined…

• *Which processing technique will produce the best contrast and the most suitable latent prints?*

• *Will the length of time that the bloody latent print remained on the surface make it more or less receptive to chemical enhancement?*
Tartrazine

Construction Paper

Semi-Glossy Paper
Tartrazine

Leather

Linoleum
Tartrazine

Metal

Plastic
Tartrazine

Tile
Merbromin

Construction Paper

Semi-Glossy Paper
Merbromin

Leather

Linoleum
Merbromin

Metal

Plastic
Merbromin

Tile
DFO

Metal

Plastic
A.B.T.S.

Leather  Linoleum
A.B.T.S.

Metal

Plastic
A.B.T.S.

Tile
Acid Yellow/Semi-Glossy Photo Paper
Acid Yellow 7

Leather

Linoleum
Acid Yellow 7

Tile
White Gel Lift after Acid Yellow

Construction Paper

Semi-Glossy Paper
White Gel Lift after Acid Yellow

Leather

Linoleum
White Gel Lift after Acid Yellow

Metal

Plastic
White Gel Lift after Acid Yellow

Tile
Number of Prints Created Per Substrate

- Tile: 50
- Plastic: 50
- Metal: 40
- Linoleum: 60
- Leather: 40
- GP: 47
- CP: 36
Total of 328 latent prints
12 latent print examiners

- **Part 1**: analyze each print assign a score of 1 to 3
  1 = Not suitable
  2 = Ridge detail present
  3 = Identifiable

“Overall chemical performance rating”

DFO on plastic: 3+3+3+2+2+3+2+1+3+2+3+3 = 30/12 = rating of 2.5
Part 1 Results

DFO scored highest overall chemical performance rating on five of the seven substrates

- Semi-glossy paper: 3.0
- Linoleum: 2.93
- Metal: 2.98
- Tile: 3.0
- Plastic: 2.68
- Construction paper: 1.0
- Leather: 2.45

Acid Yellow’s overall chemical performance ratings were marginally less than DFO

- Semi-glossy paper: 2.96 (- .04)
- Linoleum: 2.82 (- .11)
- Metal: 2.59 (- .39)
- Tile: 2.97 (- .03)
- Plastic: 2.4 (- .28)
- Construction paper: 2.54 (+ 1.54)
- Leather: 2.78 (+ .33)
• Part 2: Examiners shown only suitable latent prints grouped by substrate and age
• Asked to rank the top three latent prints from each group based on clarity and contrast
  “Best”
  “Second Best”
  “Third Best”
## Chemical Development Techniques by Examiner Preference

<table>
<thead>
<tr>
<th>Days</th>
<th>Best</th>
<th>%</th>
<th>Second Best</th>
<th>%</th>
<th>Third Best</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>CP</td>
<td>Acid Yellow</td>
<td>92</td>
<td>Merbromin</td>
<td>50</td>
<td>Acid Yellow/Merbromin</td>
<td>50/50</td>
</tr>
<tr>
<td>CP</td>
<td>Acid Yellow</td>
<td>92</td>
<td>Merbromin</td>
<td>75</td>
<td>Acid Yellow</td>
<td>42</td>
</tr>
<tr>
<td>CP</td>
<td>Tartrazine-475</td>
<td>42</td>
<td>Acid Yellow</td>
<td>42</td>
<td>Acid Yellow/Tartrazine-475</td>
<td>50/50</td>
</tr>
<tr>
<td>GP</td>
<td>DFO</td>
<td>83</td>
<td>Tartrazine-475</td>
<td>75</td>
<td>Tartrazine-WL</td>
<td>83</td>
</tr>
<tr>
<td>GP</td>
<td>Acid Yellow</td>
<td>75</td>
<td>Gel</td>
<td>58</td>
<td>Tartrazine-475</td>
<td>42</td>
</tr>
<tr>
<td>GP</td>
<td>Acid Yellow</td>
<td>92</td>
<td>Tartrazine-495</td>
<td>67</td>
<td>Tartrazine-WL/Gel</td>
<td>42</td>
</tr>
<tr>
<td>Leather</td>
<td>Acid Yellow</td>
<td>100</td>
<td>Gel</td>
<td>58</td>
<td>Merbromin</td>
<td>58</td>
</tr>
<tr>
<td>Leather</td>
<td>Acid Yellow</td>
<td>100</td>
<td>DFO</td>
<td>92</td>
<td>Gel</td>
<td>83</td>
</tr>
<tr>
<td>Leather</td>
<td>Acid Yellow</td>
<td>92</td>
<td>Merbromin</td>
<td>67</td>
<td>Tartrazine-WL</td>
<td>50</td>
</tr>
<tr>
<td>Lin</td>
<td>Acid Yellow</td>
<td>100</td>
<td>DFO</td>
<td>50</td>
<td>Tartrazine-475</td>
<td>50</td>
</tr>
<tr>
<td>Lin</td>
<td>Acid Yellow</td>
<td>50</td>
<td>Tartrazine-css</td>
<td>50</td>
<td>DFO</td>
<td>67</td>
</tr>
<tr>
<td>Lin</td>
<td>DFO</td>
<td>92</td>
<td>DFO/Merbromin</td>
<td>50</td>
<td>Merbromin</td>
<td>50</td>
</tr>
<tr>
<td>Metal</td>
<td>DFO</td>
<td>92</td>
<td>Acid Yellow</td>
<td>58</td>
<td>Tartrazine-WL</td>
<td>67</td>
</tr>
<tr>
<td>Metal</td>
<td>Acid Yellow</td>
<td>83</td>
<td>DFO</td>
<td>83</td>
<td>Merbromin</td>
<td>75</td>
</tr>
<tr>
<td>Metal</td>
<td>Tartrazine-475</td>
<td>75</td>
<td>DFO</td>
<td>58</td>
<td>Tartrazine-630</td>
<td>67</td>
</tr>
<tr>
<td>Tile</td>
<td>Acid Yellow</td>
<td>75</td>
<td>Merbromin/DFO</td>
<td>25/25</td>
<td>DFO/Tartrazine-css</td>
<td>33/33</td>
</tr>
<tr>
<td>Tile</td>
<td>Acid Yellow</td>
<td>100</td>
<td>DFO</td>
<td>67</td>
<td>Gel</td>
<td>58</td>
</tr>
<tr>
<td>Tile</td>
<td>Acid Yellow</td>
<td>83</td>
<td>Tartrazine-css</td>
<td>50</td>
<td>DFO</td>
<td>50</td>
</tr>
<tr>
<td>Plastic</td>
<td>Acid Yellow</td>
<td>92</td>
<td>ABTS-WL</td>
<td>50</td>
<td>ABTS-670</td>
<td>58</td>
</tr>
<tr>
<td>Plastic</td>
<td>Acid Yellow</td>
<td>92</td>
<td>ABTS-WL</td>
<td>50</td>
<td>ABTS-WL</td>
<td>50</td>
</tr>
<tr>
<td>Plastic</td>
<td>Acid Yellow</td>
<td>50</td>
<td>DFO</td>
<td>50</td>
<td>DFO/ABTS-WL</td>
<td>33/33</td>
</tr>
</tbody>
</table>
Part 2 Results

