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Technology Transition Workshop| *Alexandre Beaudoin & Brian Dalrymple*

The History and Evolution of Indanedione

History of Fingerprint Development

- **Techniques dependent on**
  - **Surface – (porous / nonporous)**
  - **Specific properties**
- **Powder – the first detection technique**
- **Likely accidental (serendipity)**

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History of Fingerprint Development

- **Fingerprint ingredients / properties**
  - **Sebaceous oil (stickiness)**
  - **Sodium chloride**
  - **Lipids**
  - **Amino acids**

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History of Fingerprint Development

- **1892 – Forgeot (colleague of Bertillon) explored silver nitrate**
- **1932 – Hudson used silver nitrate in Lindbergh baby kidnapping**
- **1940s – Introduction of ninhydrin**
  - **Presumptive test for protein**
  - **Amino acids on chromatograms**
- **1955 – Patent granted to Oden and von Hofsten**
  - **Usage of ninhydrin to develop fingerprints**

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Silver Nitrate

- **First technique for porous surfaces**
  - **Paper, cardboard, wood**
  - **Detection target – sodium chloride**
  - **Silver chloride – darkens on exposure to light**
  - **Easily affected by humidity**
  - **Salt migrates from ridge sites**
  - **Ridge detail quickly degraded in humid environment**

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Ninhydrin

- **1950 – 1970 – Slowly emerged as reagent of choice for porous exhibits**
- **Unaffected by extremes of humidity**
- **Effective on wide range of paper and other nonporous surfaces**
- **In mainstream use in present day**

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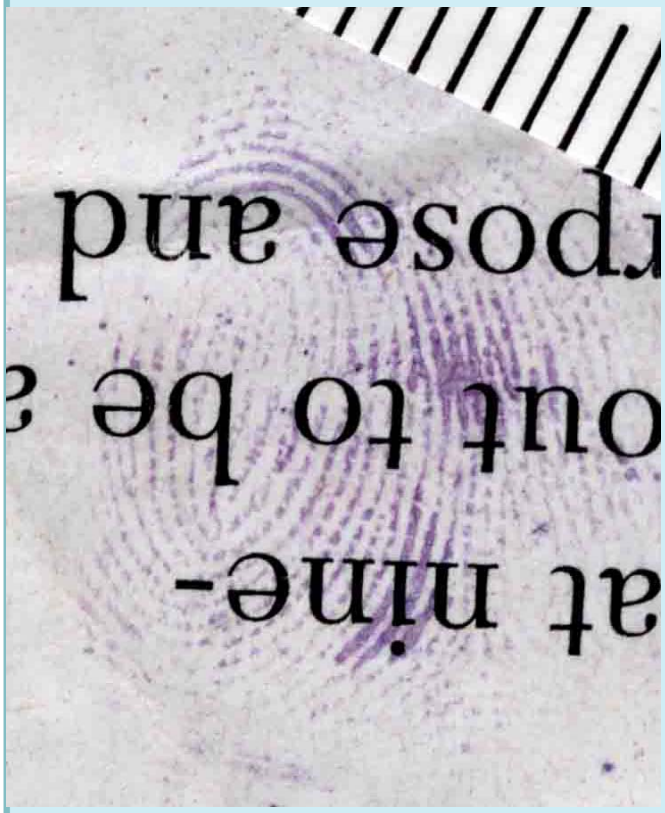
Ninhydrin



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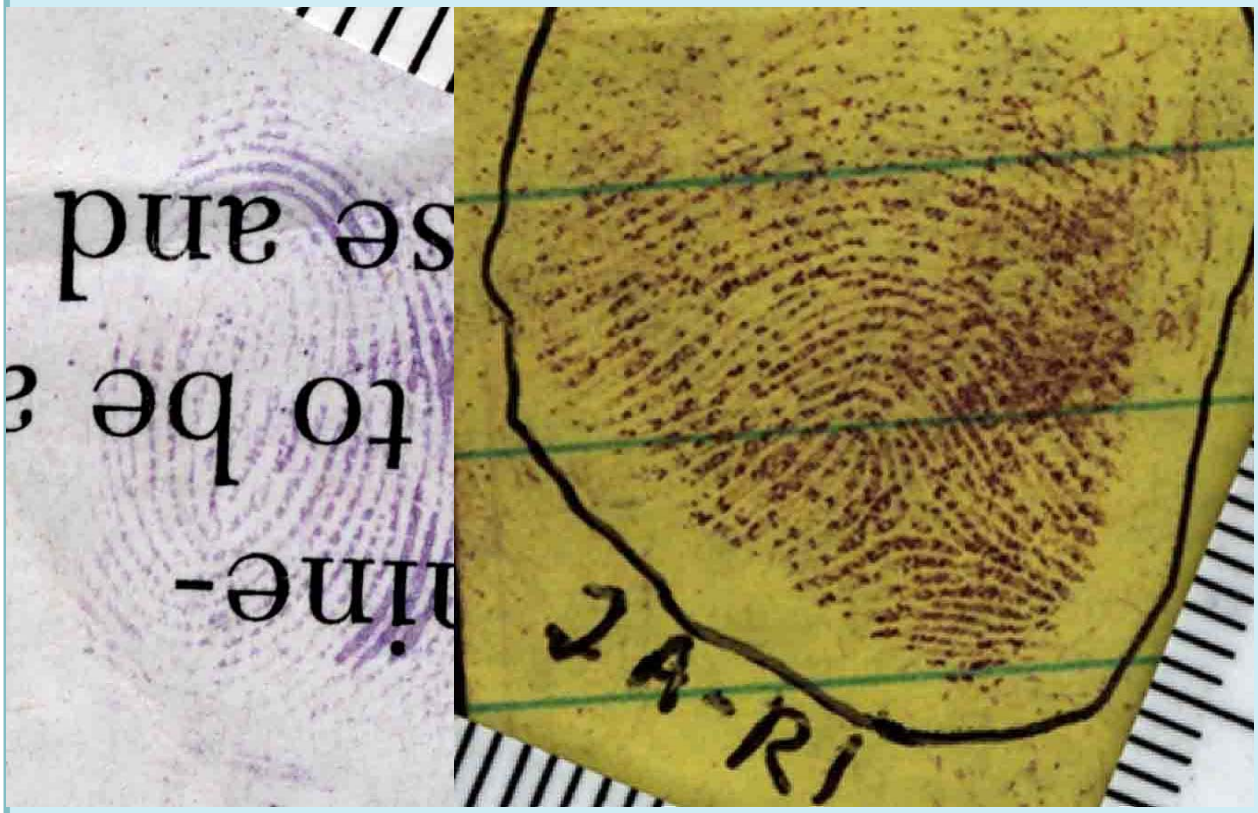
Ninhydrin



