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Depletion Studies on Different Fluorescent Powder Compositions

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Abstract

A depletion series was used to evaluate the relative sensitivity of a number of fluorescent powder compositions on a non porous surface. A set of exemplar finger impressions of one particular finger successively impinged on to aluminium foil without recharging the sweat secretions was considered in this investigation. Amongst the studied fluorescent dye based compositions, Rhodamine B and Fluorescein based compositions were adjudged to give best results in terms of ridge clarity of depletion marks.

Kewords: Fluorescent powder; Depletion series; Fingerprint; Sensitivity.

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Introduction

Latent fingermarks are a source of positive evidence and are indispensable for establishing identity. The detection and subsequent development of latent fingermarks is thus necessary in criminal investigations [1]. Therefore it is pertinent to render the latent impression visible by an optical, physical or chemical technique. The powder dusting technique is one of the oldest and most common methods of latent print detection, with one of the earliest references dating back to 1891 [2]. This is a physical method of developing latent fingermarks and is based on the premise that the powder particles adhere to the moisture and oily components of sweat residue. For evaluating the efficacy and sensitivity of the powder method, the quality of developed prints is assessed by visual examination [3].

Fresh as well as aged fingermarks have been developed for different time intervals with these formulations. A series of fingermarks is deposited by successive contacts of the same finger with the surface. Each successive contact leaves progressively less residue on the surface and therefore as one proceeds down the depletion series, the quality of developed print concomitantly decreases [4]. The number of fingermarks in a specific depletion series that develop to optimum quality depends on the nature of surface and the constituent (s) of sweat that the development process targets. In general, on a porous surface the sweat residue depletes consistently till the 5th impression, while the 6th one leaves too meagre an amount to affect visualization by chemical techniques [5].

On non-porous surfaces the absorption of sweat constituents is less and some of the techniques develop even the 10th impression of the depletion series. In the present investigation, we have used a non-porous surface, aluminium foil, to develop latent impressions by fluorescent compositions and thereafter examine the results of depletion studies.

We have done the quality and sensitivity check for all the studied fluorescent powder compositions. These studies are published separately.

Materials and Method

In the present study, Starch (Sigma Aldrich) and talc or hydrated magnesium silicate (commercial grade) was taken as an adhesive material. The following fluorescent dyes have been used for the preparation of different formulations coded as indicated.

1. Brilliant Blue (Sigma Aldrich) ($\lambda_{max\text{-}abs}$ 596 nm); code ST-B
2. Acridine orange (Sigma Aldrich) ($\lambda_{max\text{-}abs}$ 489 nm); code ST-A
3. Eosin Y (Sigma Aldrich) ($\lambda_{max\text{-}abs}$ 524 nm); code ST-E
4. Rhodamine B (S.D.Fine Chem.) ($\lambda_{max\text{-}abs}$ 543 nm); code ST-R
5. Fluorescein (Sigma Aldrich) ($\lambda_{max\text{-}abs}$ 494 nm); code ST-F

Brilliant blue R is a triphenylmethane dye that is used in the textile industry, as well as for staining proteins in analytical biochemistry [6]. Rhodamine B is a bluish red, fluorescent, amphoteric dye used generally as a biological stain along with osmic acid to fix and stain blood [7]. Acridine orange is a metachromatic, fluorescent, cationic dye, commercially used in lithographic applications and dyeing leather [8]. Eosin Y is a water soluble dye, used in textile dyeing and ink manufacturing. Fluorescein is a synthetic organic dye, slightly soluble in water and alcohol. It has an absorption maximum at 494 nm and emission maximum of 521 nm (in water) [9].

The experiments were carried out in the months of December/January when the temperature varied from 20 to 250C and the relative humidity between 40% and 50%. To 25 mL distilled water, a mixture of 4 g starch, 1g hydrated magnesium silicate and 50 mg of a fluorescent dye were added. The contents were allowed to dry under natural conditions. The solid mass was ground to a fine powder and stored in glass beakers covered with aluminium foil. The dye content in the compositions was 1.0-1.5%.

We used 15 aluminium foils (approx. 0.3 * 25m, thickness 11micron MFM HomewrappTM for fingermark deposition. The detection of the latent fingermark by fluorescent powder compositions was performed using powder dusting method [10]. The powder mechanically adheres to the residue defining the ridge pattern of the fingertips.