- Of the twenty-one sets of latent prints
  - Acid Yellow was “Best” 15/21 or 71.4%
  - DFO was chosen as “Best” 4/21 or 19%
The Age Factor

Of the 49 possible chemical and substrate combinations

- 10 (20.4%) showed a decrease in rating as the latent aged
- Most frequently 3/10 when no chemicals were used
- Substrates on which this occurred: 4/10 on linoleum and 3/10 on plastic

Of the 49 possible chemical and substrate combinations

- 7 (14.3%) showed an increase in the rating as the latent aged
- Most frequently when Merbromin was used 3/7 (43%)
- Substrates on which this occurred: 3/7 on semi-glossy paper and 2/7 on plastic
DFO/Metal

After selecting Auto Levels function in Adobe™ Photoshop™ CS
Advantages of Acid Yellow

- Successfully developed bloody latent prints on all seven of the substrates to include black construction paper and leather
Advantages of Acid Yellow

- Successfully developed bloody latent prints on all seven of the substrates to include black construction paper and leather surface
- Cost effective technique. Can be purchased in a 25 gram jar for $18.85. Two grams makes 2 liters of working solution.
- Mixing procedure and application were simple and didn’t require additional equipment beyond standard glassware
- Have the option for a second visualization step using a white gel lifter
Acid Yellow/Plastic

Gel Lift of same impression
Advantages of Acid Yellow

- Successfully developed bloody latent prints on all seven of the substrates to include black construction paper and leather surface
- Cost effective technique. Can be purchased in a 25 gram jar for $18.85. Two grams makes 2 liters of working solution.
- Mixing procedure and application were simple and didn’t require additional equipment beyond standard glassware
- Have the option for a second visualization step using a white gel lifter
- Only need an ALS for visualization
2007 Case Example

Attempted Murder
White Light Only
After Processing with Acid Yellow
Acid Yellow

Record Fingerprint Card #1 Finger...
2007 Case Example

Murder-Suicide
Acid Yellow Record fingerprint card: #1 Finger
Follow-up Research

• What is the best sequencing for processing using Acid Yellow?
• What effects will super glue fuming have on Acid Yellow’s performance?

METAL

PLASTIC
R6G ONLY at 532nm

LP RESIDUE  BLOOD
After Acid Yellow at 450nm

LP RESIDUE

BLOOD
Acid Yellow ONLY at 450nm
After R6G at 532nm

LP RESIDUE

BLOOD
Metal

- **Best sequencing:** Acid Yellow first followed by R6G/methanol
- Photography at each processing stage
- Superglue fume had no effect on performance of Acid Yellow
  - 8 minutes vs. 35 minutes
R6G ONLY at 532nm

LP Residue

Blood
BloodLP Residue

After Acid Yellow at 450nm

LP Residue  Blood
Acid Yellow ONLY at 450nm

LP Residue  Blood
After R6G at 532nm

LP Residue
Blood
Plastic

- **Best sequencing**: Acid Yellow first followed by R6G/methanol
- Photography at each processing stage
- Superglue fume had no effect on performance of Acid Yellow
  - 8 minutes vs. 35 minutes
Acid Yellow followed by R6G

Blood on Plastic

LP Residue on Plastic
Acid Yellow followed by R6G

Blood on Metal

LP Residue on Metal
Questions?