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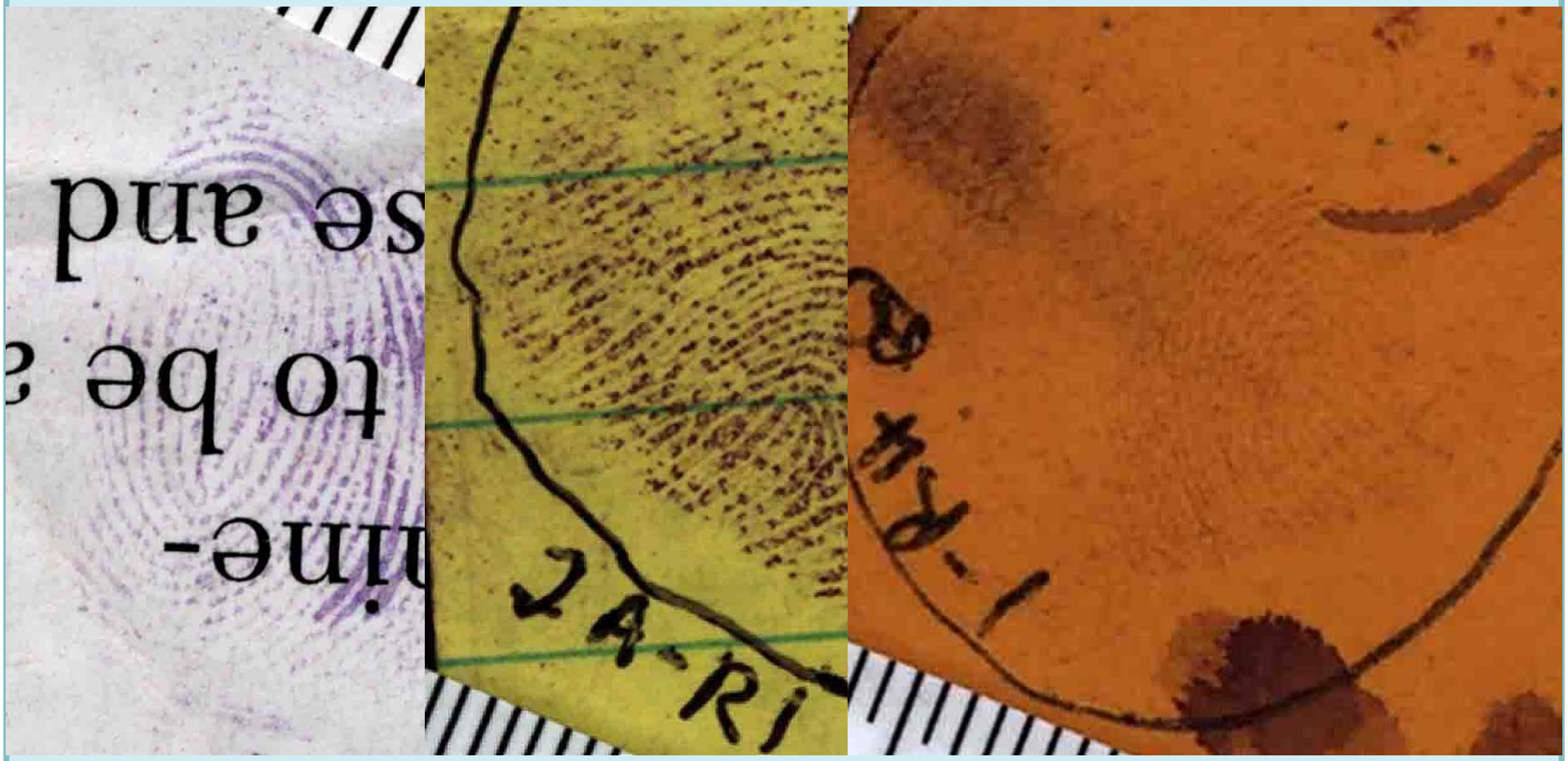
Ninhydrin



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Ninhydrin

- **1972 – adapted for regular use by Ontario Provincial Police**
  - **Promotional exam investigation**
  - **Summer months in Toronto (humid!)**
  - **Numerous papers examined by silver nitrate**
  - **Progressive degradation over time**
  - **Switched to ninhydrin in mid-examination**
  - **Clean sharp ridge detail unaffected by humidity**

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Ninhydrin

- 1980s – ninhydrin not producing satisfactory results worldwide
- Israel, Australia, England, United States
- Research into ninhydrin analogs
  - 5-methoxyninhydrin
  - Benzo(f)ninhydrin
  - 5-methylthioninhdrin
  - Naphtho(f)ninhydrin

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Diazafloren-9-one (DFO)

- 1990 – Introduced by Pounds et al.
- Reported as 2 ½ times more sensitive than ninhydrin
- Strong color mode
- Strong luminescent mode
  - Excited by green light
    - YAG laser, argon laser, OPSC laser
    - Forensic light source (green)
  - Viewed through orange goggles

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DFO

- **Slow and uneven acceptance in identification community**
- **More expensive than ninhydrin**
- **Requires expensive light source**
- **Requires luminescence photography**
- **Requires more <u>time</u>**

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DFO / Ninhydrin

- 1990 – present – both reagents in use
- DFO often used as “niche” technique
- Bad batches tarnished DFO reputation
- Few comprehensive comparative studies done by police agencies
- Comprehensive reports largely ignored
- Result – routine and preferred used of DFO is rare
- Sequential use of DFO and ninhydrin even less frequent

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Current Lab Realities

- Operational budgets cut
- Training budgets cut
- Any existing research budgets cut or eliminated
- Exhibits for examination either holding or rising
- New techniques mean more
  - Man-hours / staff
  - Equipment / lab space
  - Photography
  - Fingerprint comparisons
  - Court
- Daubert – more adversarial review

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Current Lab Realities

- **Identification function is event-driven**
- **Now being converted to dollar-driven**
- **Choice between**
  - **What we see needs to be done**
  - **What we can afford to do**

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1,2 Indanedione

- **Ninhydrin analog**
- **1997 – developed**
  - **U.S. Secret Service – Ramotowski et al.**
  - **University of Pennsylvania – Joullie et al.**
  - **Israel Police Force – Almog et al.**
  - **Australian Federal Police – Lennard et al.**

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1,2 Indanedione

- Less color mode intensity than ninhydrin or DFO (author)
- Intense yellow fluorescence
- Initial recommendations for moist heat (like ninhydrin)
- Excited by green light
  - Laser 532 nm
  - Forensic light sources – 505 nm, 530 nm
- Orange or red barrier filter for viewing and photography
- Red filter may reduce unwanted background fluorescence

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1,2 Indanedione

- **Fluorescence more yellow than DFO**

Indanedione

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1,2 Indanedione

- **Fluorescence more yellow than DFO**

Indanedione

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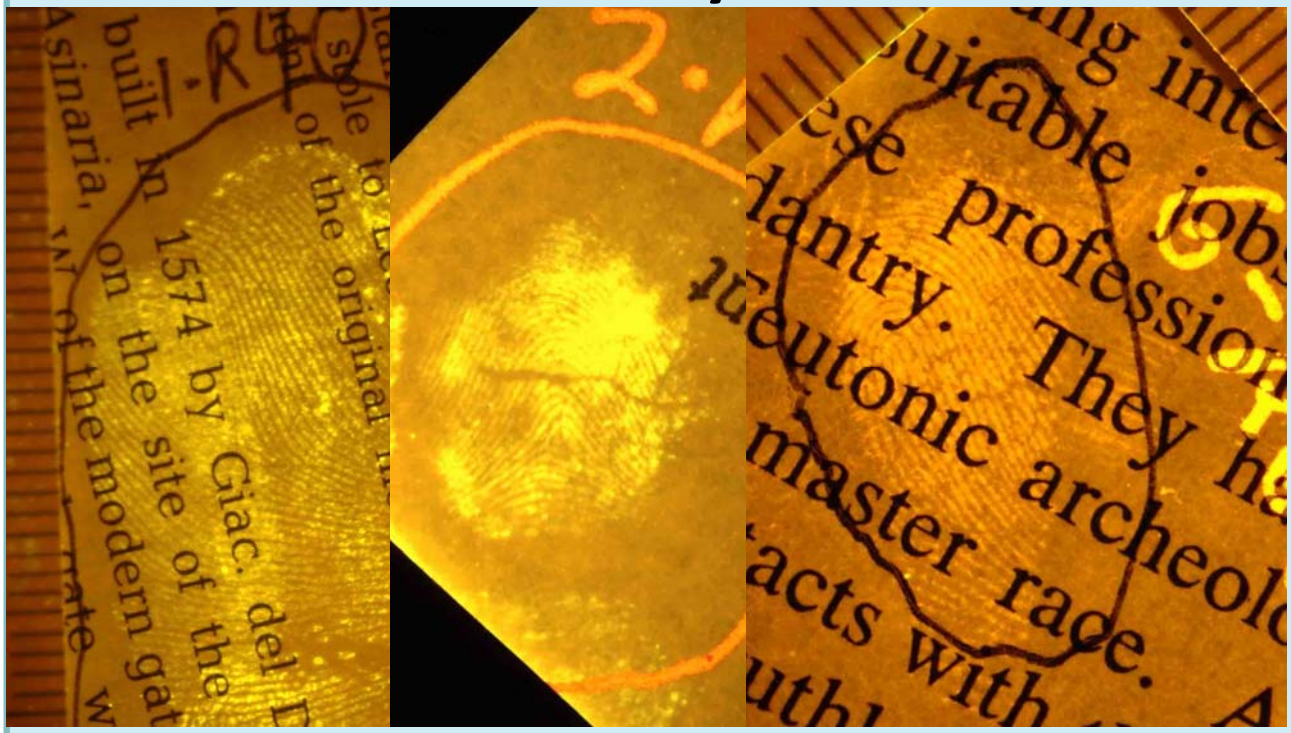
1,2 Indanedione

