

# Development of **Bloody** Latent Prints on Dark Surfaces



**Amanda L. Atkins, CLPE, CCSI**

**United States Army Criminal Investigation Laboratory**



# Disclaimer

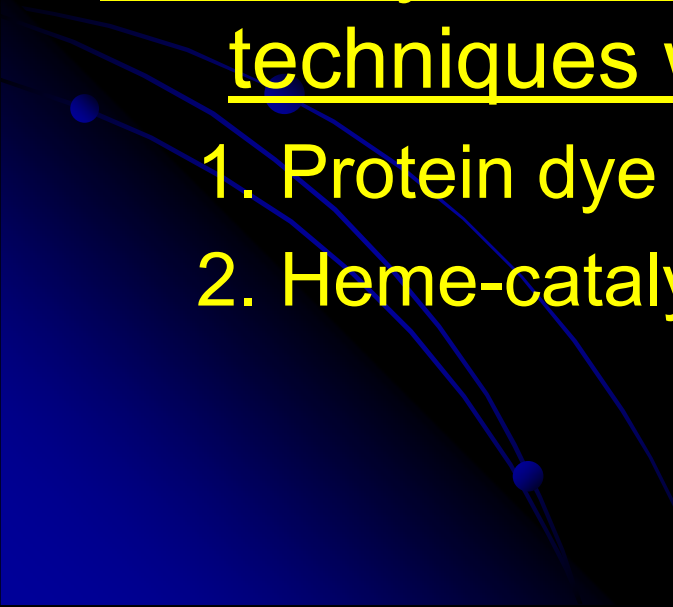


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The goal of any blood processing technique is :

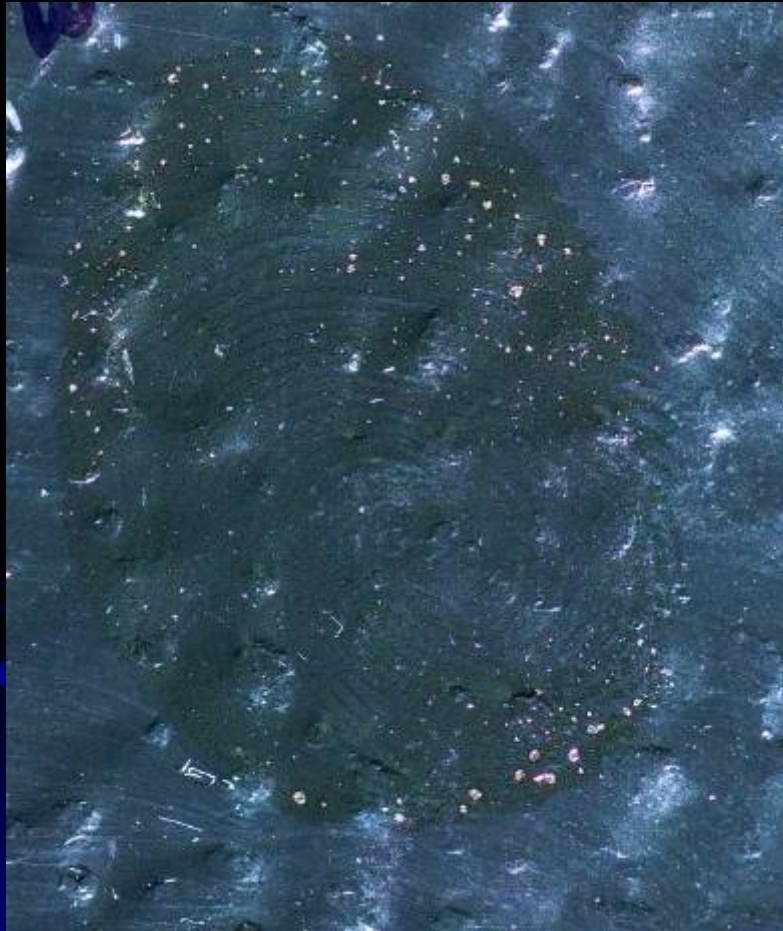
1. to enhance the ridge detail present
2. to increase the contrast between ridge detail and substrate

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
- Leucocrystal 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

## Part A:

Merbromin

Ethanol

Formic Acid

Acetone

## Part B:

Hydrogen peroxide

Acetone

- 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.

## Fixative:

20 g 5-Sulfosalicylic acid  
1 liter distilled water

## Working Solution:

1.25 g ABTS  
250 ml Citric  
Acid/Phosphate Buffer

- 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

Fixative: 20 grams 5-Sulfosalicylic Acid + 1 liter distilled water

Working Solution:

2 g Acid Yellow  
100 ml Acetic Acid  
500 ml Ethanol  
1400 ml distilled water

Rinse:

100 ml Acetic Acid  
500 ml Ethanol  
1400 ml distilled water

- 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

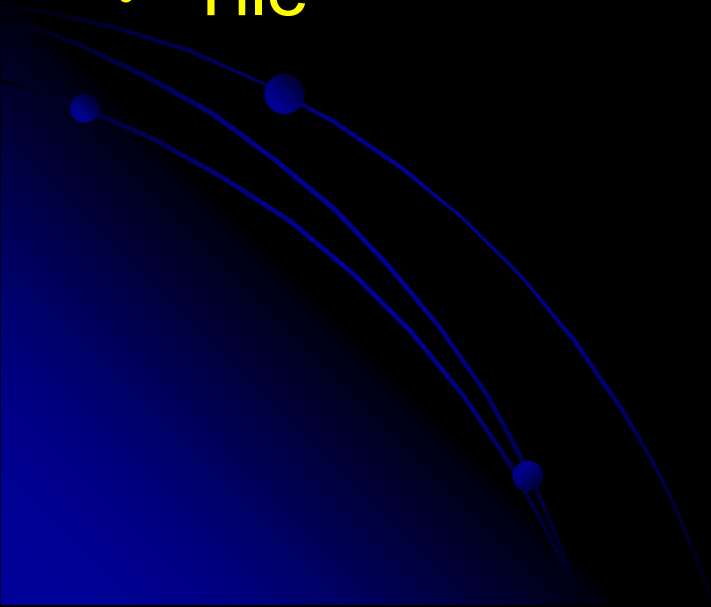
# Black Substrates

## 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



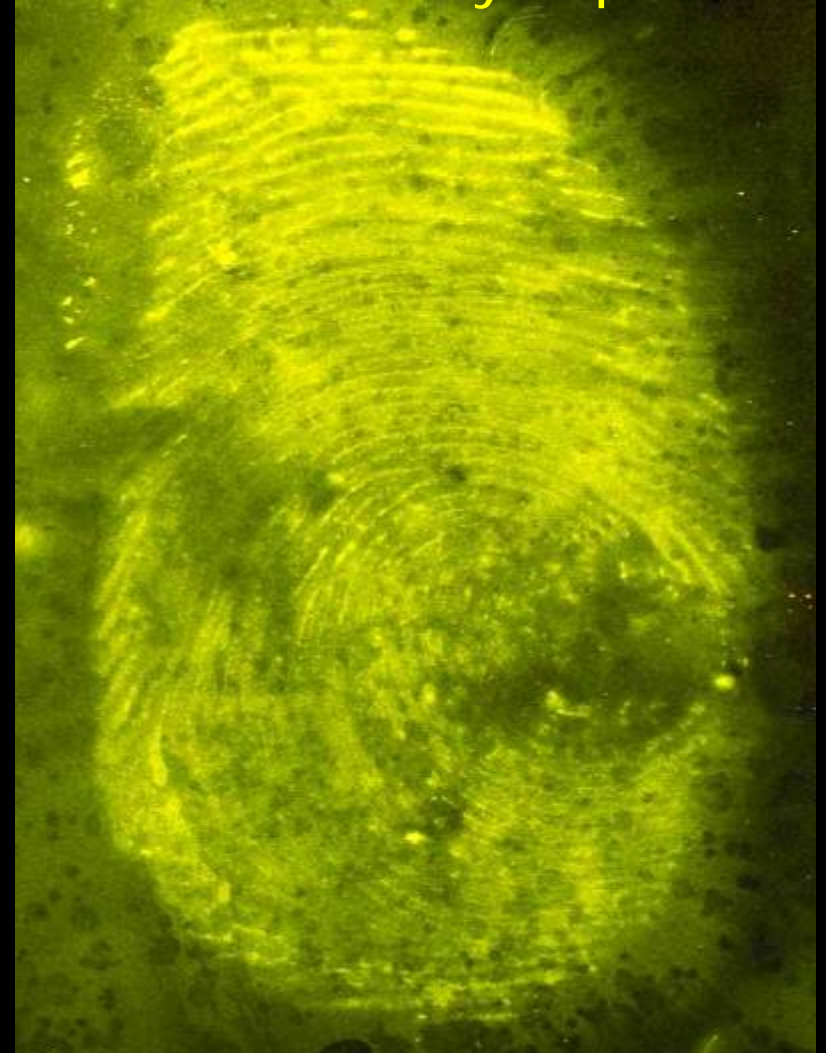
Tile

# Merbromin

Construction Paper

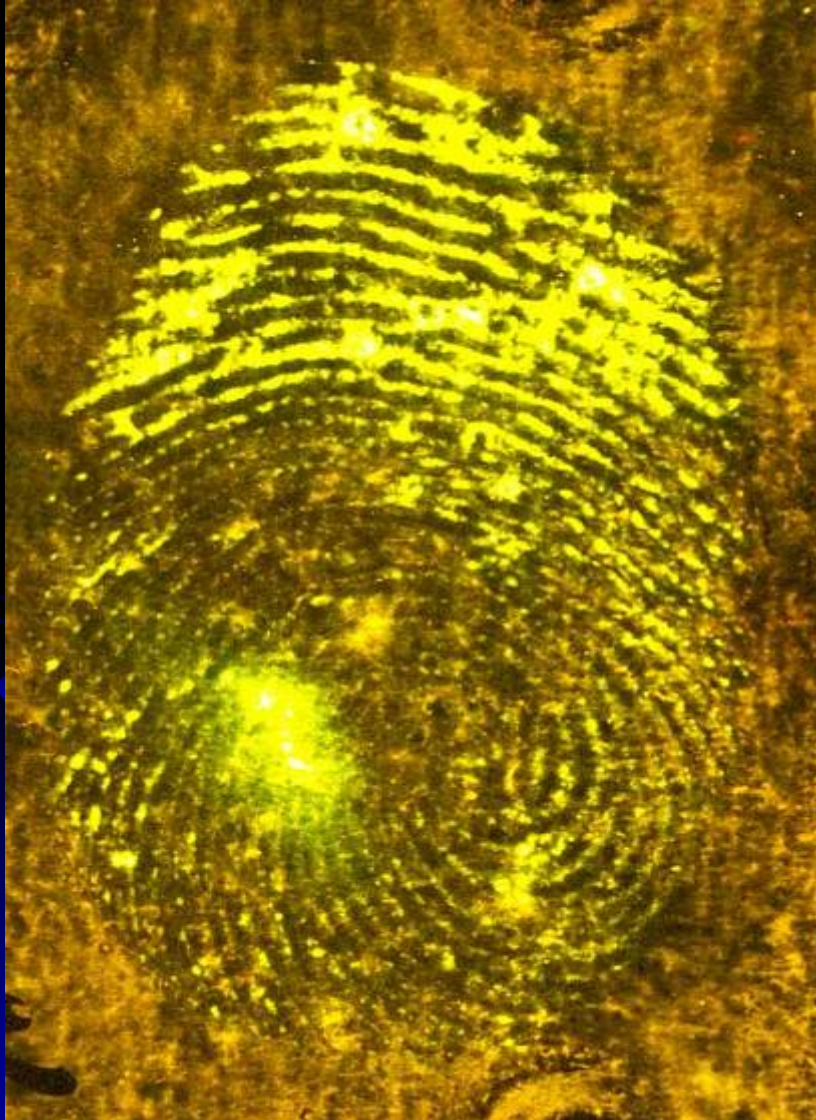


Semi-Glossy Paper

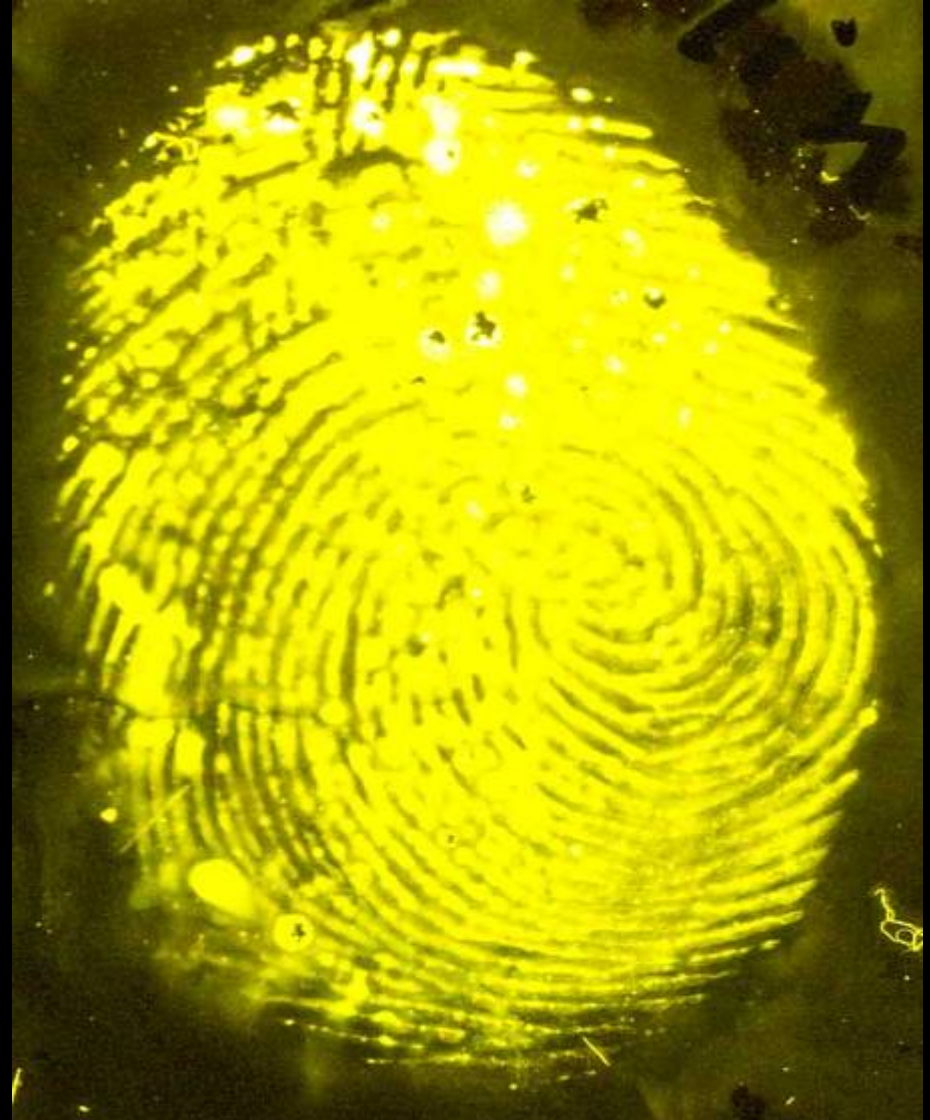


# Merbromin

Leather

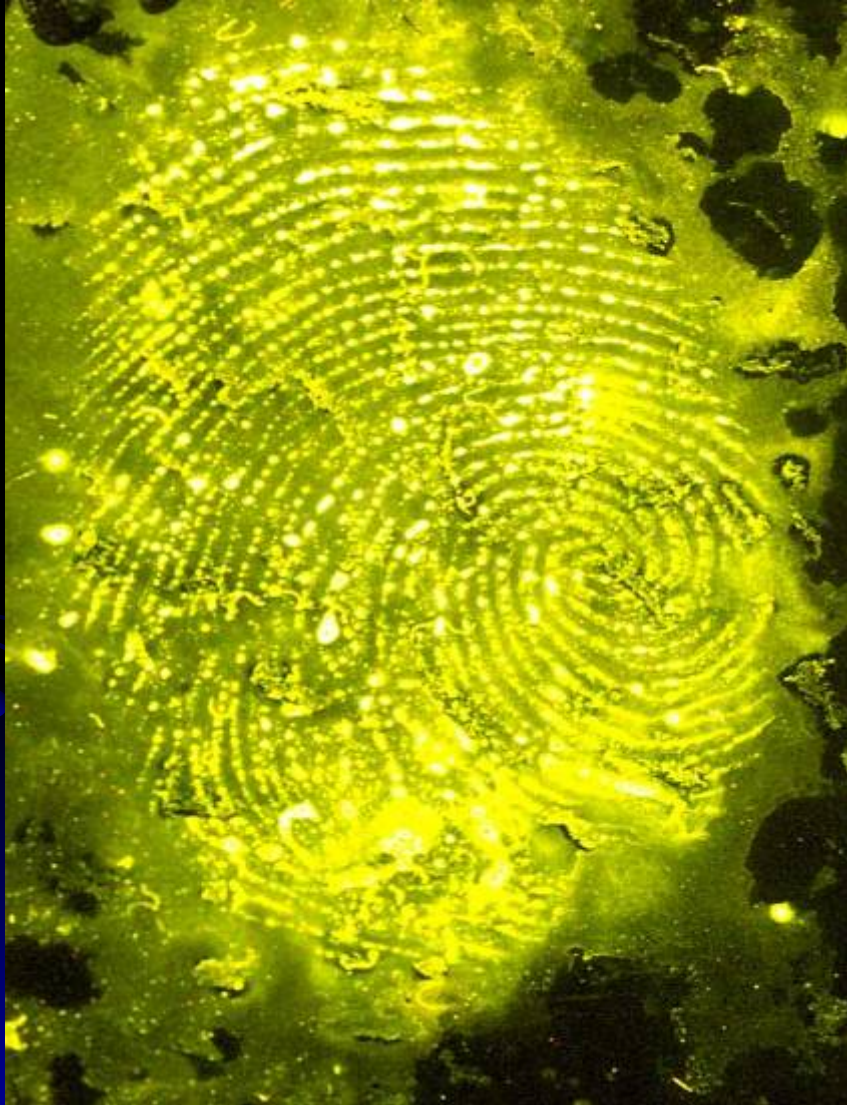


Linoleum



# Merbromin

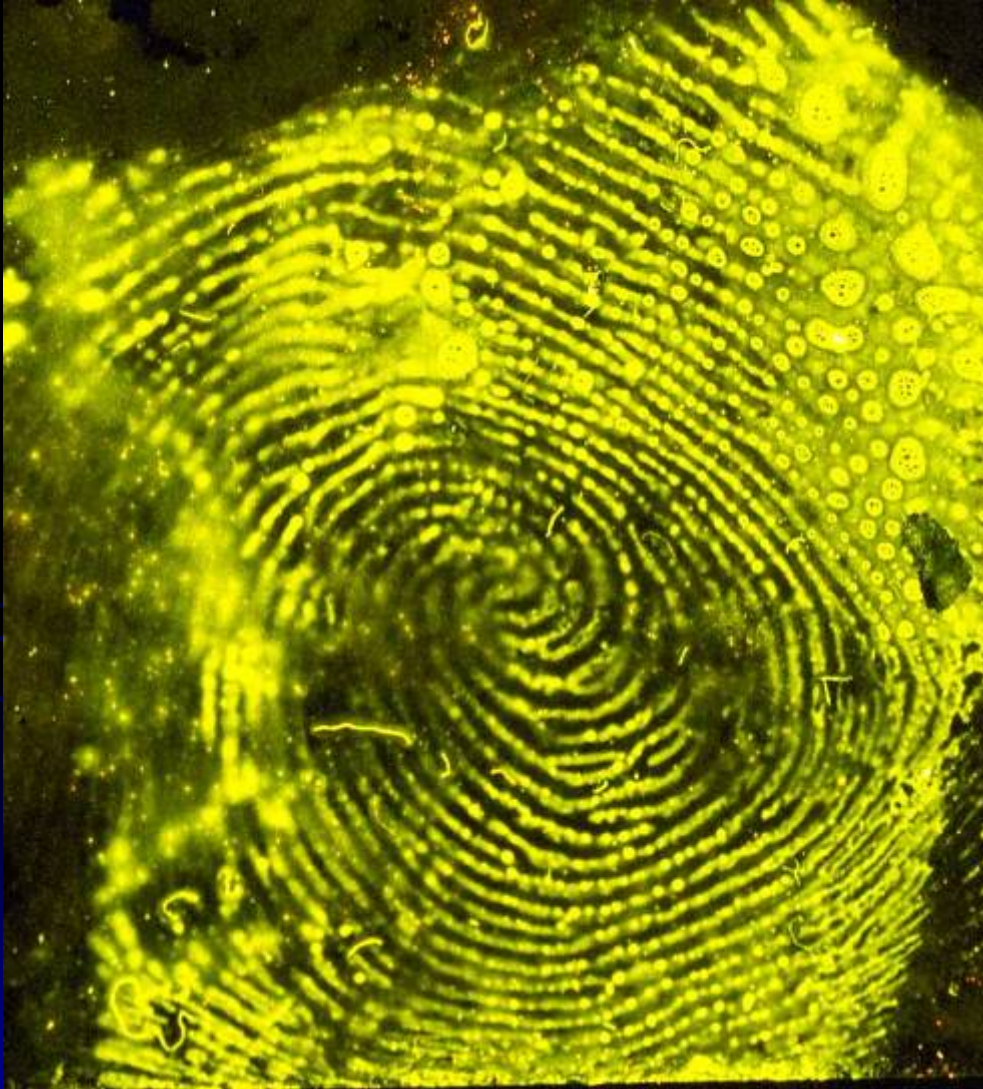
Metal