First, a forensic light source, in which oblique white light, was used to visually scan for fingermarks on the surface of foil prior to fingermark deposition. No traces were detected on the examination site (aluminium foil). Then, the site was labelled with number sequence. One male donor was chosen for deposition of fingermarks on foil. The participant deposited fingermarks on to aluminium foil, exerting medium pressure. One depletion series prepared for each fluorescent powder compositions. His hands were washed prior to finger mark deposition. During the deposition of latent fingermarks the contact time was around 1 second without recharging it with latent secretions. The procedure took 1 h as there were short intervals between each deposition. Thus, a total 75 latent fingermarks were deposited on foil. Fifteen successive latent fingermark of the same finger were impinged on to aluminium foil, to obtain a depletion series of progressively decreasing sweat residue. The same procedure was followed for each composition to be tested. The depletion series were constructed, using the same finger, and the impressions were marked from 1 to 15, 1 having the maximum and 15 having the least sweat deposition. Fingermarks were developed by powdering method immediately after deposition. There was no time lapse between the deposition and development of fingermarks.

Development Methods

Visual Assessment

Visual examination was used prior to other methods. The latent prints were examined using white light [11,12].

Powder/Brush

A few grams of each fluorescent powder composition was taken on a clean and dry watch glass and spread out as a thin layer. The latent fingerprint was developed by picking the powder with the aid of a brush and applying it over the latent impression. The excess of powder was removed by gently tapping the surface. For each fluorescent powder composition, a camel hairbrush was used, all of them of same brand (SIRCHIE, Standard Size Fiberglass Brush, 122L). Application of powder to the print by brushing is a simple and an easy technique. It took 1-2 minutes to develop each impression.

Photographs were taken using a digital camera (Canon power shot A1100IS-14.2MP-100 mm macro lens) in the auto mode. All the photographs were taken with full resolution to capture finer details. However, when it comes to the actual fingermarks images, the resolution is 480 pixels x 290 pixels. The images were stored in the jpeg format for record.

Results and Discussion

When comparing the fingermarks for the first seven depletions, the quality of development was almost equal, with performance unable to be differentiated in term of quality (Figure 1). The ridges were clearly defined in terms of detail, with observable upto 7th impression (pores and ridges). Differences in terms of sensitivity emerged beyond 7th impression (Graph 1). Images of fingermarks 1, 3, 5, 7 and 10 recorded on to aluminium foil by each composition are depicted in Figure 1.

The ST-B, ST-A and ST-E compositions developed impressions up to depletions 8, 9 and 10 respectively. Brilliant blue and Rhodamine B based compositions exhibited fluorescence in the multiple wavelength range while acridine orange based composition worked well only in the short range.

Graph 1: Depletion series of latent fingermarks on aluminium foil using (a) Brilliant Blue code-ST-B, (b) Acridine orange code-ST-A, (c) Eosin Y-code-ST-E, (d) Rhodamine B- code-ST-R and (e) Fluorescein code-ST-F compositions. The grades were scored in colour mode.

The results show that ST-E, ST-R and ST-F compositions give constant results up to the 10th