- **Fluorescence more yellow than DFO**



Indanedione **DFO**

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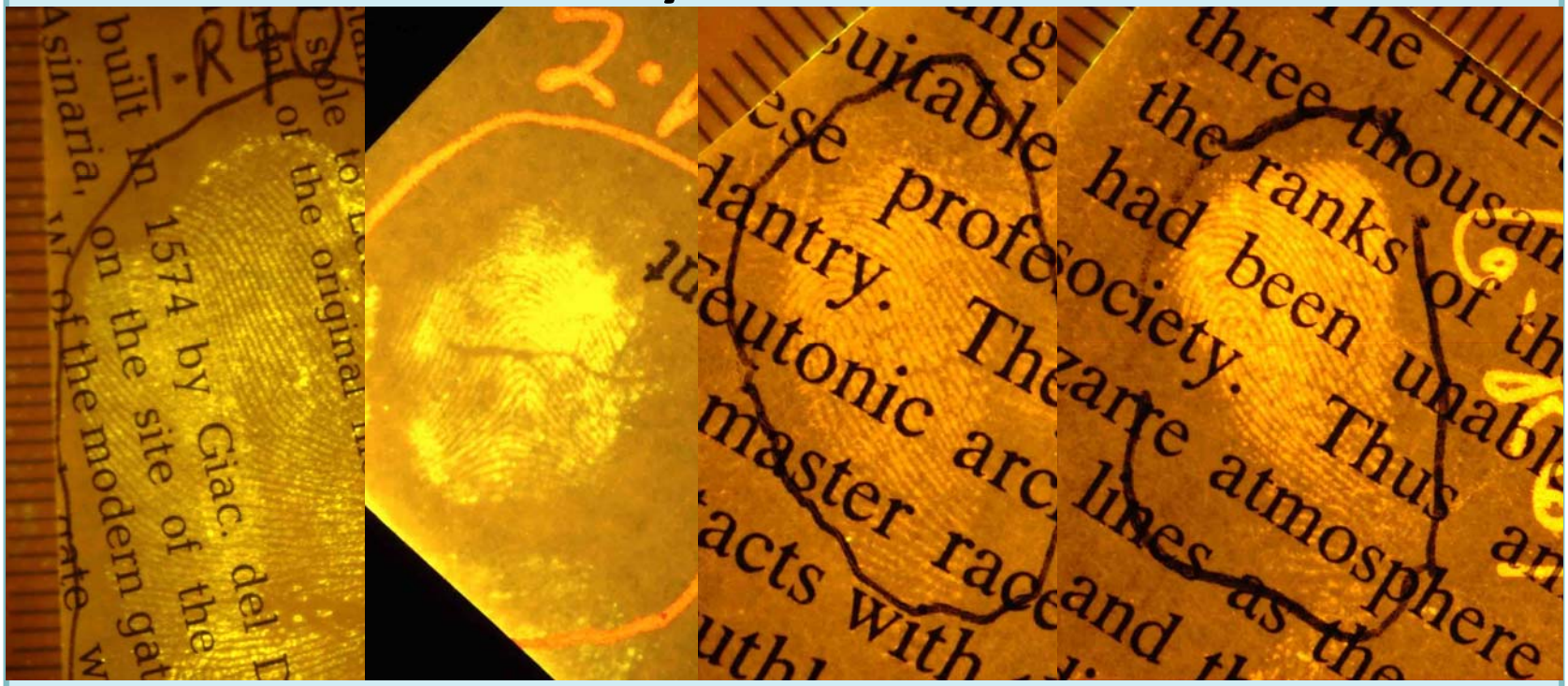
1,2 Indanedione

- **Fluorescence more yellow than DFO**



Indanedione **DFO**

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1,2 Indanedione

- **Color mode weak**
- **Intense fluorescent mode**

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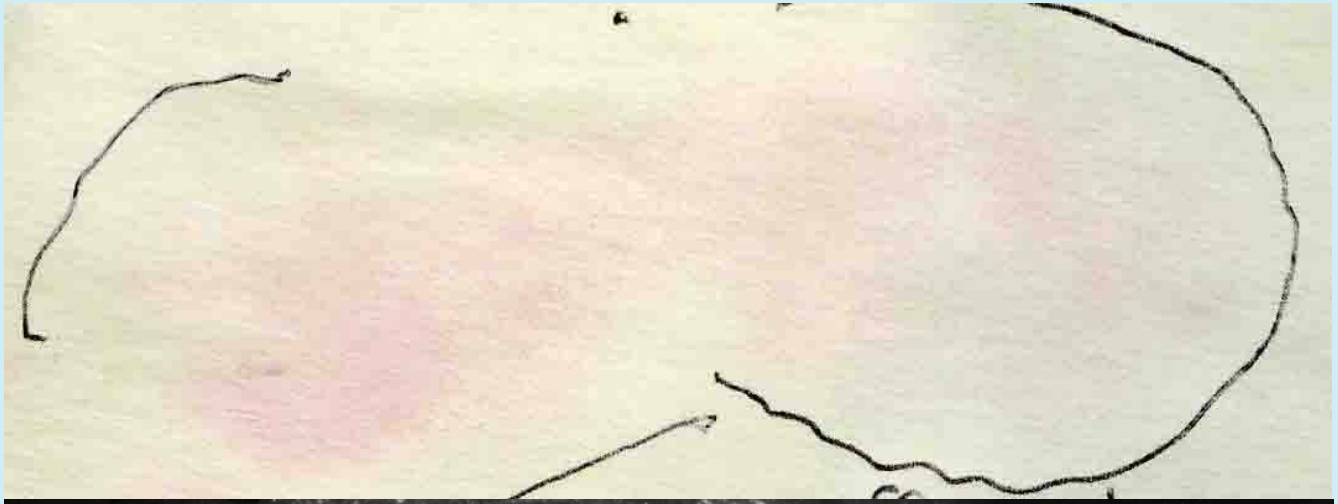
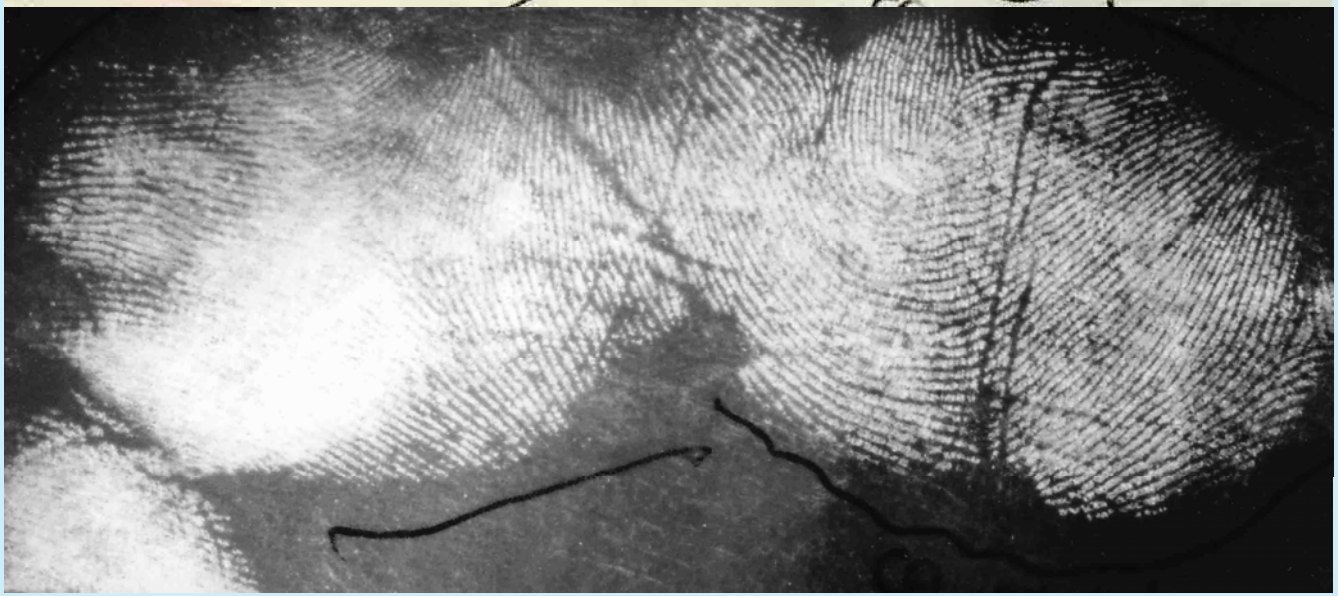