Plastic



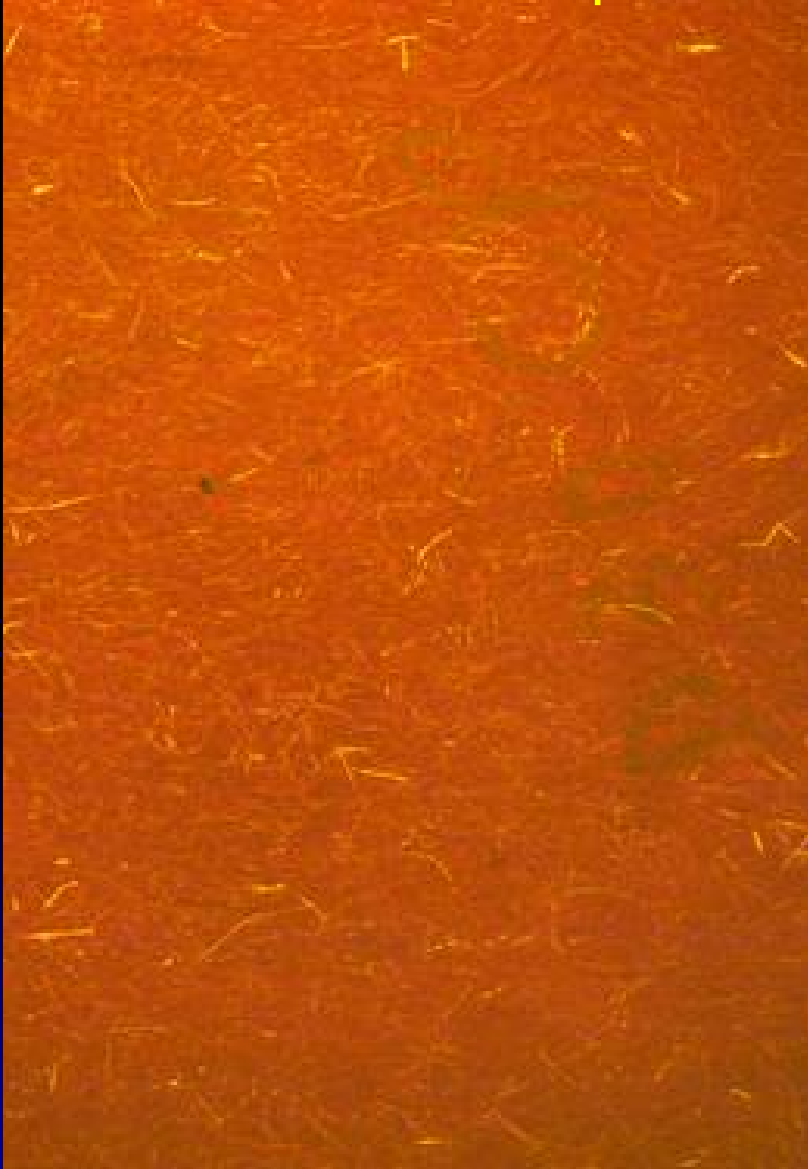
# Merbromin



Tile

# DFO

Construction Paper



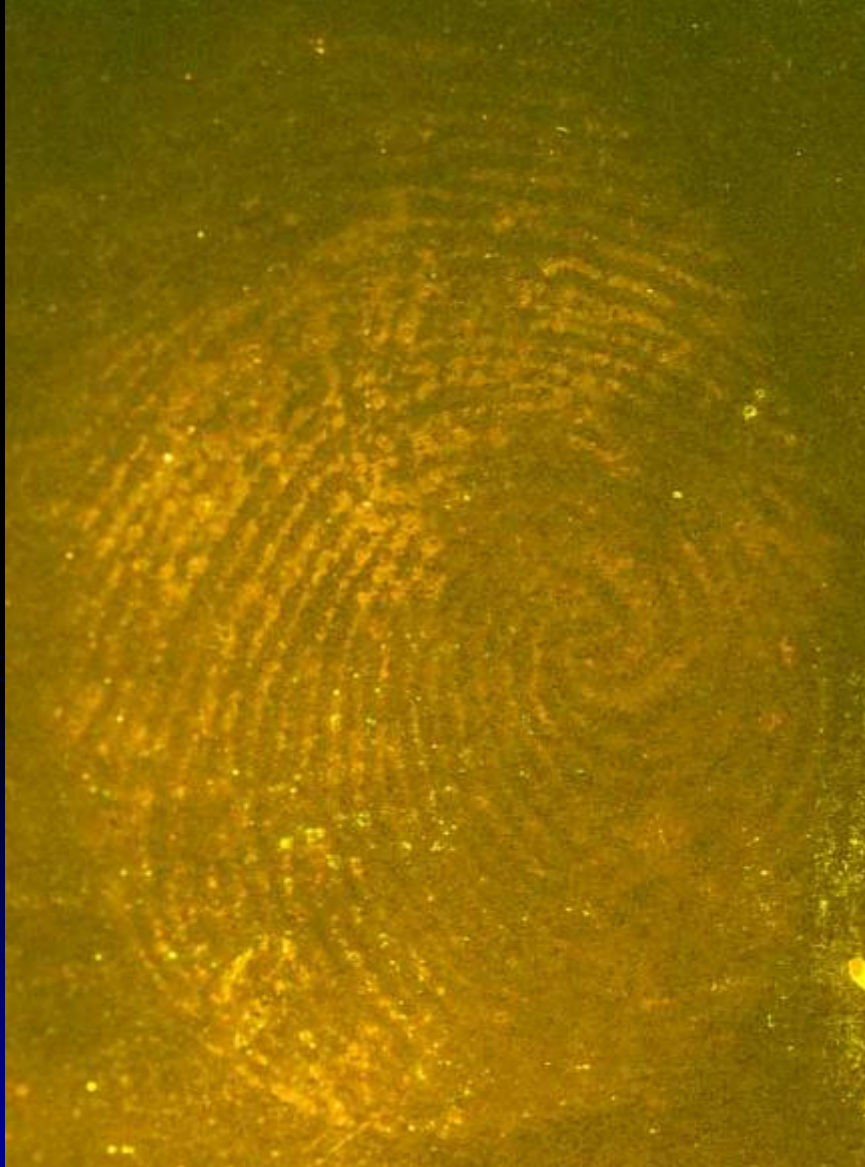
Semi-Glossy Paper



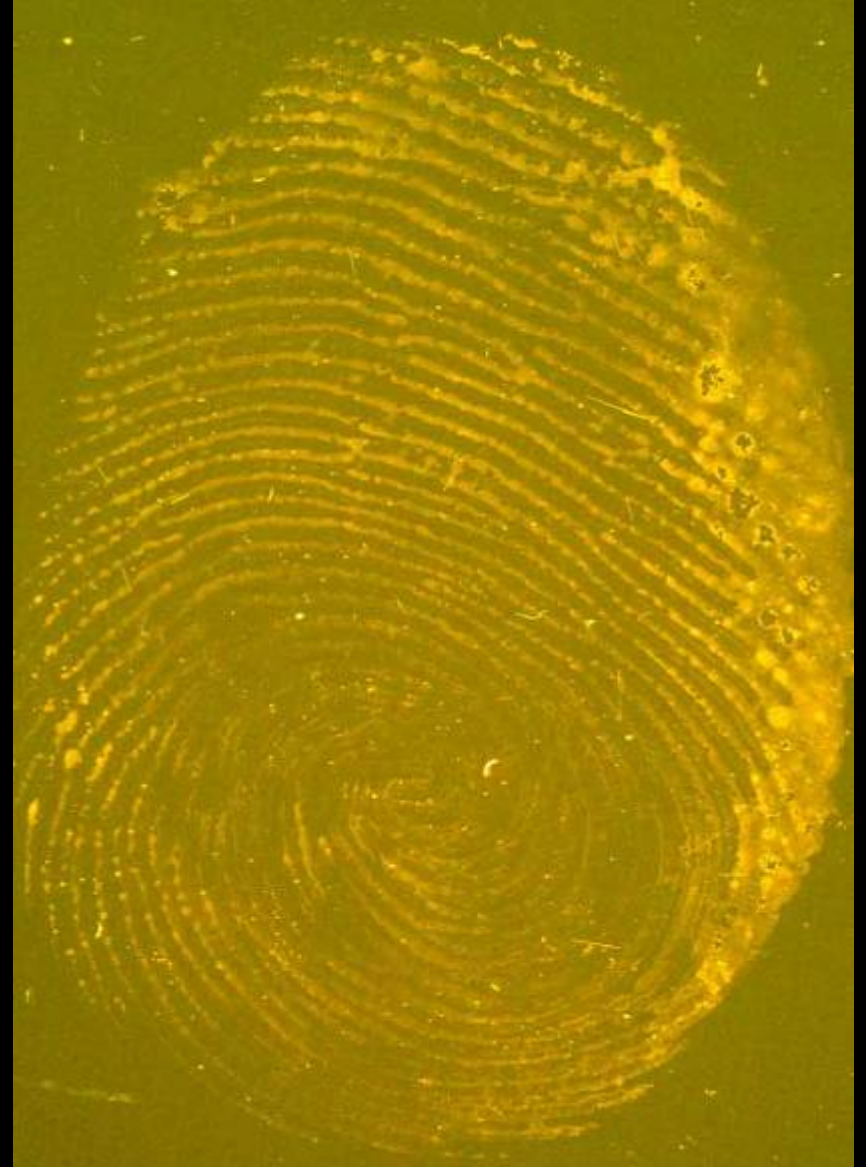


# DFO

Leather

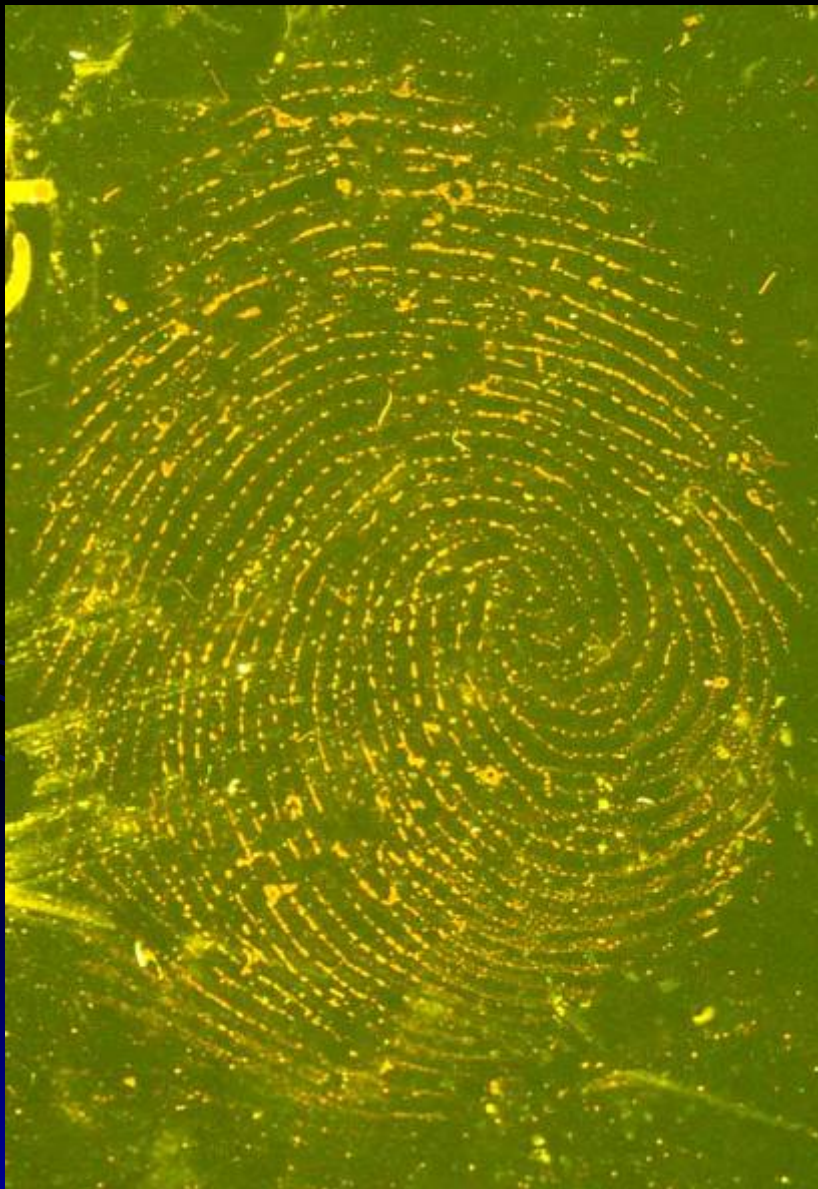


Linoleum

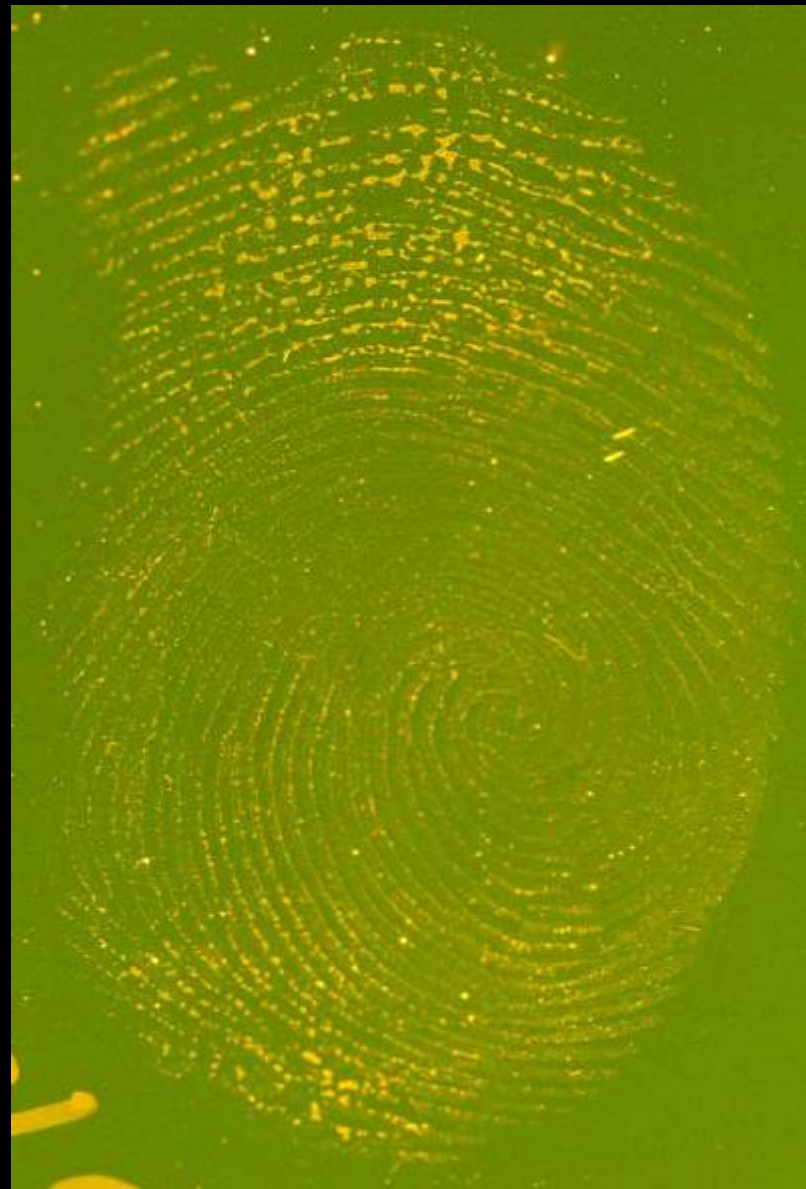


# DFO

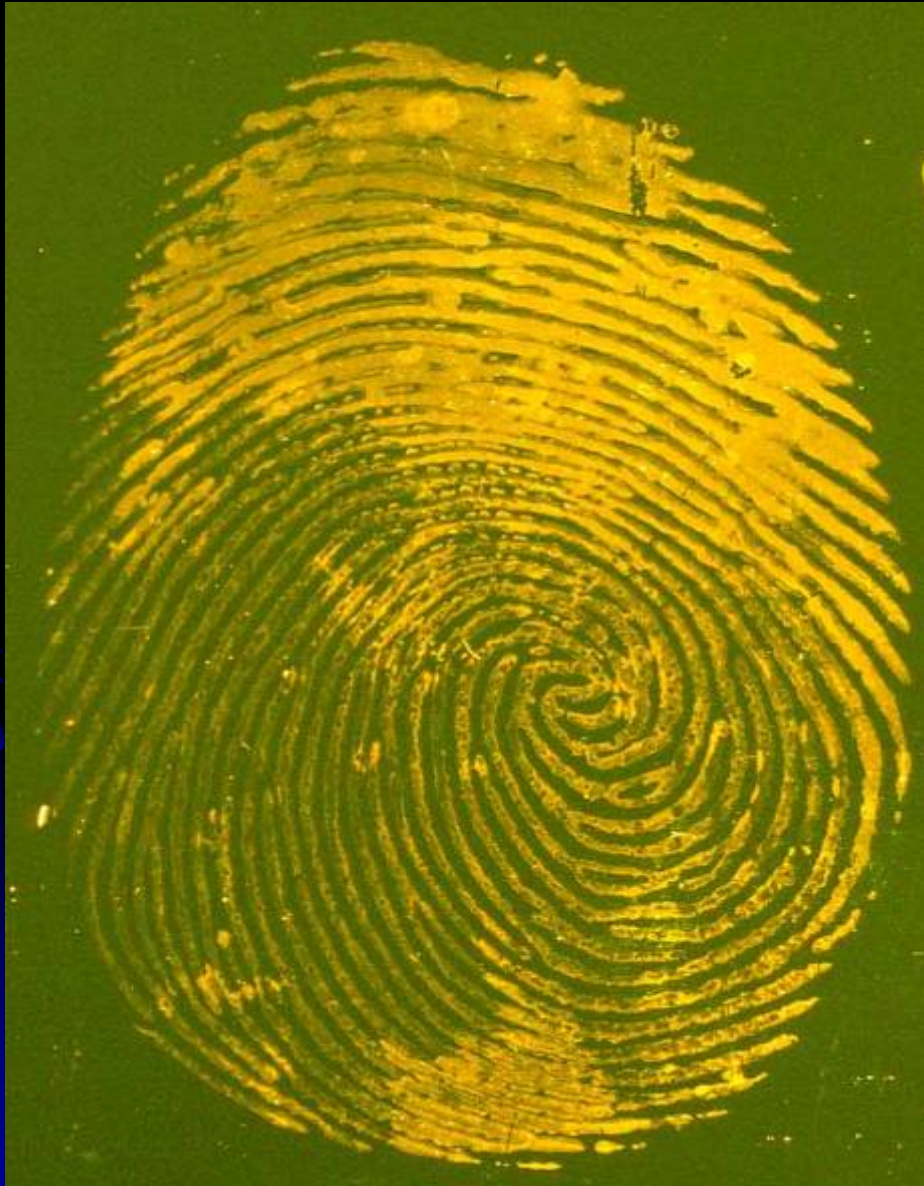
Metal



Plastic



# DFO



Tile

# A.B.T.S.

Construction Paper



Semi-Glossy Paper



# A.B.T.S.

Leather



Linoleum



# A.B.T.S.

Metal



Plastic



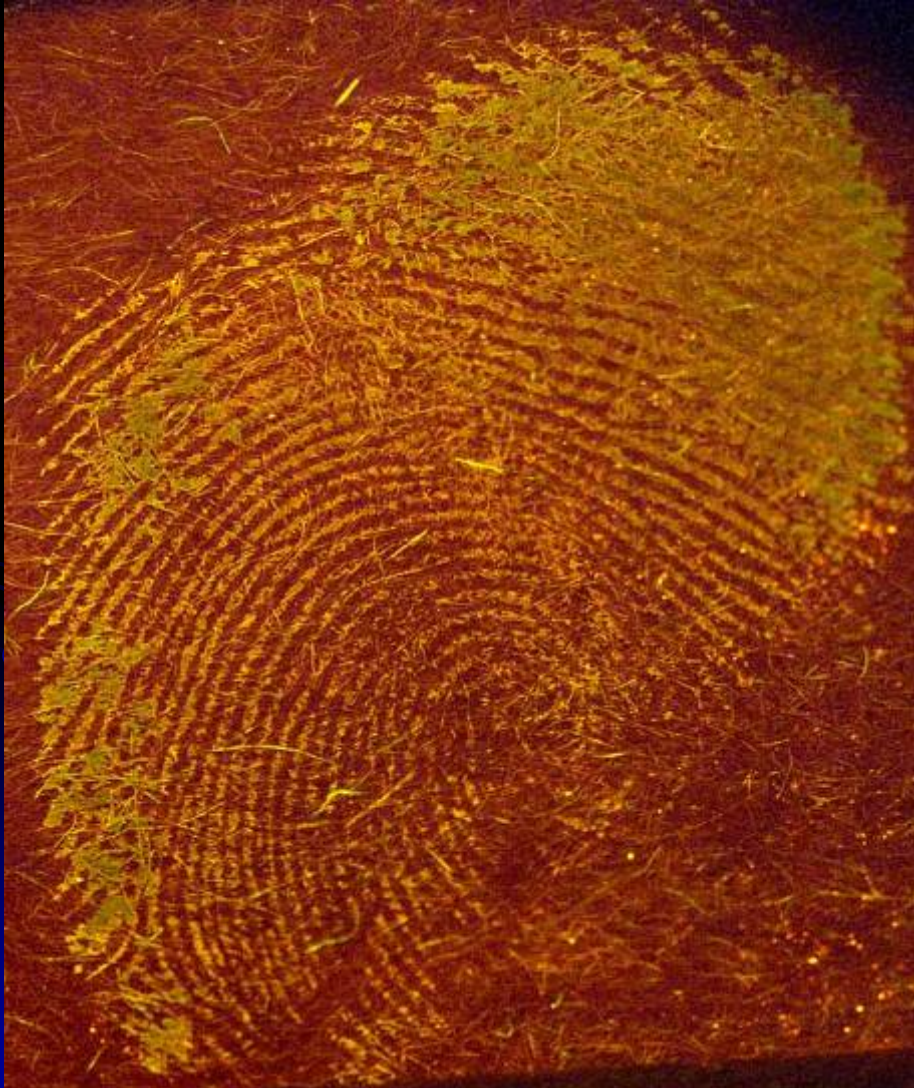
A.B.T.S.