COLOR MODE



FLUORESCENT MODE

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1,2 Indanedione – Issues

- **Source – quality and purity (author)**
- **Formula**
  - **Israeli**
  - **British**
  - **Australian**
- **Shelf life**
- **Post-treatment – heat and/or humidity**
- **Addition of zinc chloride ($ZnCl_2$) – Lennard et al.**
- **Pre-treatment – exhibit humidity (Ramotowski)**

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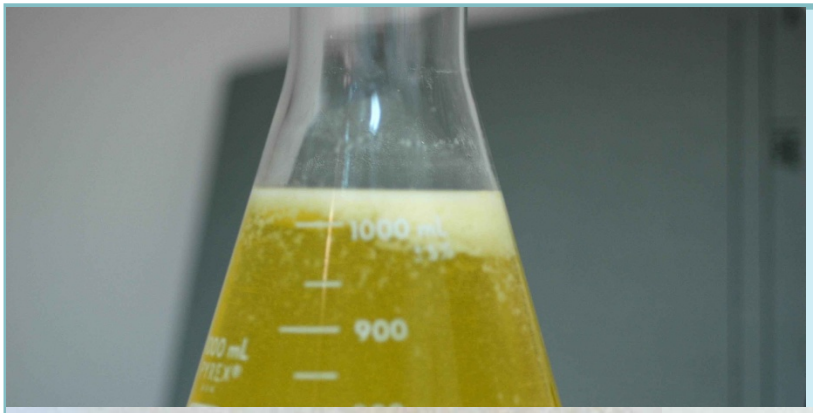

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Ninhydrin – Reaction Time and Stability

- **Case Report**
  - **Several hundred paper exhibits**
  - **Treated with ninhydrin – many impressions marked**
  - **Multiple identifications on multiple subjects**
  - **Court six months later**
  - **Multiple new impressions – multiple new identifications**

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Ninhydrin – Reaction Time and Stability

- **Case Report**
  - **Multiple paper exhibits processed in ninhydrin**
  - **Multiple impressions identified**
  - **Documents placed in storage**
  - **Court one year later**
  - **Many impressions disappeared**

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Ninhydrin / DFO – Reaction Efficiency

- **Ninhydrin exclusively stain reagent (color)**
- **DFO dual mode (color and fluorescence)**
- **DFO fluorescence mode 2 ½ times more sensitive than ninhydrin**
- ***Ninhydrin can develop added ridge detail after DFO***
- ***??***

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Ninhydrin / DFO – Reaction Efficiency

- **Ninhydrin product (Ruhemann's purple) unstable**
- **Ninhydrin reaction incomplete**
- **DFO reaction incomplete**
- **<u>Conclusion</u>**
  - **DFO and ninhydrin react at different speeds and/or to different degrees with different amino acids**
- **Nineteen amino acids reported as potential components of finger residue**

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Indanedione versus DFO

- **Numerous comparative studies**
- **At least five countries**
  - **Different formulae**
  - **Different samples**
  - **Different donors**
  - **Different climates (temperature / humidity)**
- **Different results!**

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Indanedione versus DFO

- **Ramotowski - 2008**

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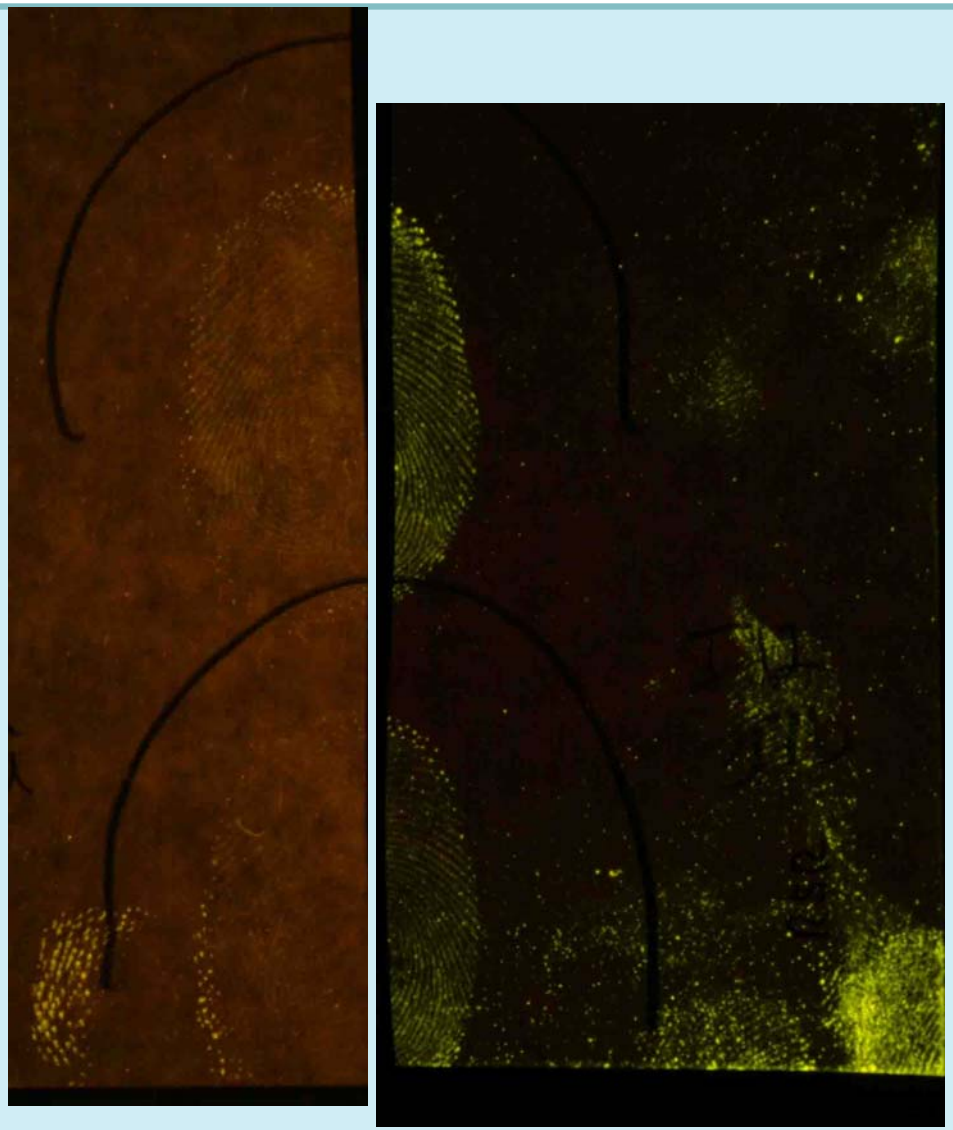
DFO



INDANEDIONE

Images courtesy of R. Ramotowski, U.S. Secret Service

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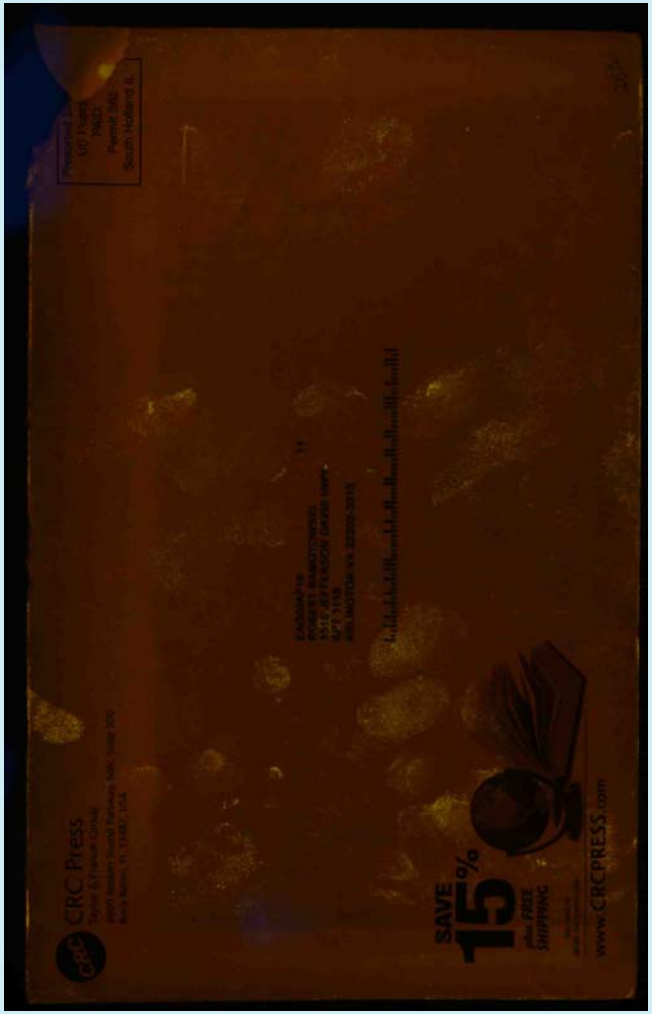
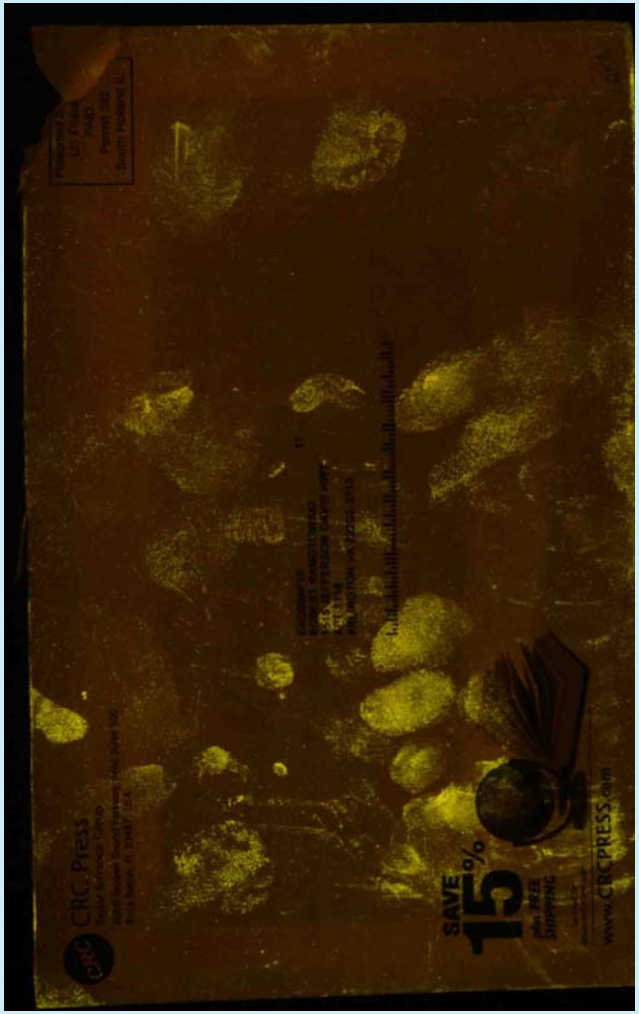


DFO



INDANEDIONE

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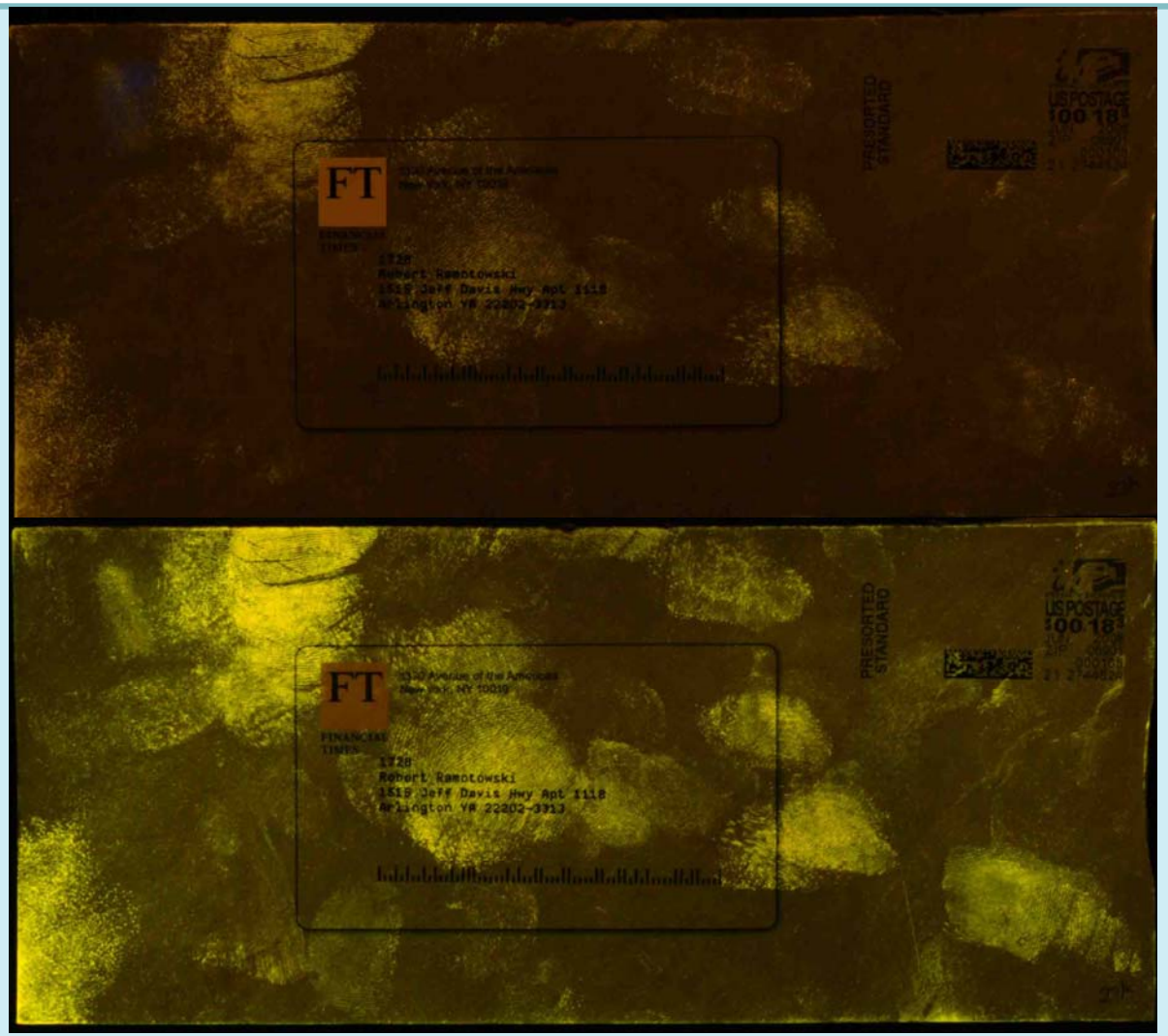
DFO