Tile

# Acid Yellow 7

Construction Paper

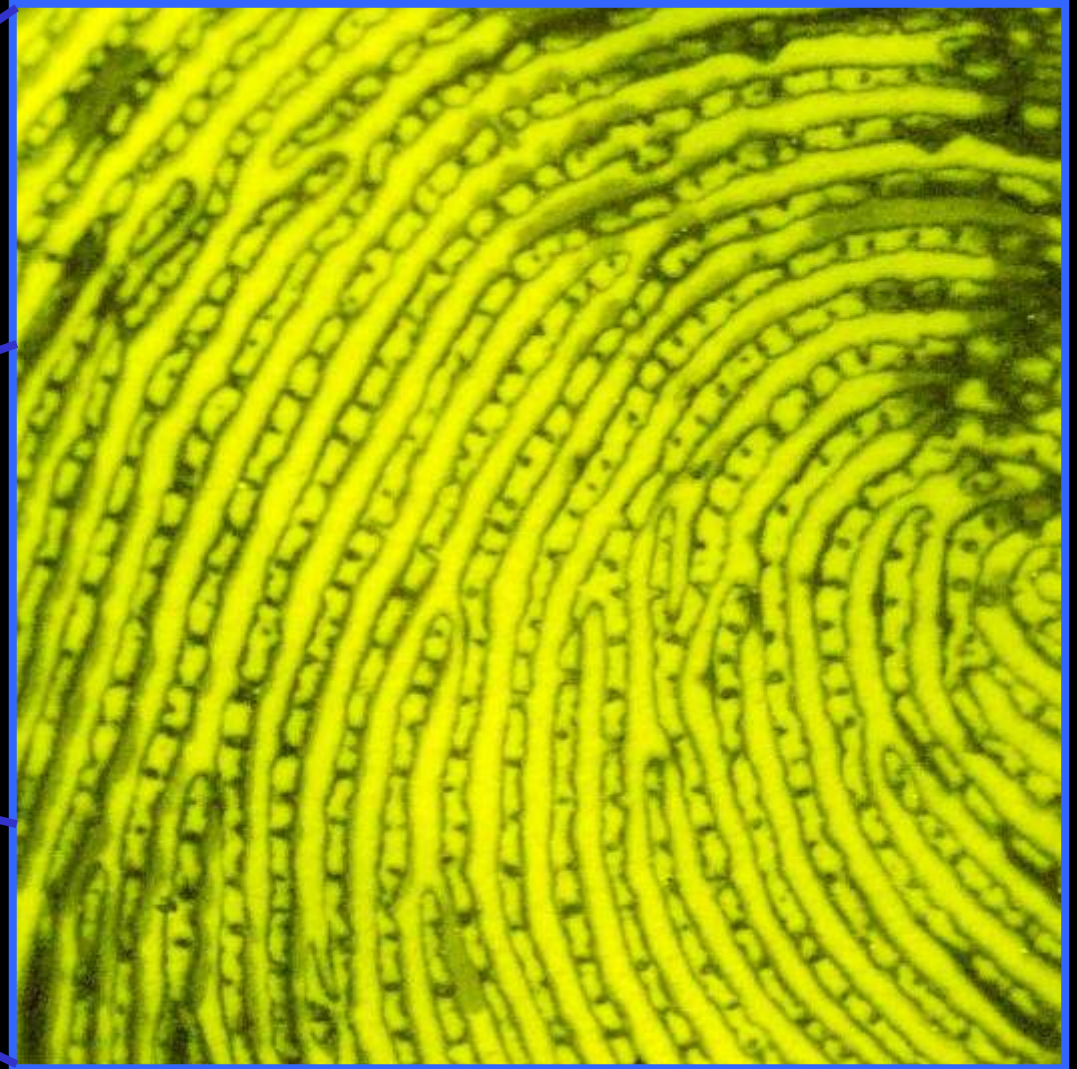


Semi-Glossy Paper





# Acid Yellow/Semi-Glossy Photo Paper



# Acid Yellow 7

Leather



Linoleum



# Acid Yellow 7

Metal

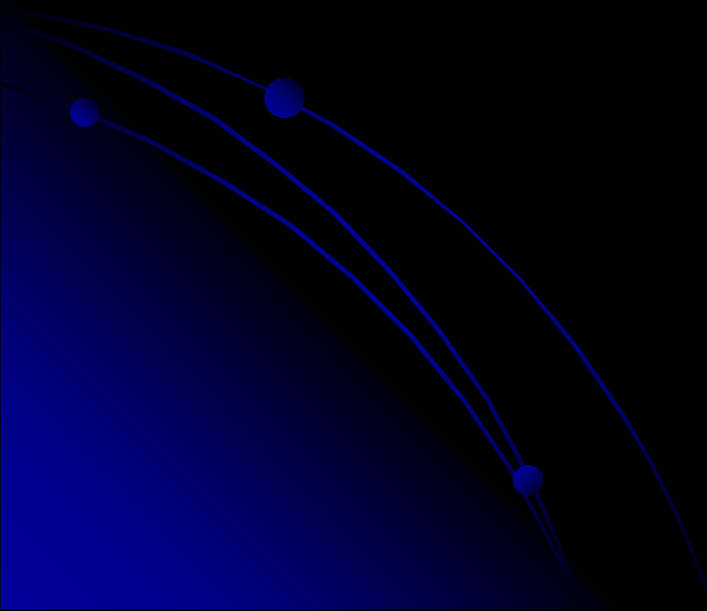


Plastic



# Acid Yellow 7

Tile



# White Gel Lift after Acid Yellow

Construction Paper

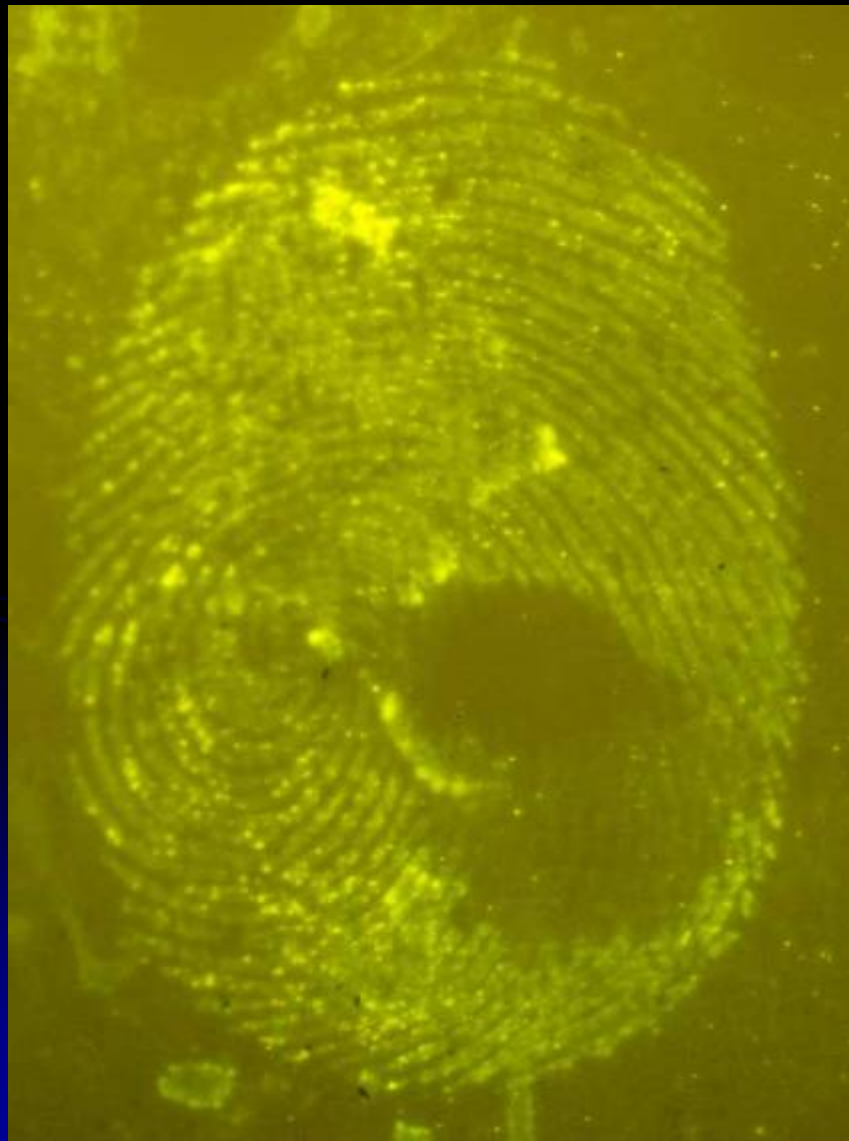


Semi-Glossy Paper

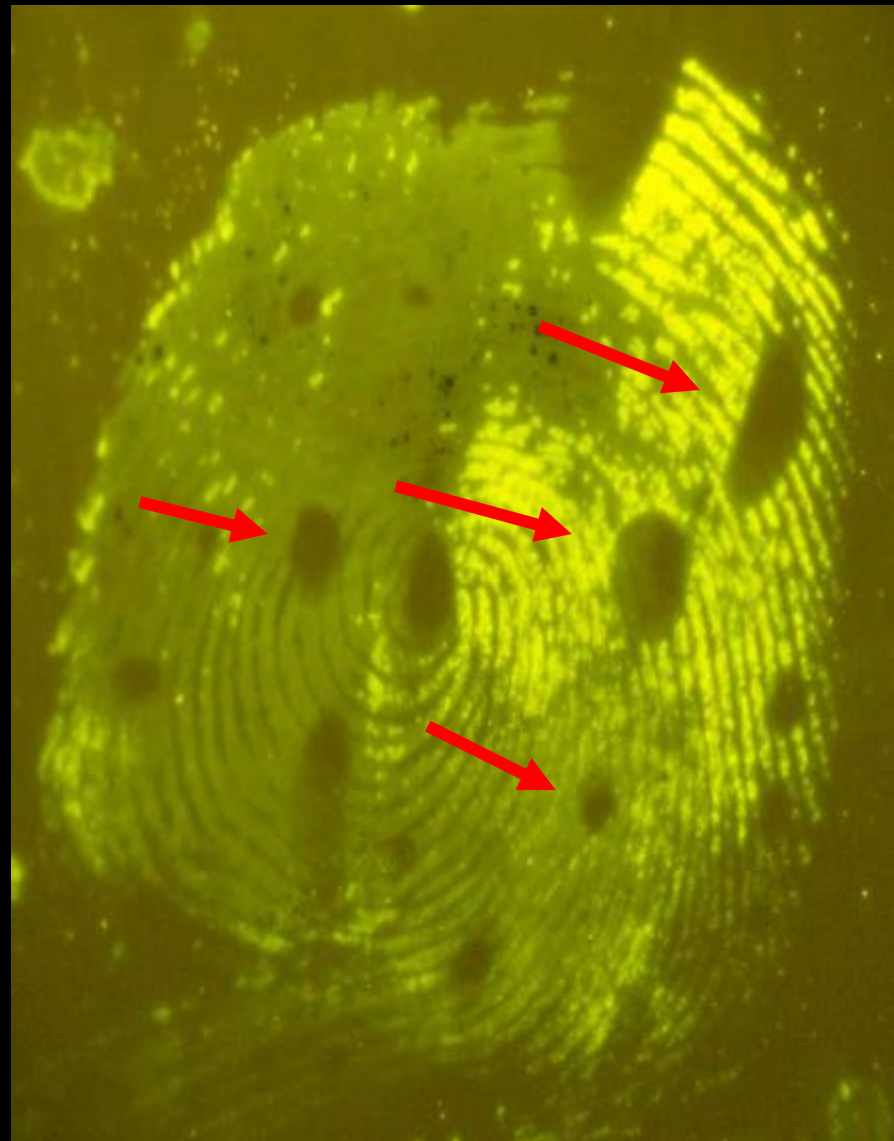


# White Gel Lift after Acid Yellow

Leather

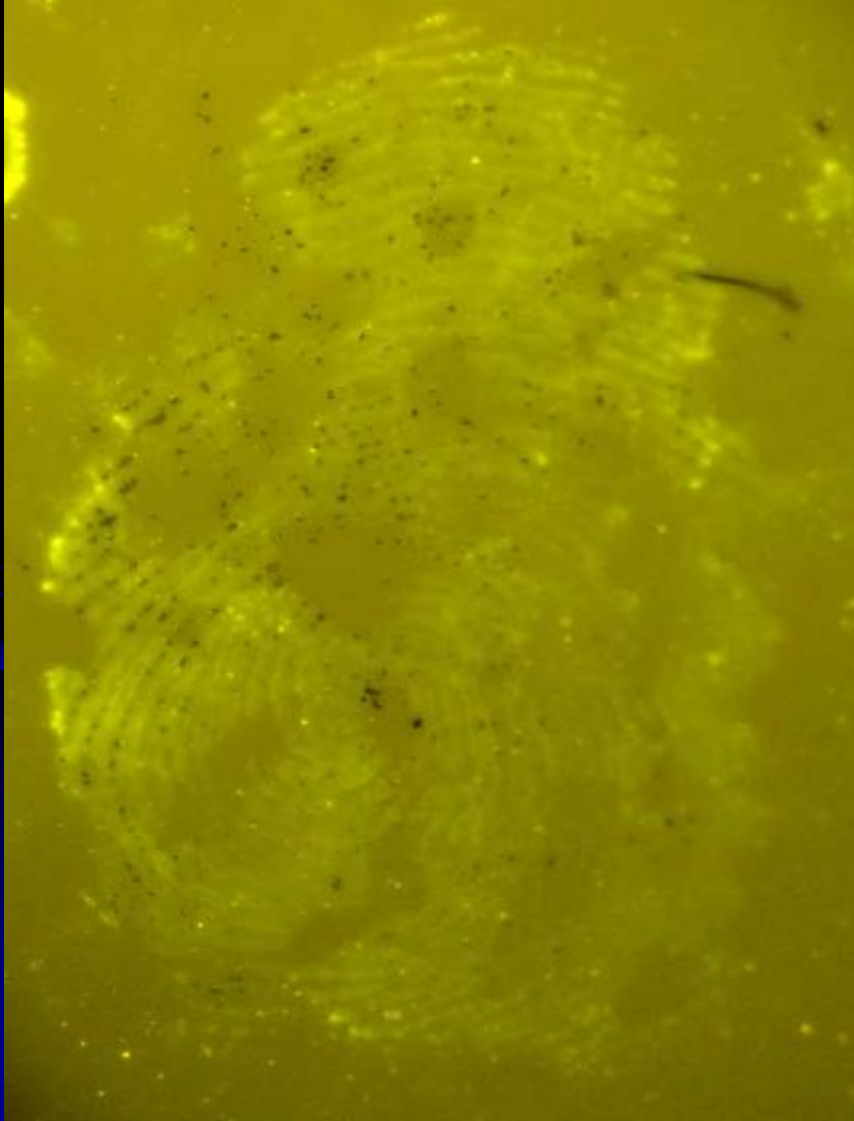


Linoleum

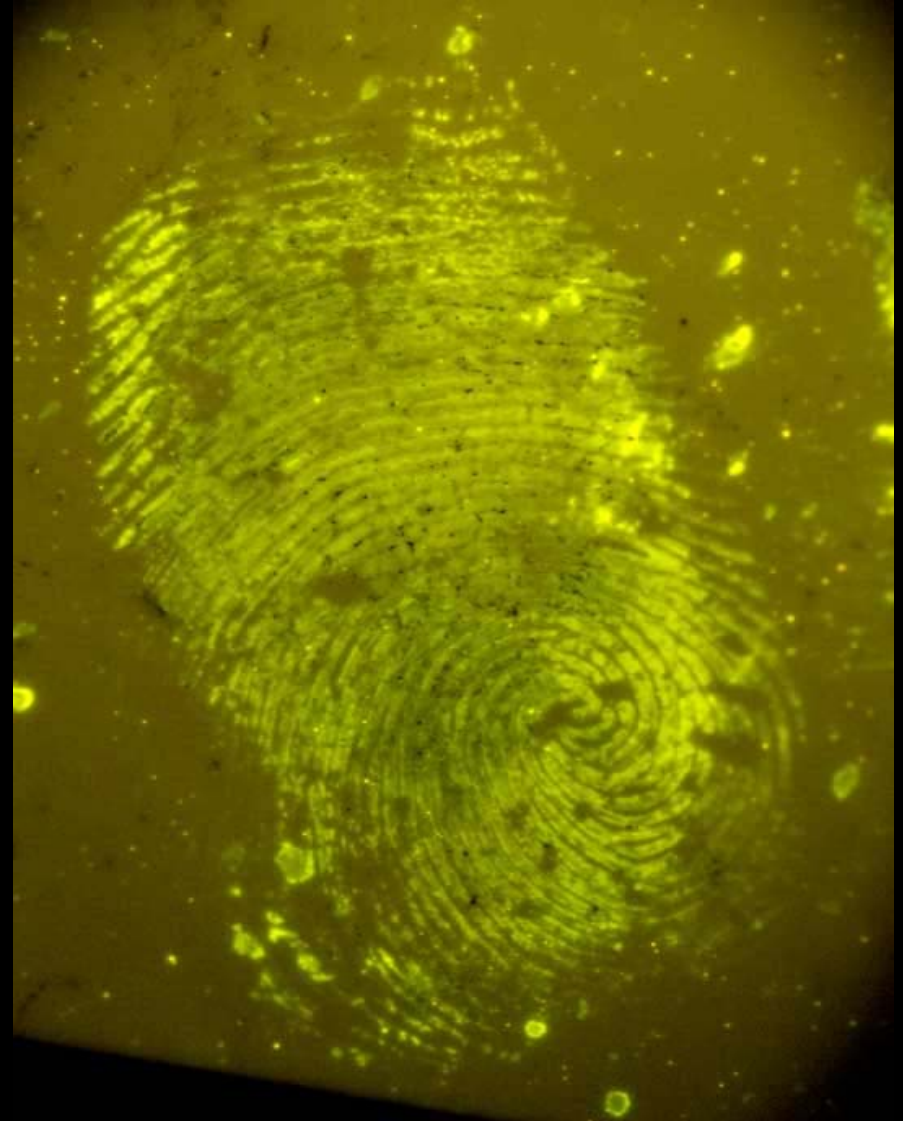


# White Gel Lift after Acid Yellow

Metal

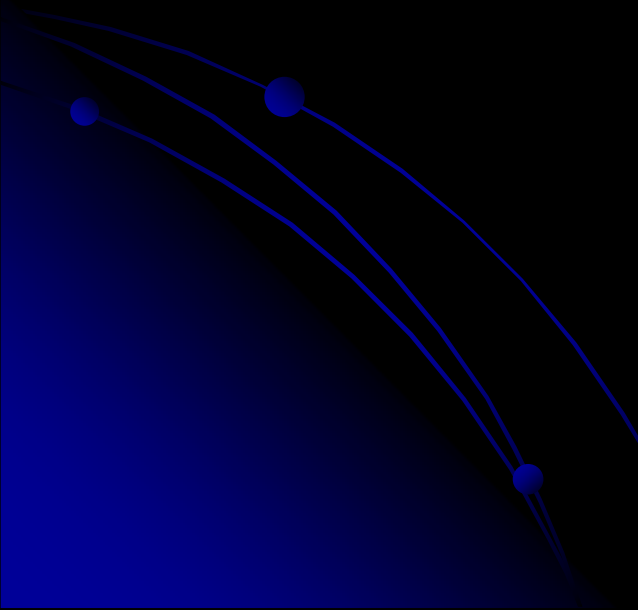
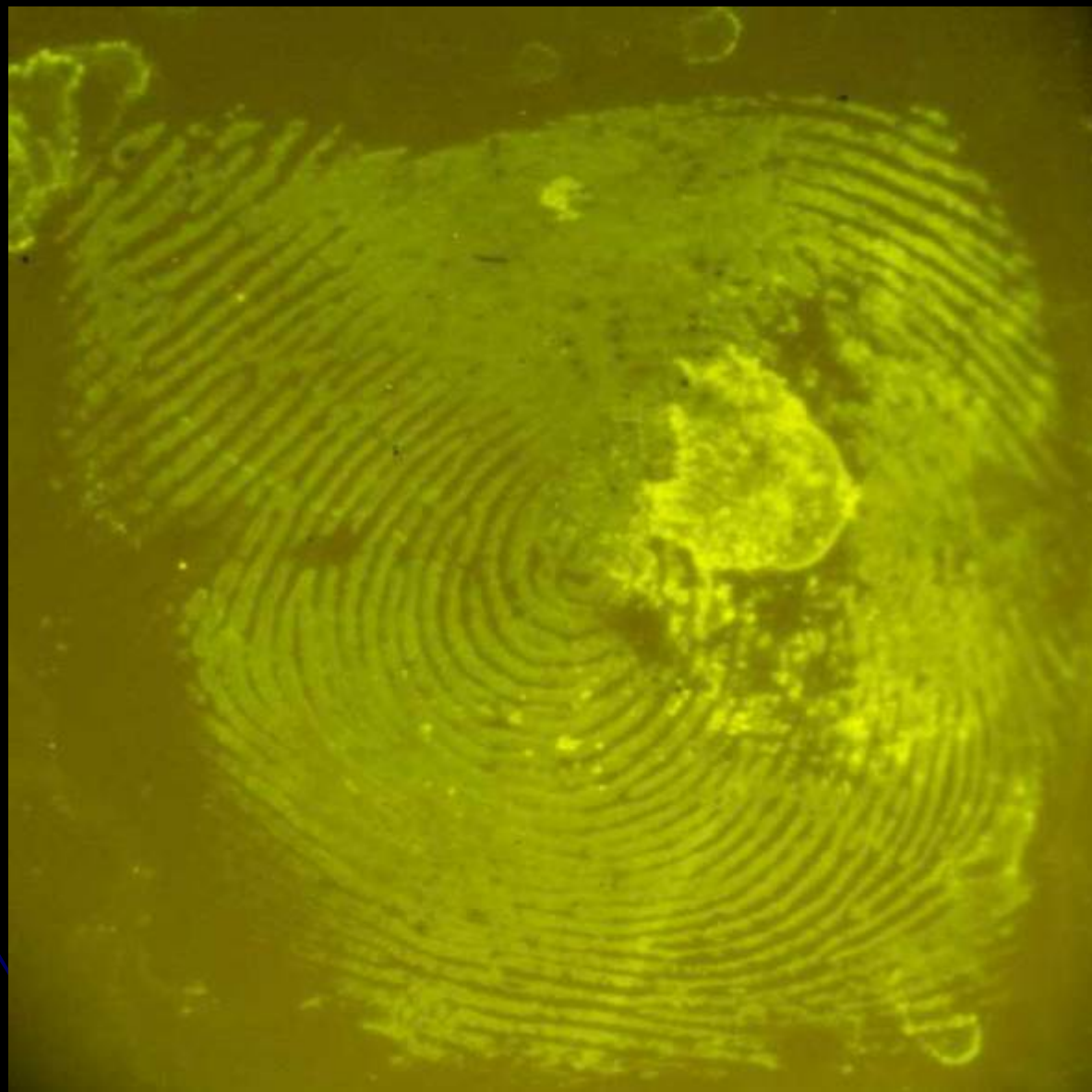


Plastic



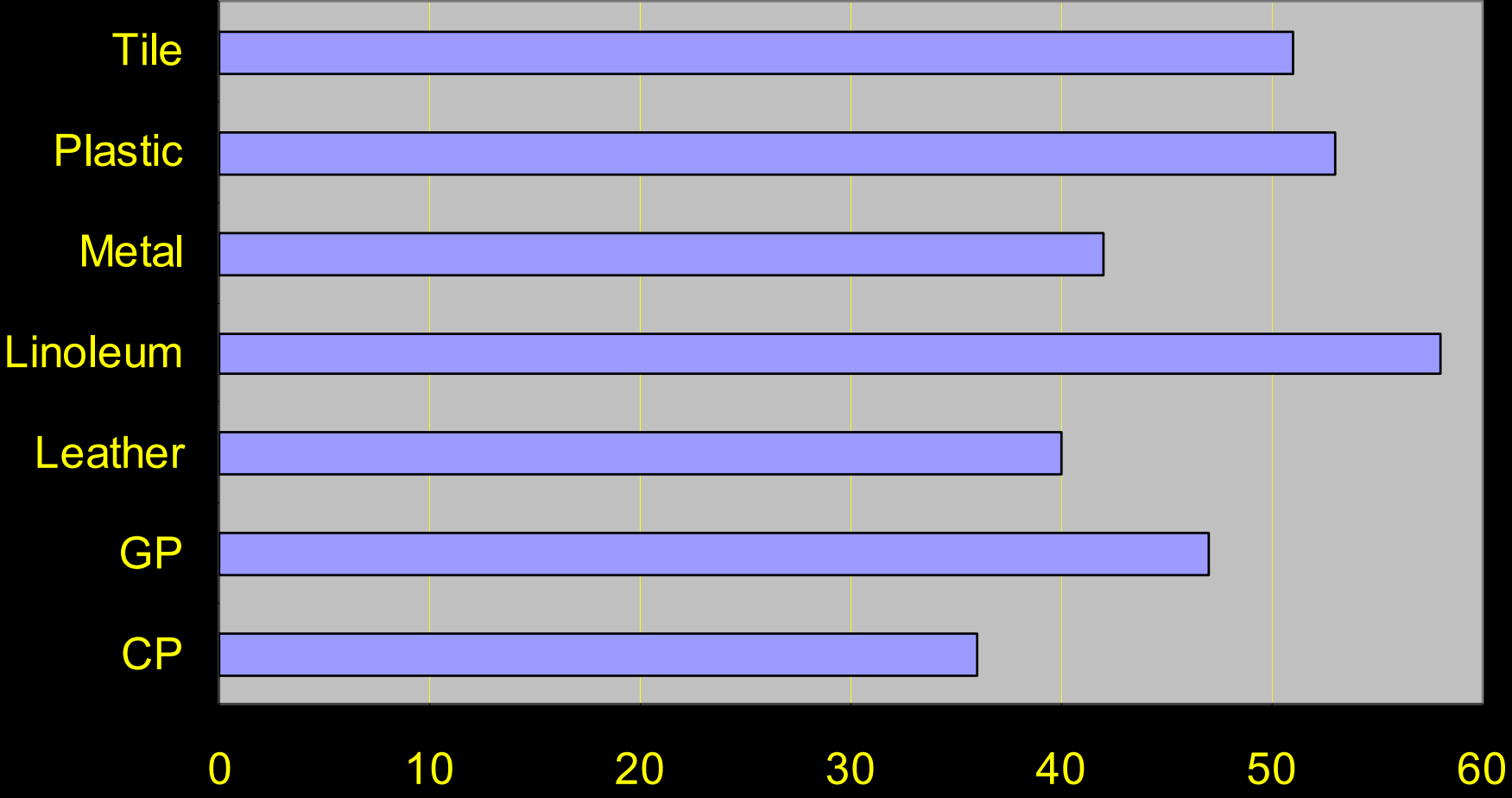
# White Gel Lift after Acid Yellow

Tile





# Number of Prints Created Per Substrate



# Total of 328 latent prints

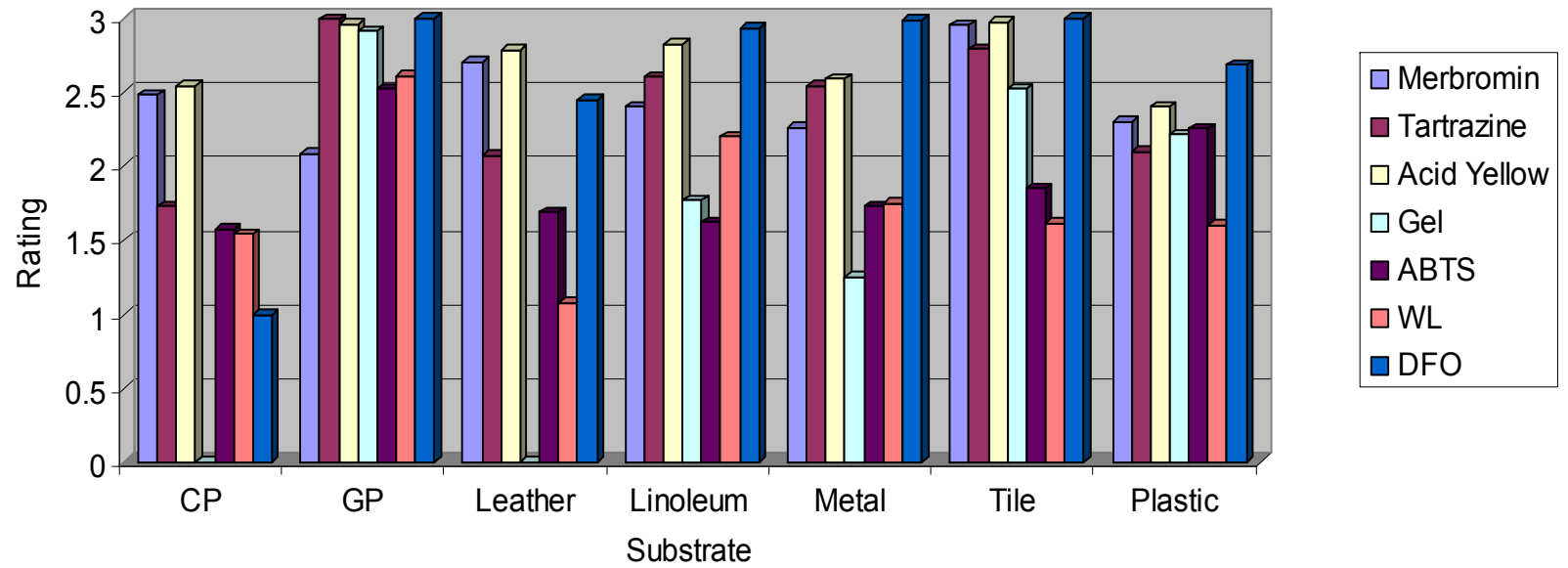
## 12 latent print examiners

- 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**

Overall Chemical Performance Rating by Substrate



# 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

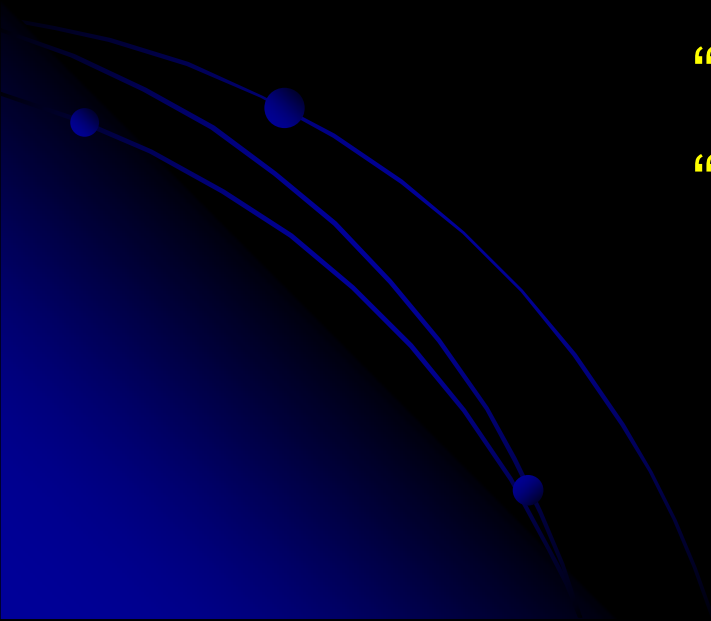
- Semi-glossy paper: 2.96 (- .04)
- Linoleum: 2.82 (- .11)
- Metal: 2.59 (- .39)
- Tile: 2.97 (- .03)
- Plastic: 2.4 (- .28)
- Construction paper: 2.54 (+ 1.54)
- Leather: 2.78 (+ .33)

- 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”

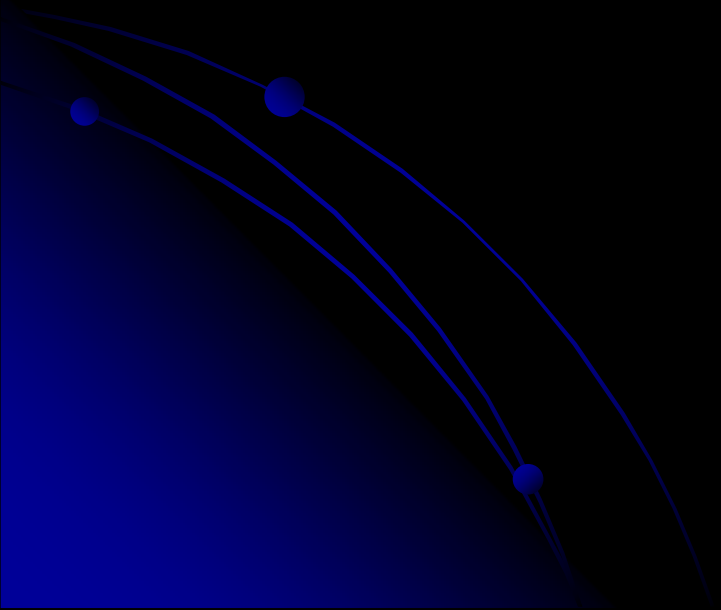


# Chemical Development Techniques by Examiner Preference

	Days	Best	%	Second Best	%	Third Best	%
CP	3	Acid Yellow	92	Merbromin	50	Acid Yellow/Merbromin	50/50
CP	15	Acid Yellow	92	Merbromin	75	Acid Yellow	42
CP	30	Tartrazine-475	42	Acid Yellow	42	Acid Yellow/Tartrazine-475	50/50
GP	3	DFO	83	Tartrazine-475	75	Tartrazine-WL	83
GP	15	Acid Yellow	75	Gel	58	Tartrazine-475	42
GP	30	Acid Yellow	92	Tartrazine-495	67	Tartrazine-WL/Gel	42
Leather	3	Acid Yellow	100	Gel	58	Merbromin	58
Leather	15	Acid Yellow	100	DFO	92	Gel	83
Leather	30	Acid Yellow	92	Merbromin	67	Tartrazine-WL	50
Lin	3	Acid Yellow	100	DFO	50	Tartrazine-475	50
Lin	15	Acid Yellow	50	Tartrazine-css	50	DFO	67
Lin	30	DFO	92	DFO/Merbromin	50/50	Merbromin	50
Metal	3	DFO	92	Acid Yellow	58	Tartrazine-WL	67
Metal	15	Acid Yellow	83	DFO	83	Merbromin	75
Metal	30	TartrazineWL	75	DFO	58	Tartrazine-630	67
Tile	3	Acid Yellow	75	Merbromin/DFO	25/25	DFO/Tartrazine-css	33/33
Tile	15	Acid Yellow	100	DFO	67	Gel	58
Tile	30	Acid Yellow	83	Tartrazine-css	50	DFO	50
Plastic	3	Acid Yellow	92	ABTS-WL	50	ABTS-670	58
Plastic	15	DFO	58	Merbromin	42	ABTS-WL	50
Plastic	30	Acid Yellow	50	DFO	50	DFO/ABTS-WL	33/33

# 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

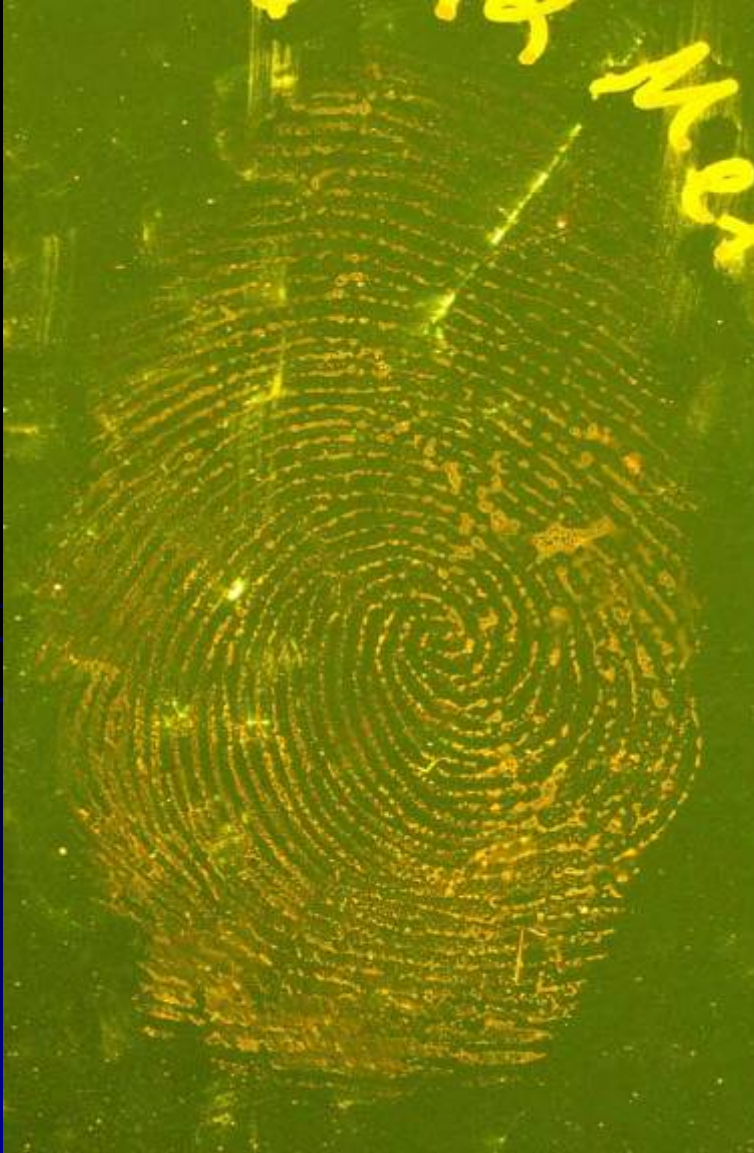
- 7 (14.3%) showed an increase in the rating as the latent aged
- Most frequently when Merbromin was used 3/7 (43%)
- Substrates on which this occurred: 3/7 on semi-glossy paper and 2/7 on plastic



# DFO/Metal

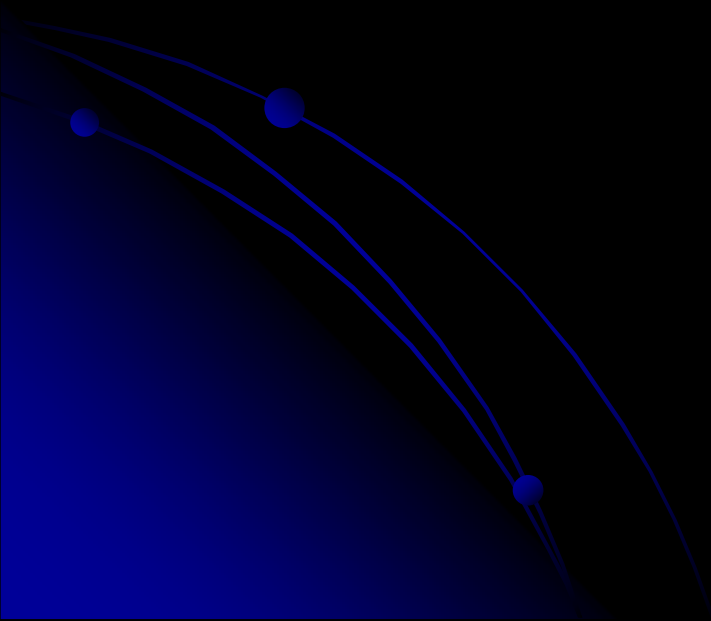
After selecting Auto Levels function in  
Adobe™ Photoshop™ CS