INDANEDIONE



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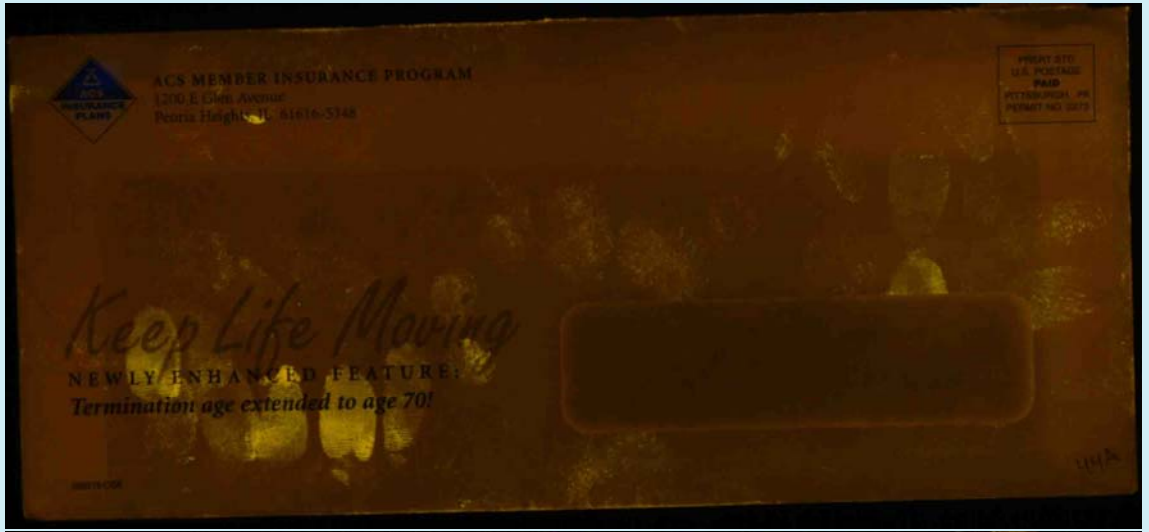
DFO



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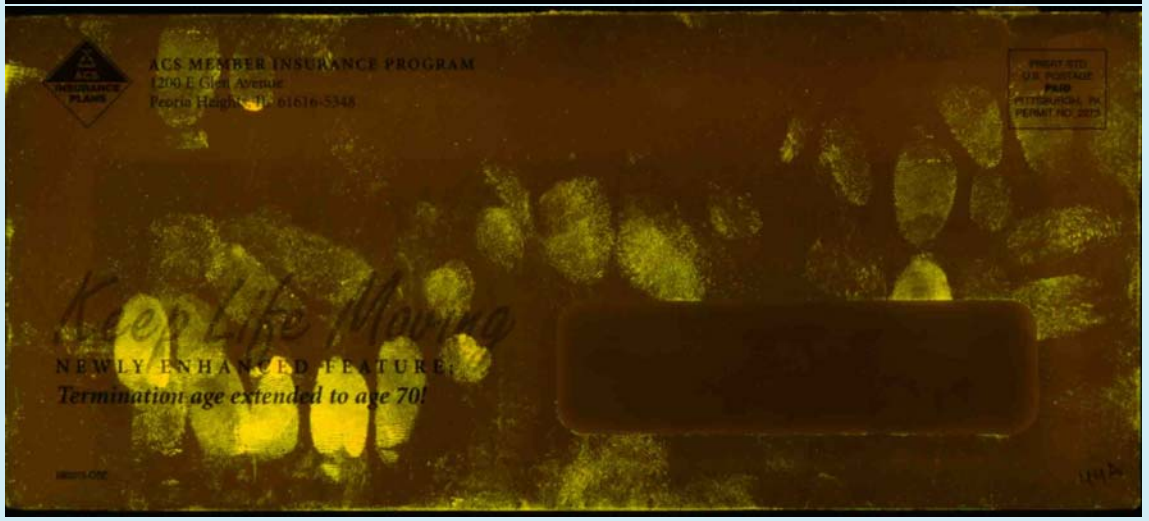

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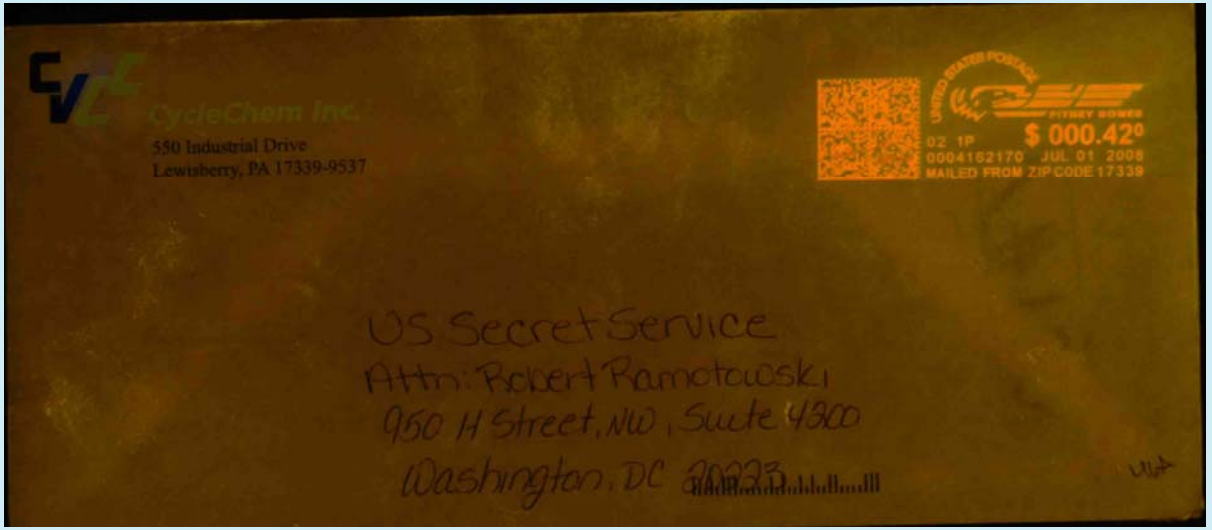
DFO



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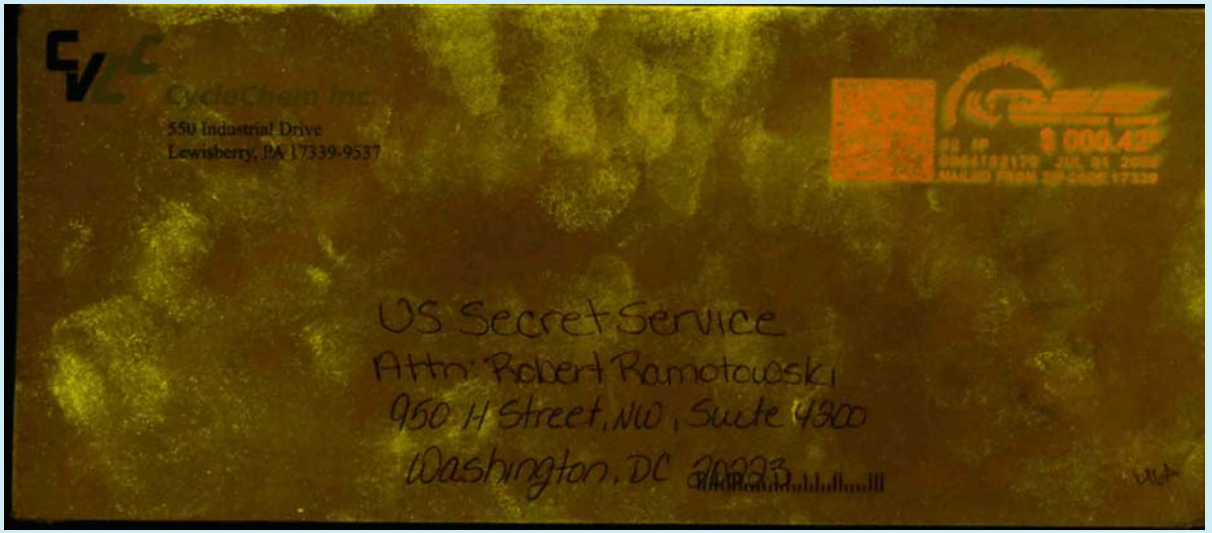

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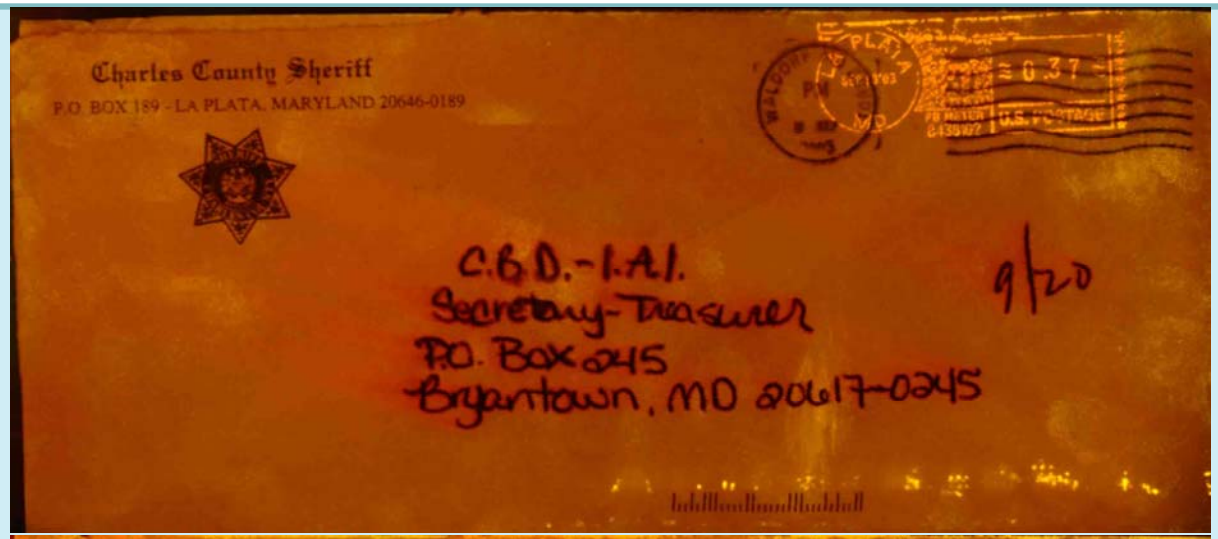
DFO



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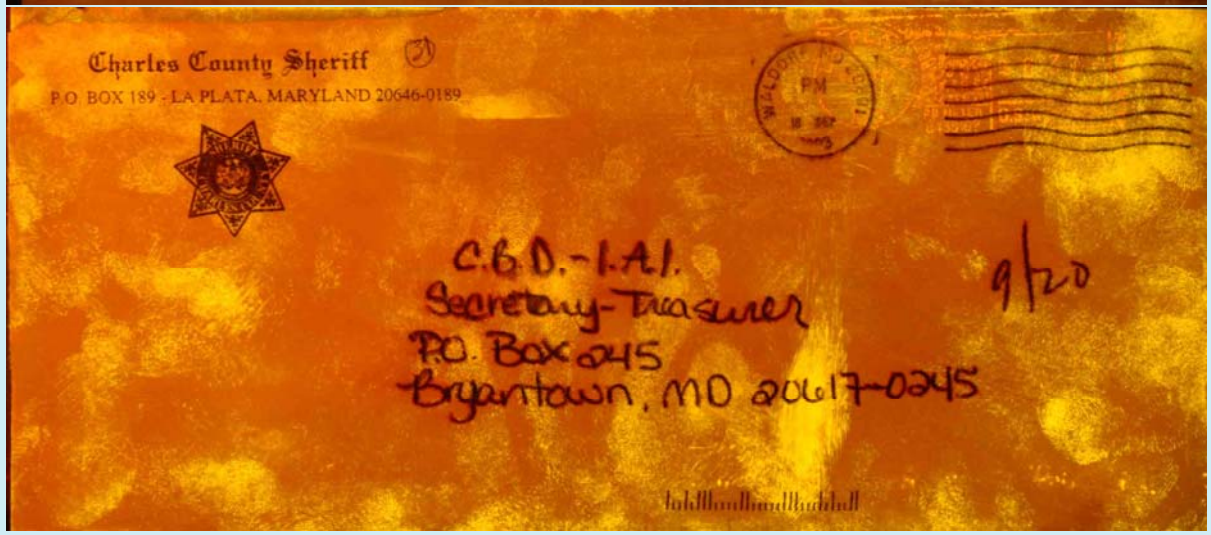

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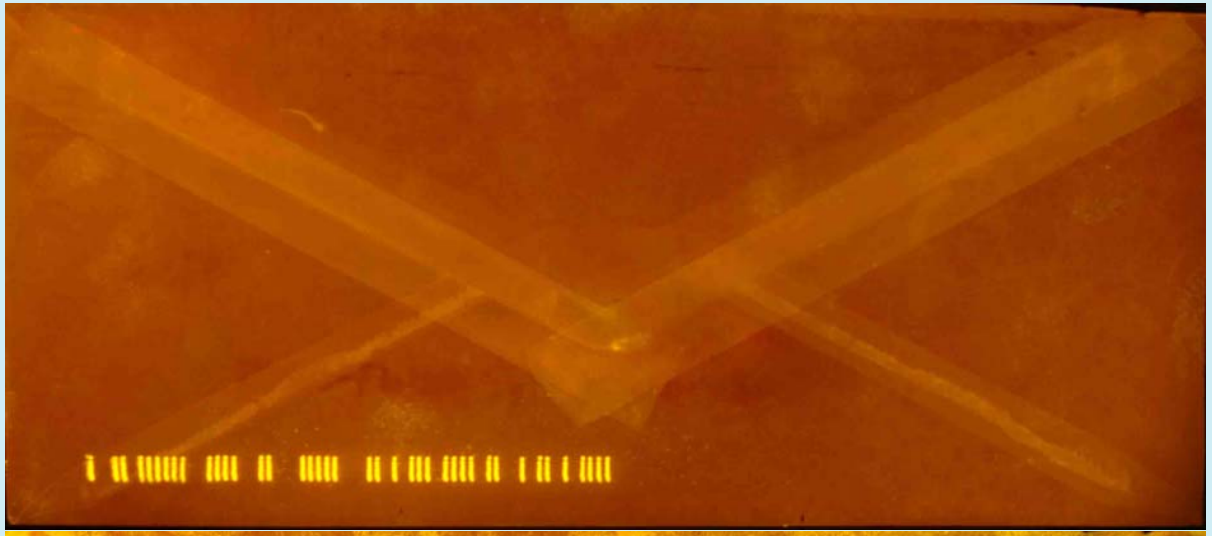
DFO