Unprocessed

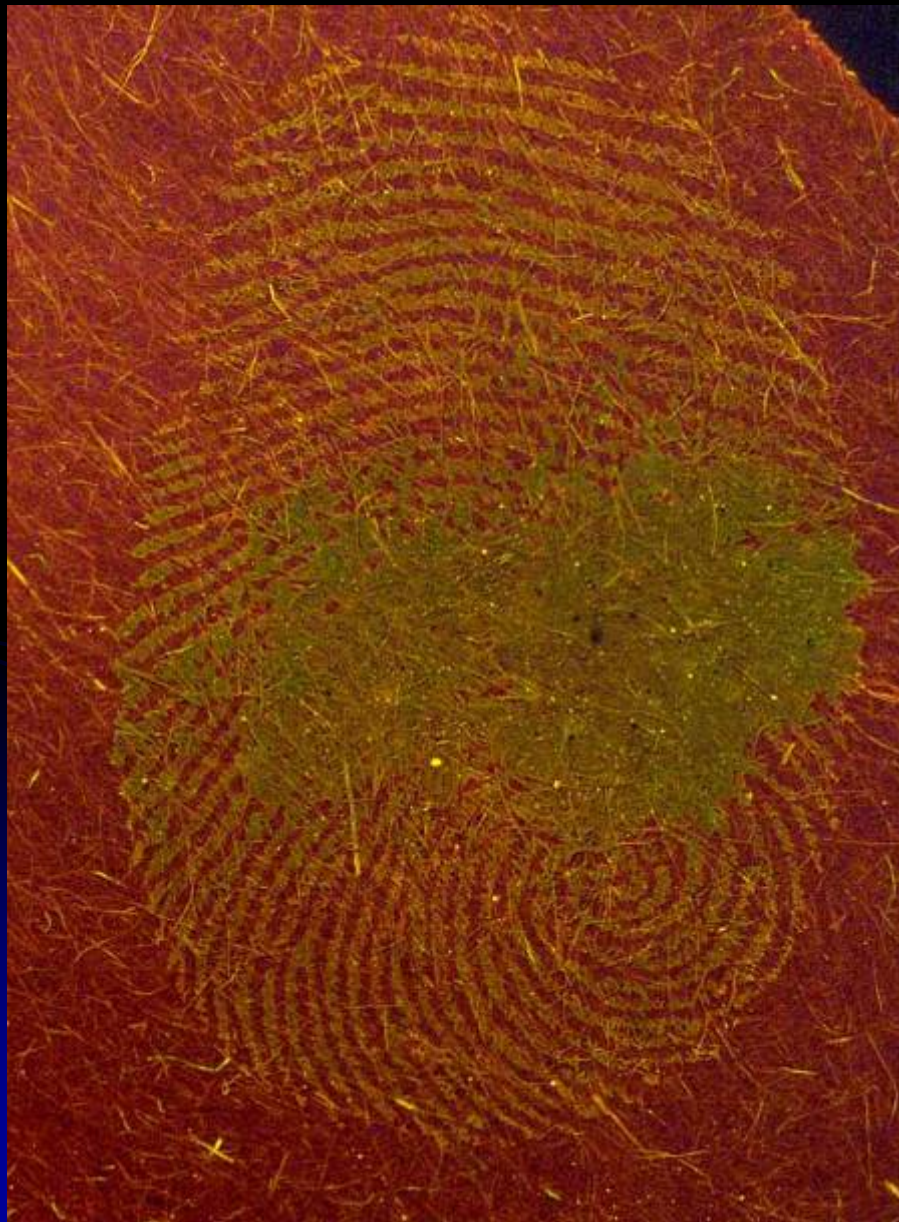


# Advantages of Acid Yellow

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



Acid Yellow/Construction Paper



Acid Yellow/Leather



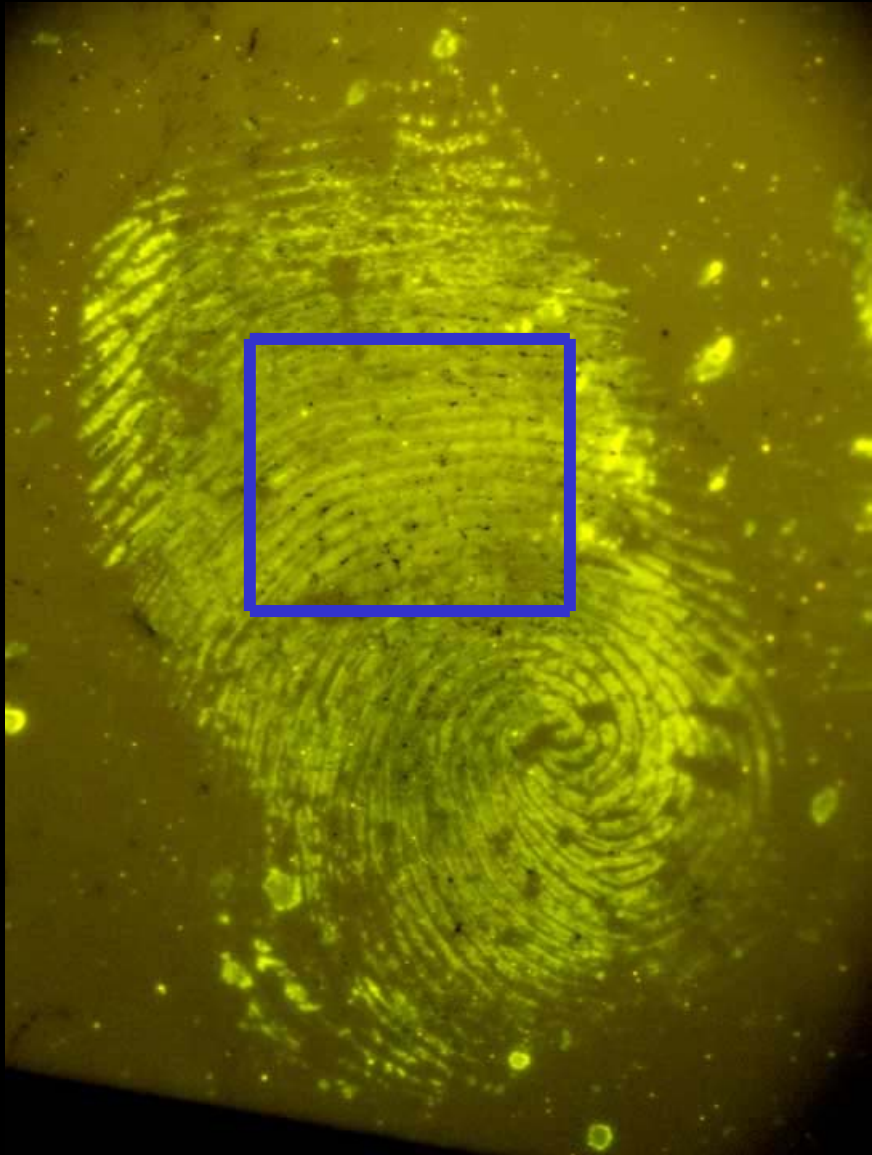
# Advantages of Acid Yellow

- 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

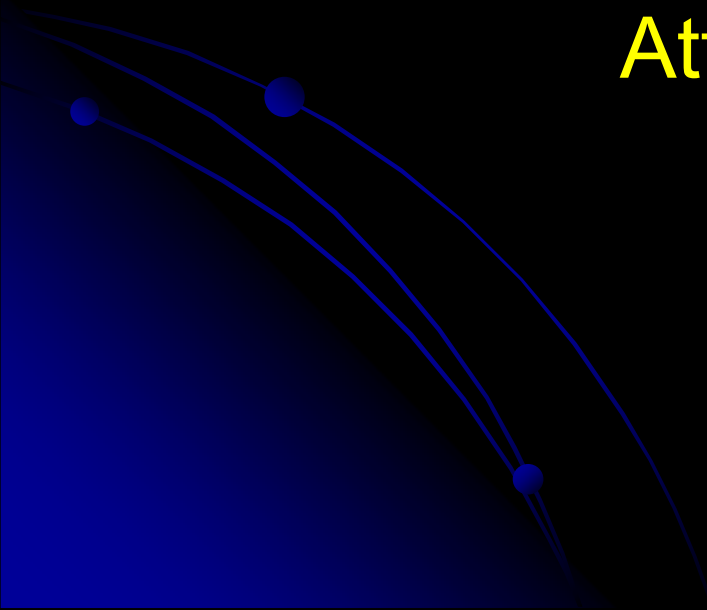


# Advantages of Acid Yellow

- 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

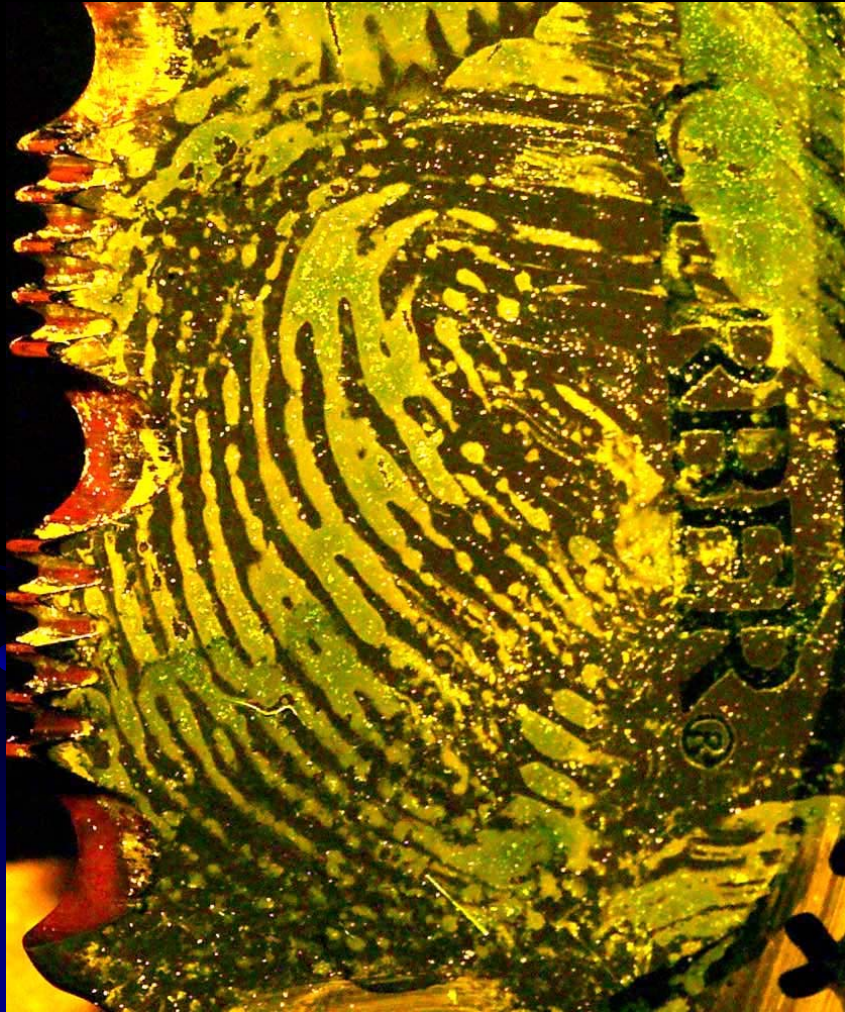




After  
Processing  
with Acid  
Yellow



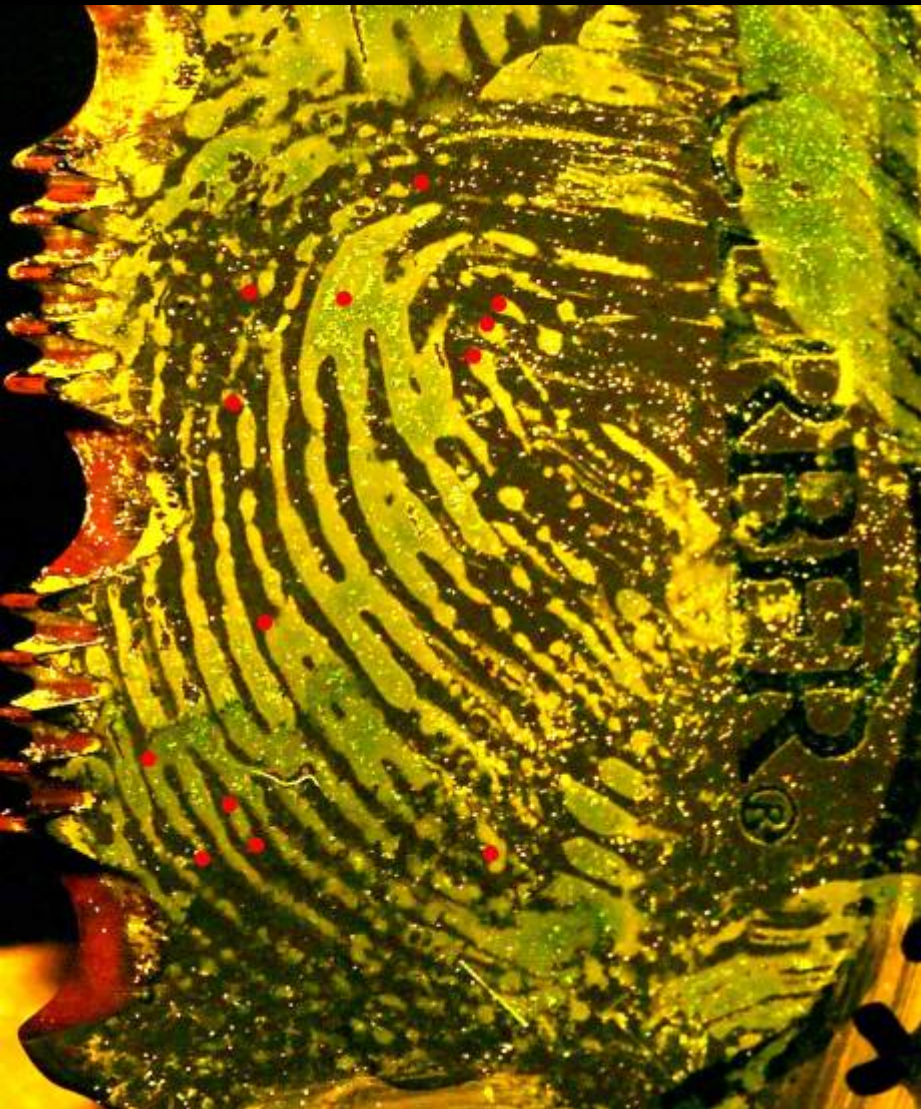
Acid Yellow



White Light



Acid Yellow

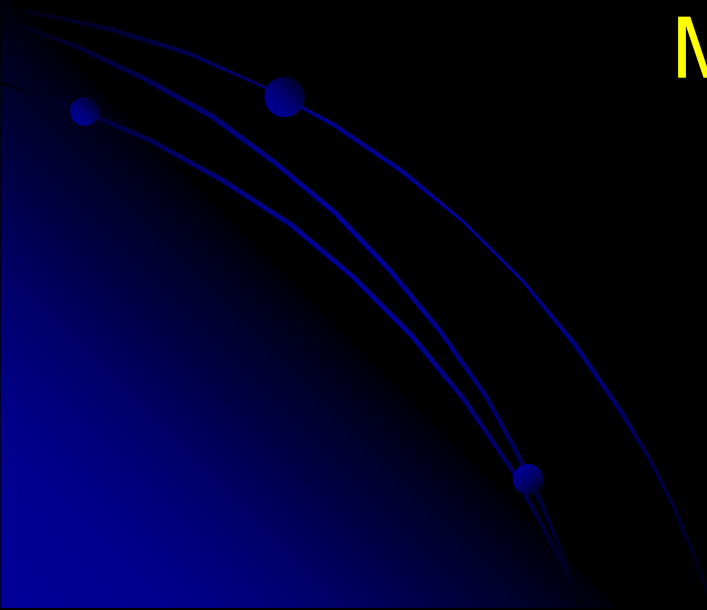


Record Fingerprint Card #1 Finger

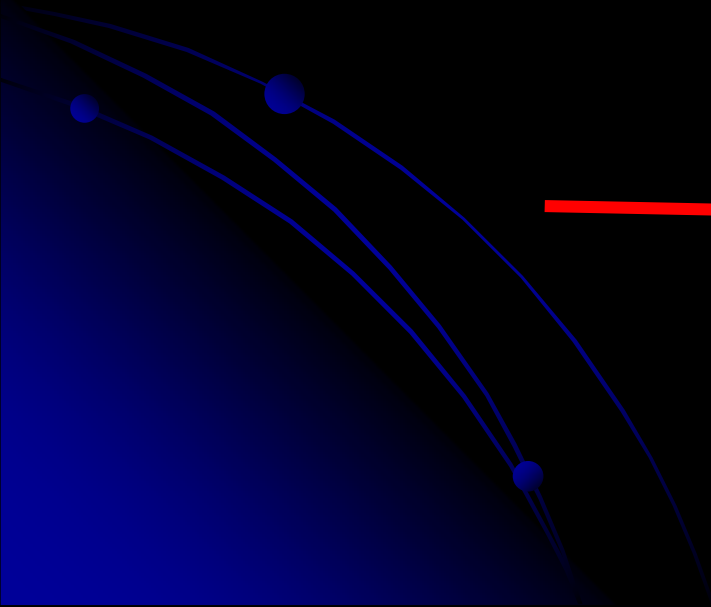


# 2007 Case Example

Murder-Suicide



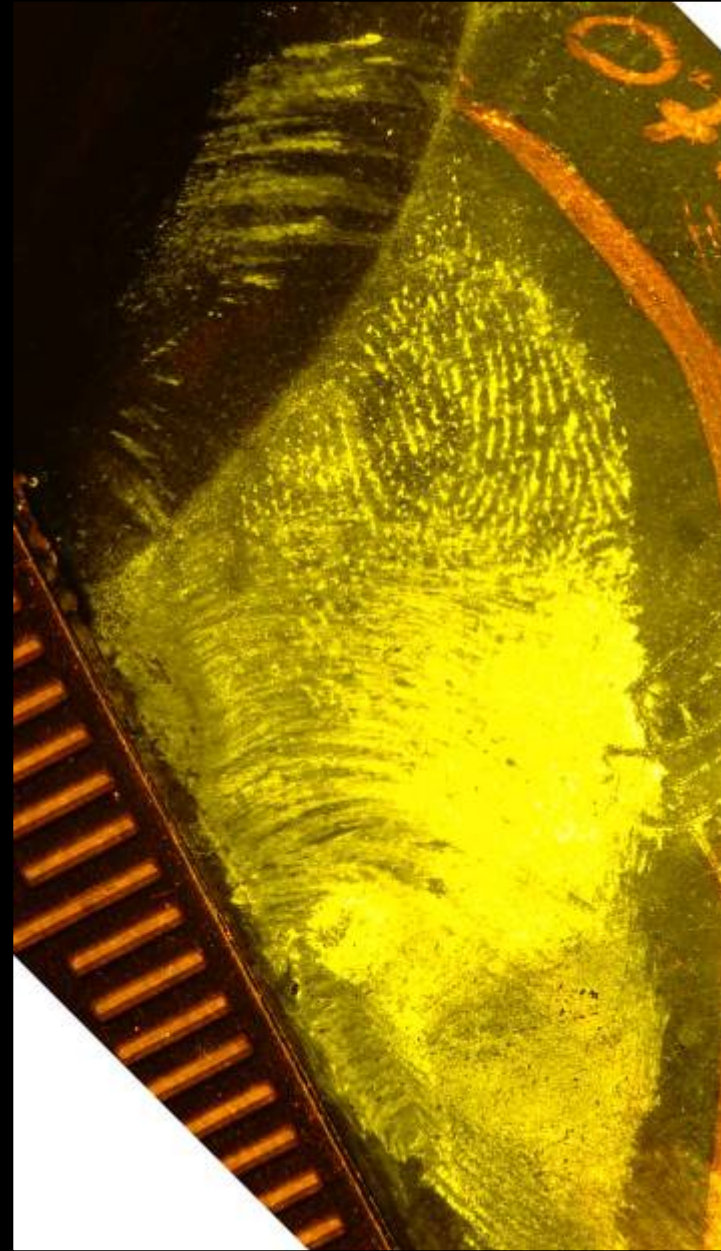
# Browning Safari 300 Win Mag



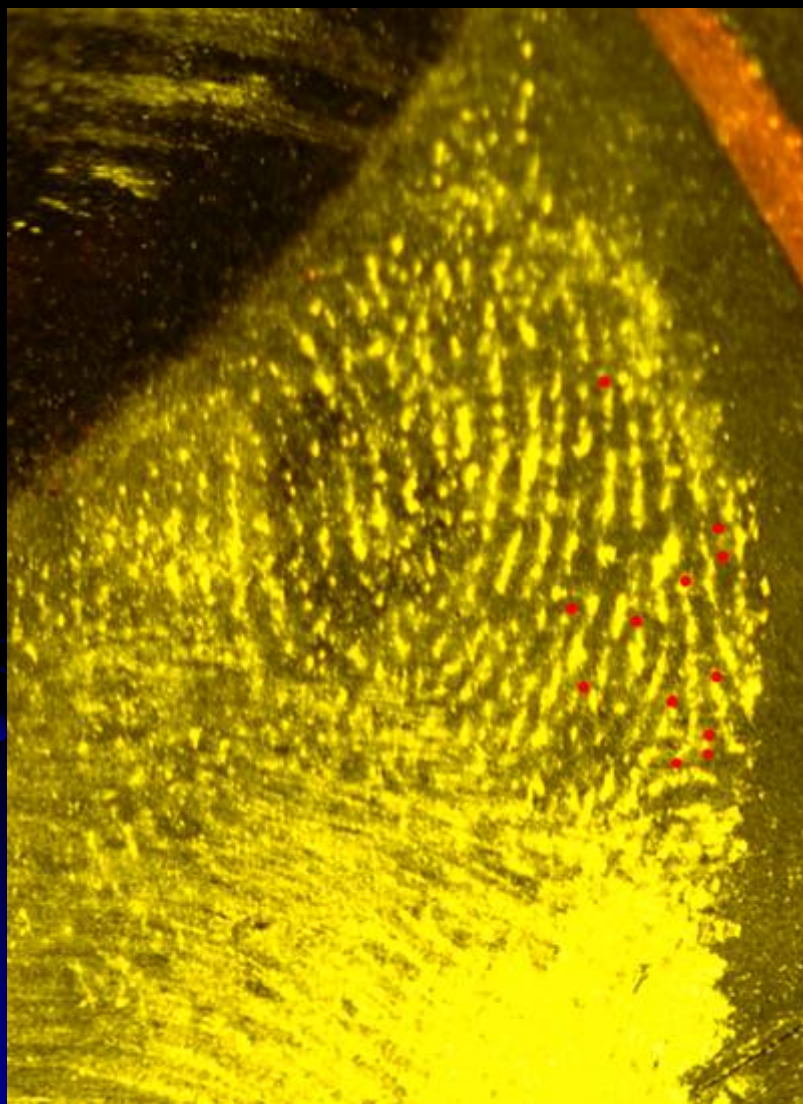
White Light Only



Acid Yellow



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?

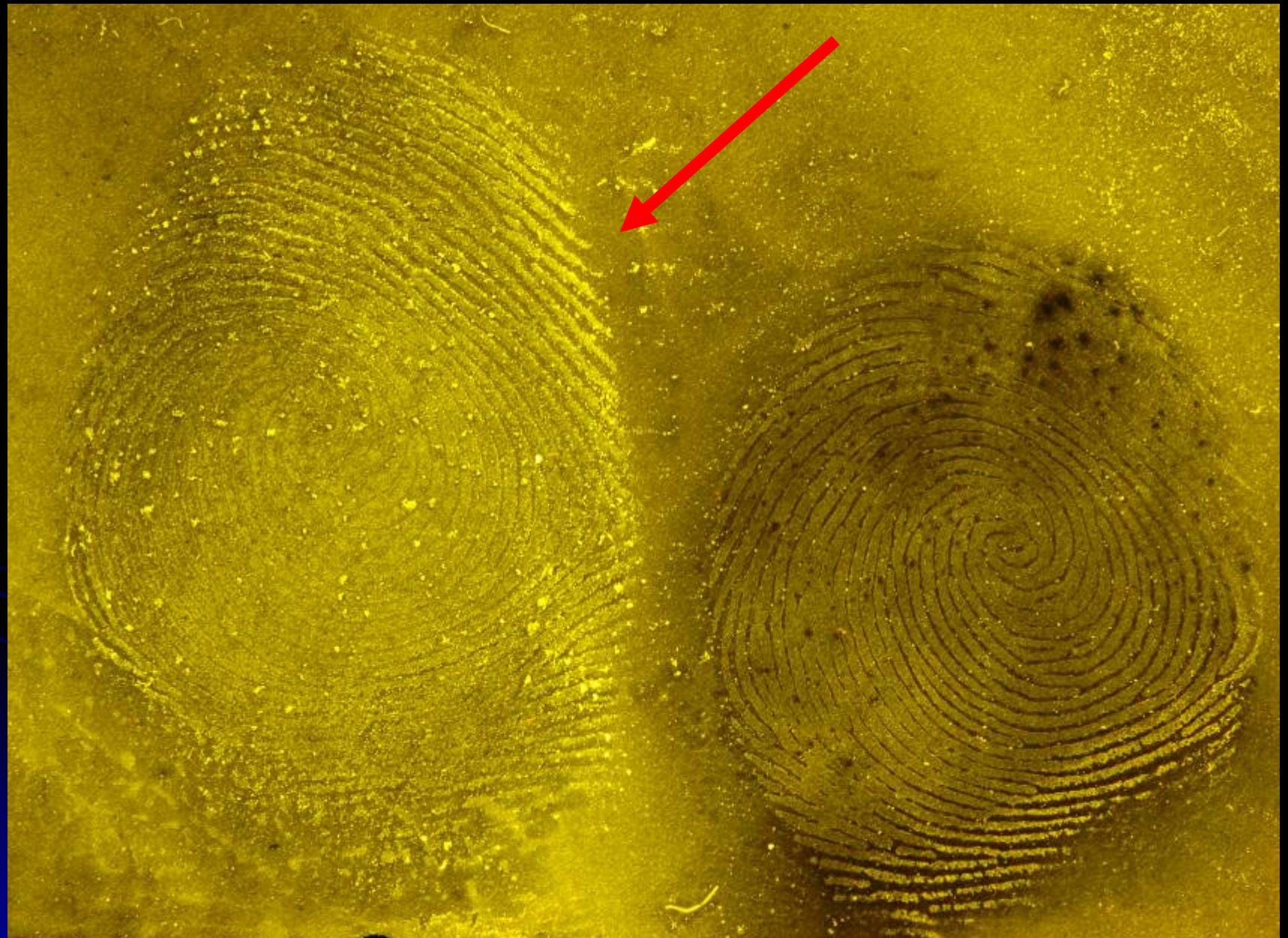


**METAL**

**PLASTIC**



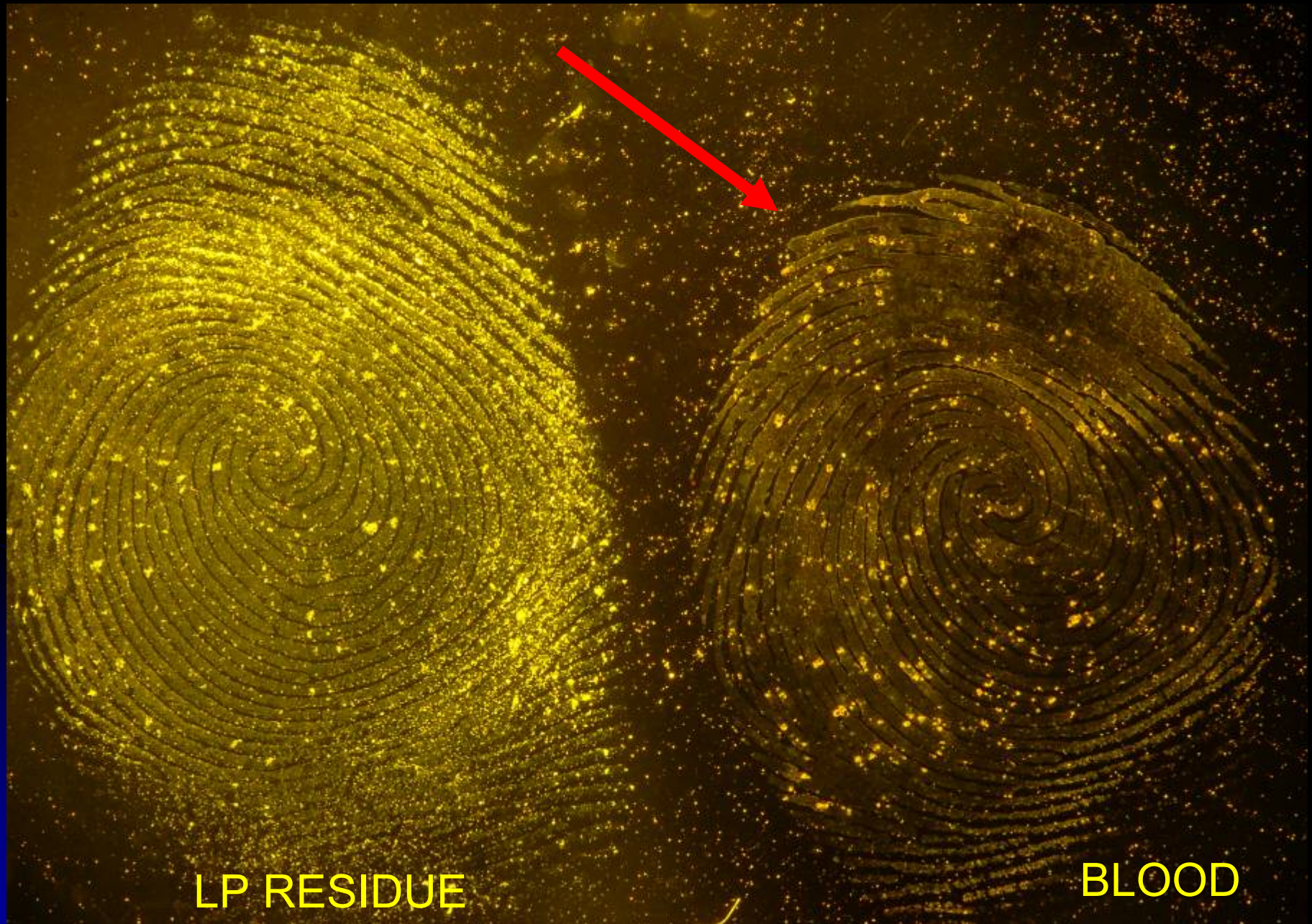
# R6G ONLY at 532nm



LP RESIDUE

BLOOD

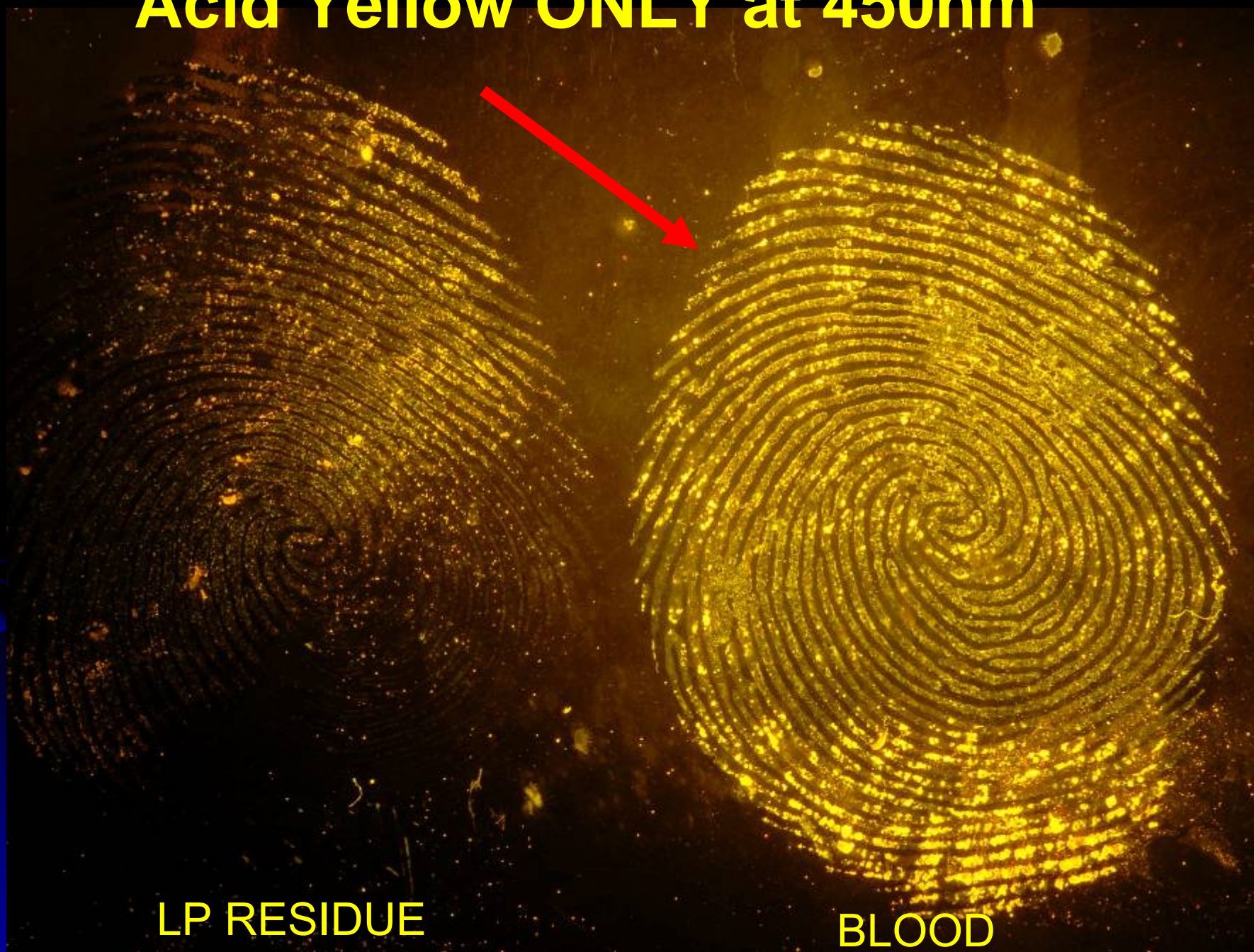
# After Acid Yellow at 450nm



LP RESIDUE

BLOOD

# Acid Yellow ONLY at 450nm



LP RESIDUE

BLOOD

# After R6G at 532nm



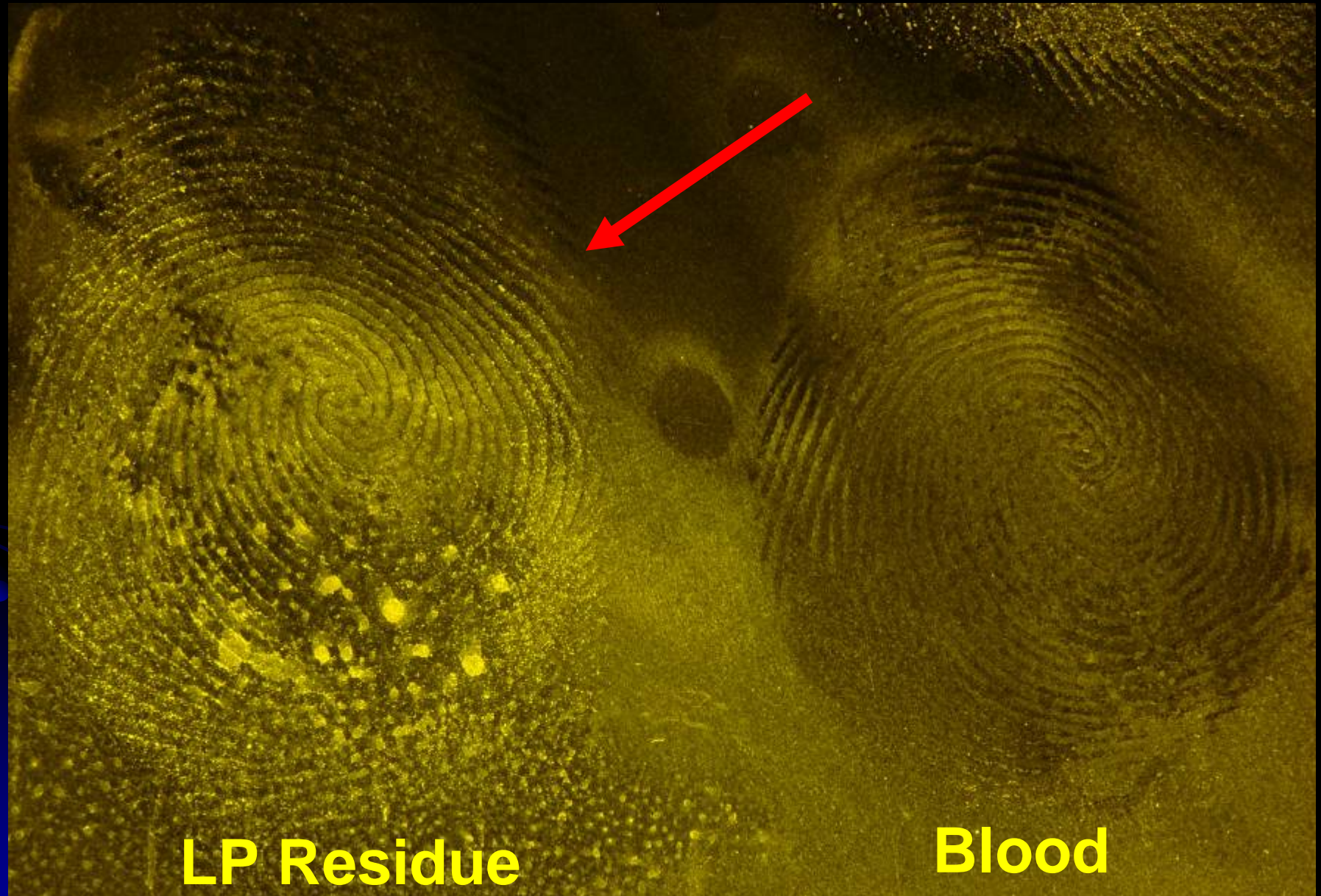
**LP RESIDUE**

**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

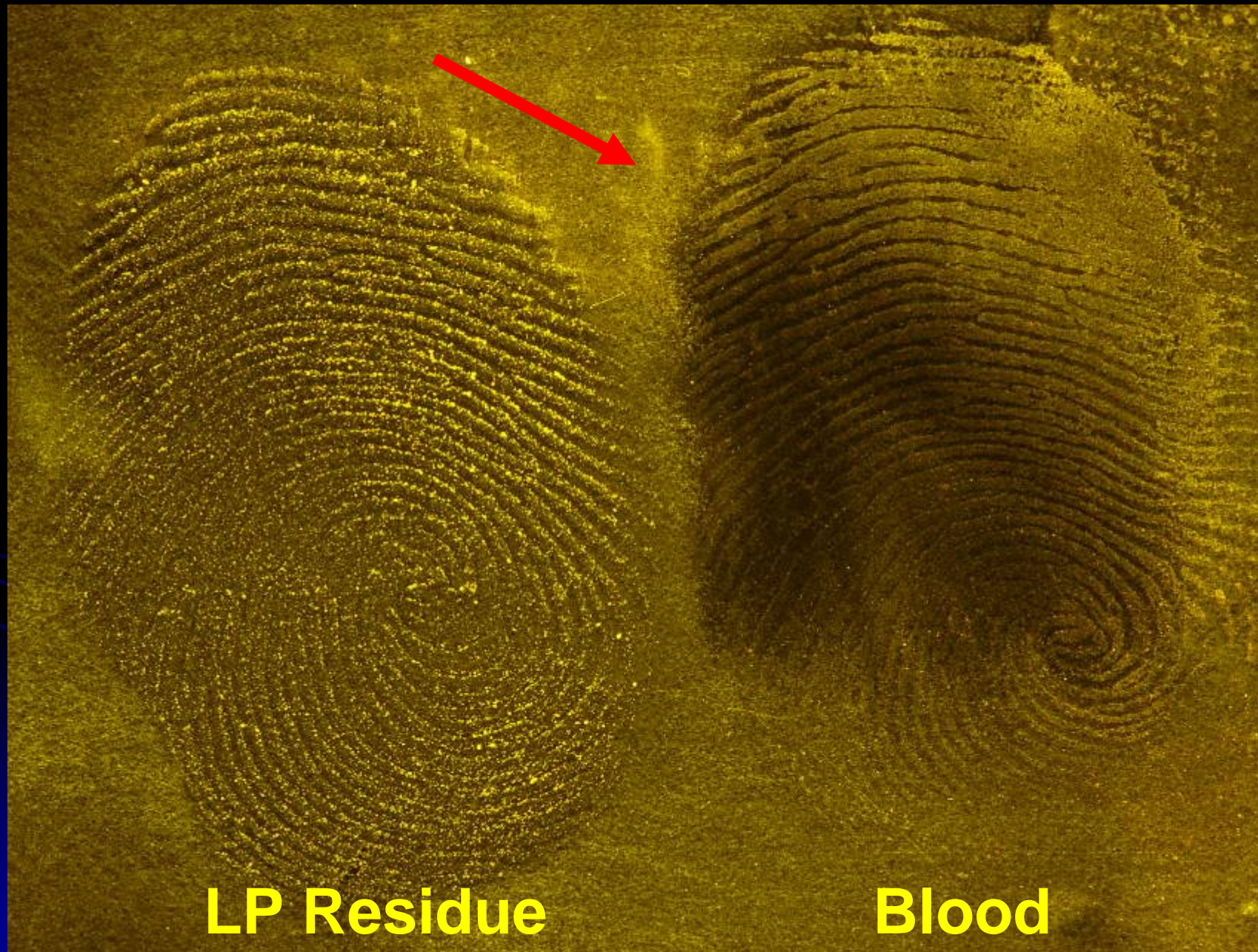