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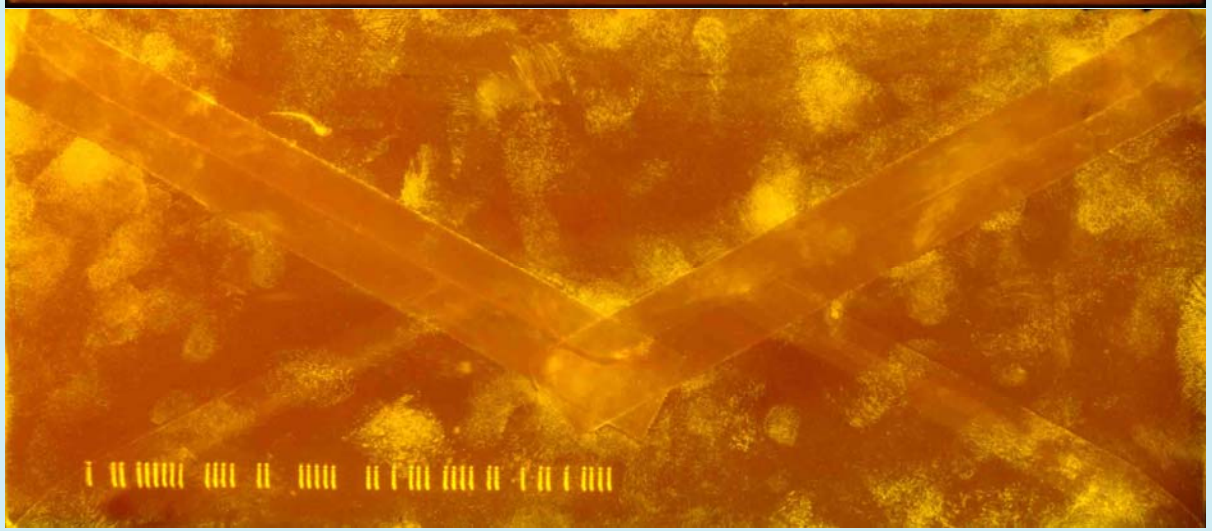

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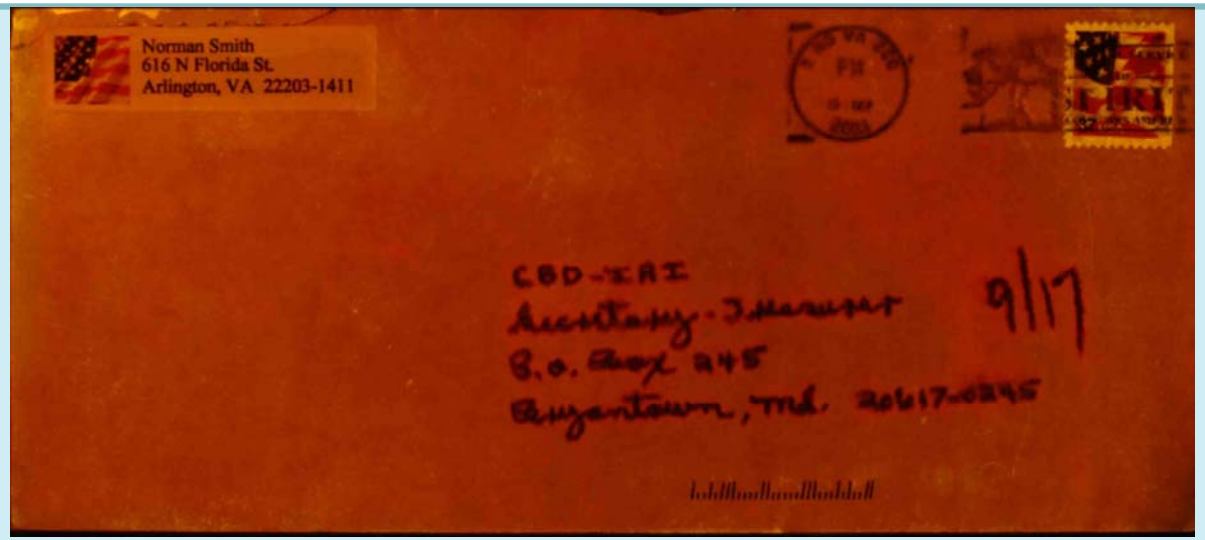
DFO



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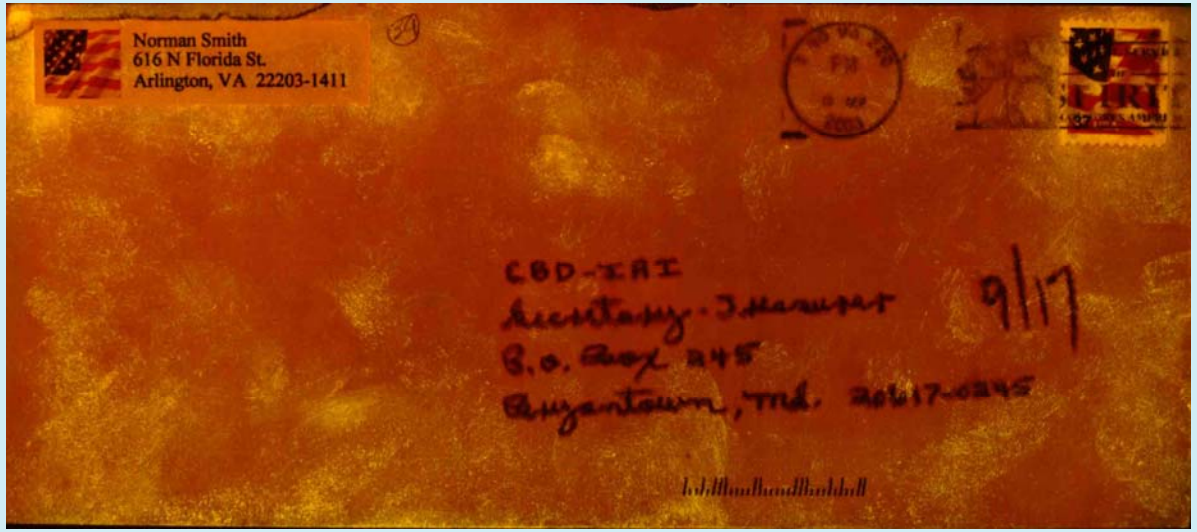

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Technology Transitions

- **Silver nitrate to ninhydrin**
  - **No increased chemistry costs**
  - **No increased time costs**
  - **Minimal required equipment**
  - **No increased training costs**
  - **Stain method to stain method**
  - **No change in photography**
  - **Only change is more fingerprints!**
  - **Rapid transition**

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Technology Transitions

- **Ninhydrin to DFO**
  - **Increased chemistry costs**
  - **Increased time costs**
  - **Forensic light source required**
  - **Significant training issues**
  - **Stain method to fluorescence method**
  - **Significant difference in photography**
  - **Many changes, including choice of sequential processing**
  - **Transition slow to nonexistent**

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Technology Transitions

- **DFO to Indanedione**
  - **No increased chemistry costs**
  - **No increased time costs (possible decrease)**
  - **Same equipment requirements as DFO**
  - **Same training requirements as DFO**
  - **Fluorescence to fluorescence method**
  - **No change in photography**
  - **More fingerprints***
  - **Cautious but steady transition**

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Transition Differences

- **1990 – Forensic light sources restricted to medium and larger agencies**
- **2000+ – Forensic lights in virtually every agency**
- **Forensic community much more adapted to fluorescence techniques**
- **Labs under greater adversarial scrutiny**

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Recommendations

- **Sequential processing for porous exhibits**
- **Amino acids**
  - **DFO plus ninhydrin or indanedione**
- **Lipids**
  - **Oil red O**
  - **Physical developer**

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Questions?

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