# R6G ONLY at 532nm



**LP Residue**

**Blood**

# After Acid Yellow at 450nm



**LP Residue**

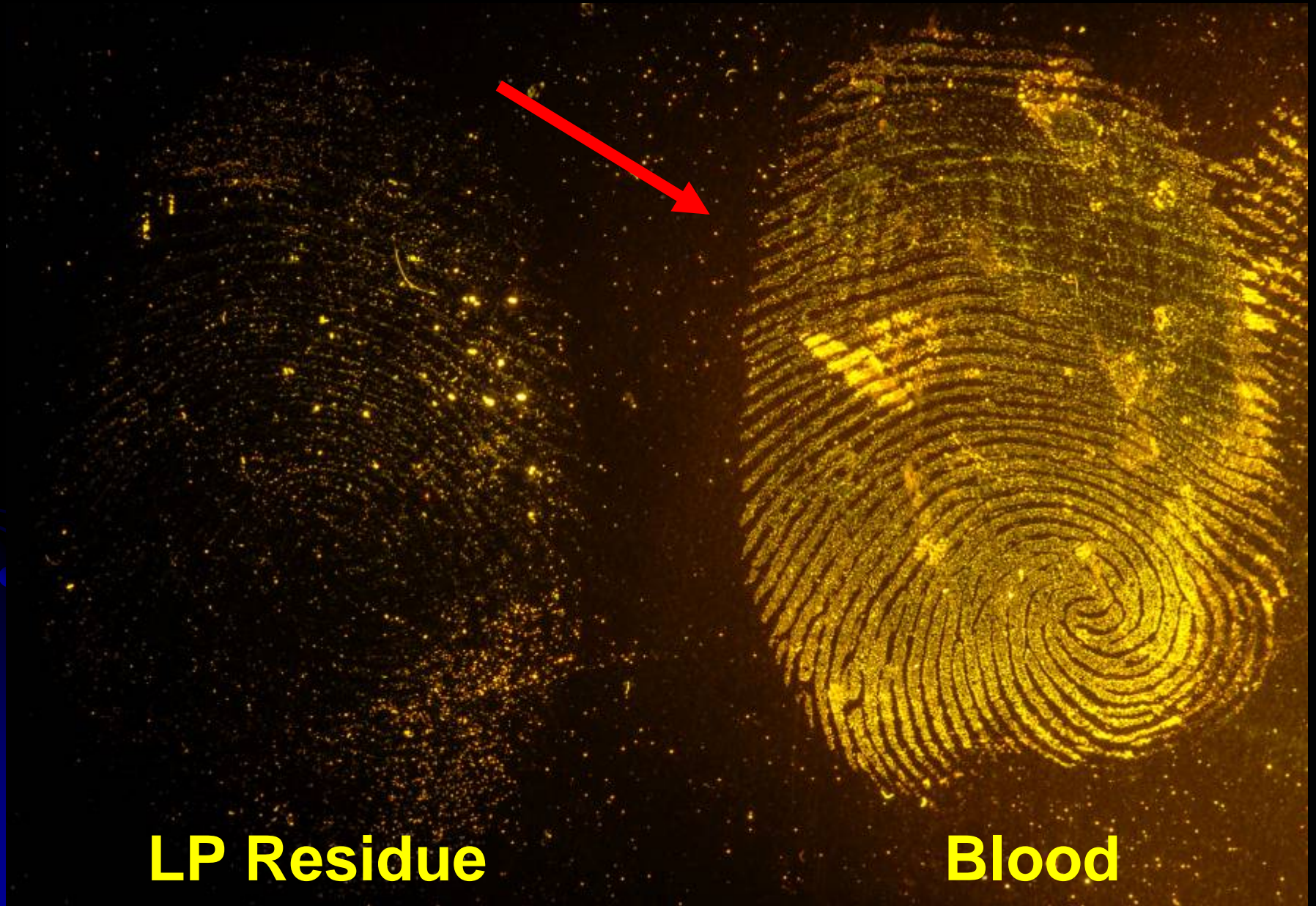
**Blood**

# Acid Yellow ONLY at 450nm



**LP Residue**

**Blood**





**After R6G at 532nm**



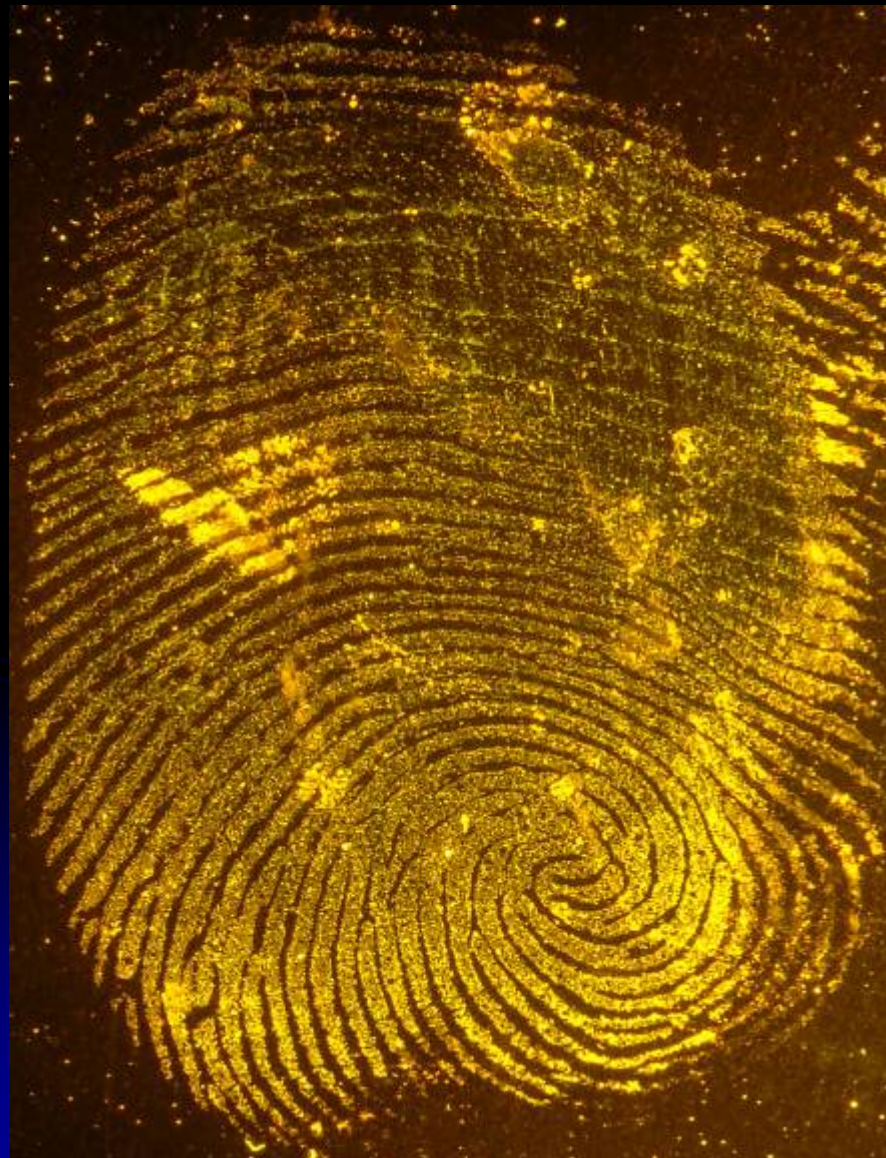
**LP Residue**

**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

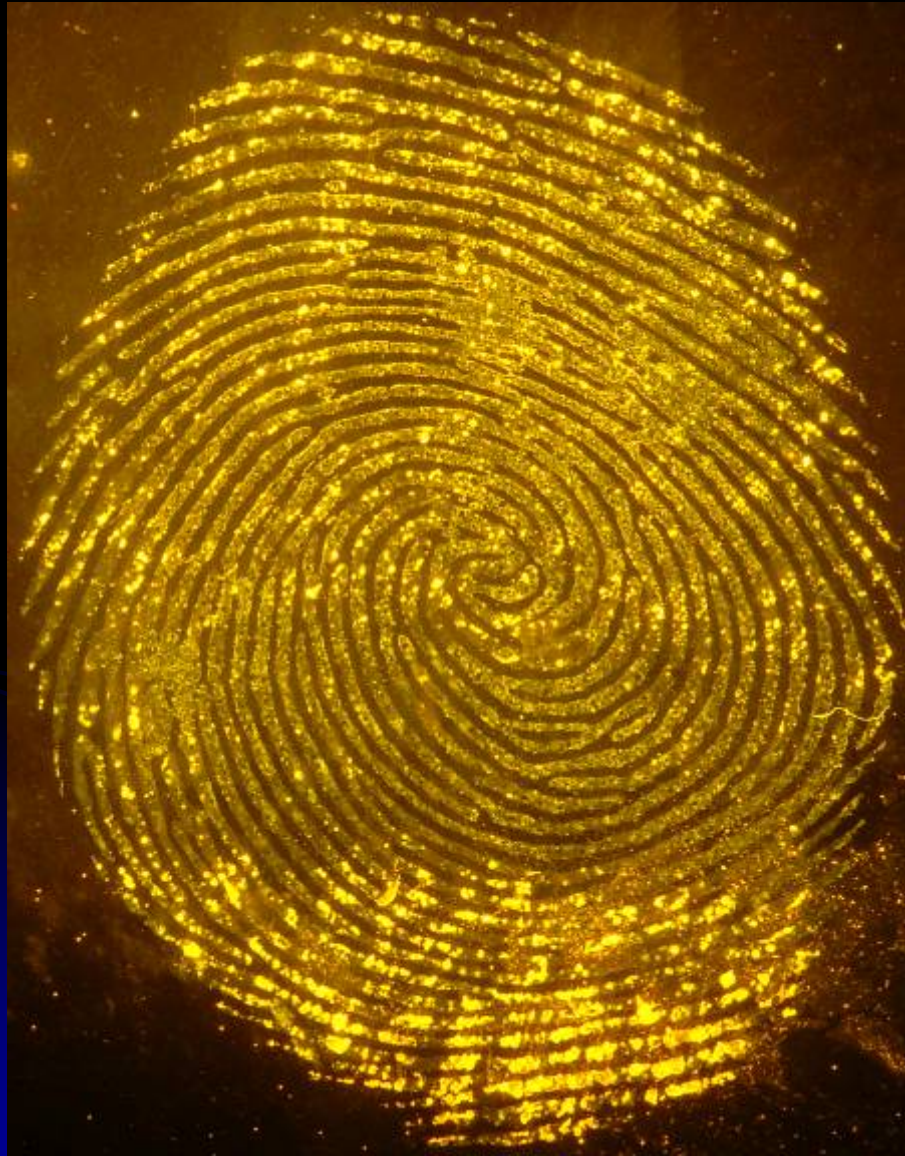


**Blood on Plastic**



**LP Residue on Plastic**

# Acid Yellow followed by R6G



**Blood on Metal**



**LP Residue on Metal**

*Questions?*