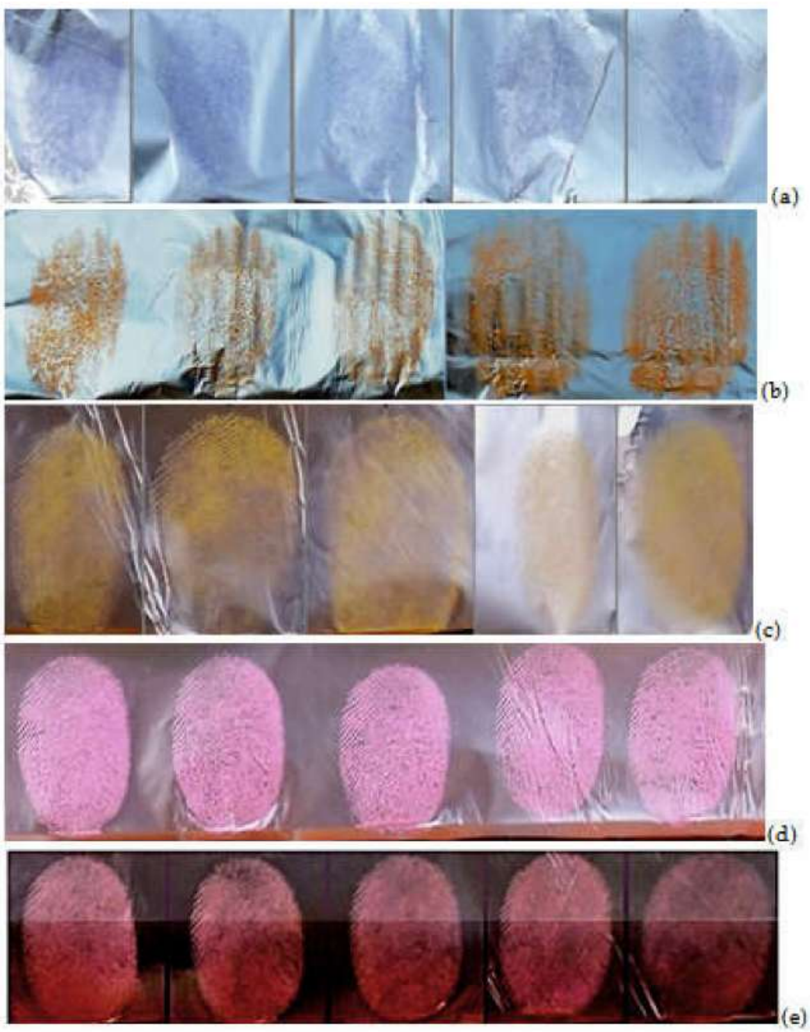


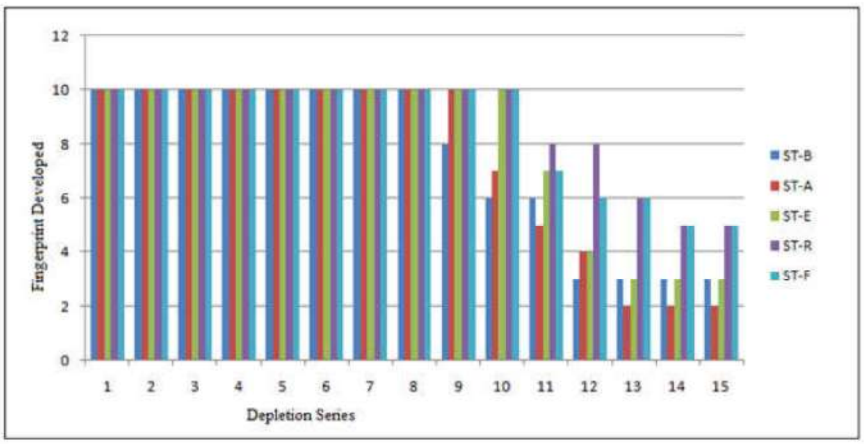
Fig. 1: Latent Fingermarks 1, 3, 5,7 and 10, developed on to aluminium foil using (a) Brilliant Blue code-ST-B, (b) Acridine orange code-ST-A, (c) Eosin Y code-ST-E, (d) Rhodamine B code-ST-R and (e) Fluorescein code-ST-F compositions

depletion mark. However, ST-A show quality differences of latent fingermarks after 12th depletion, whereas ST-R and ST-F compositions continued to give good results in terms of ridge pattern and minutiae detail even up to the last depletion (15th). These scores have been obtained by examining the fingermarks in visible mode, and that results could be improved further by examining under fluorescence.

Figure (2) shows the comparative study of latent fingerprint development using white light and fluorescent light. We also developed latent fingerprint on various porous and non porous substrates respectively. In this paper, we are focusing on depletion studies using these formulations, so we assessed results using Crime-lite® 2.

Conclusion

Latent fingermark depositions were made on to aluminium foil using five different fluorescent powder compositions. Rhodamine B and fluorescein based compositions showed optimum results in terms of detection of latent fingermarks, as well as of their depletion counterparts. The raw materials used to prepare fluorescent powder compositions are cost-effective and non-hazardous. The shelf life under ambient temperature was found to be



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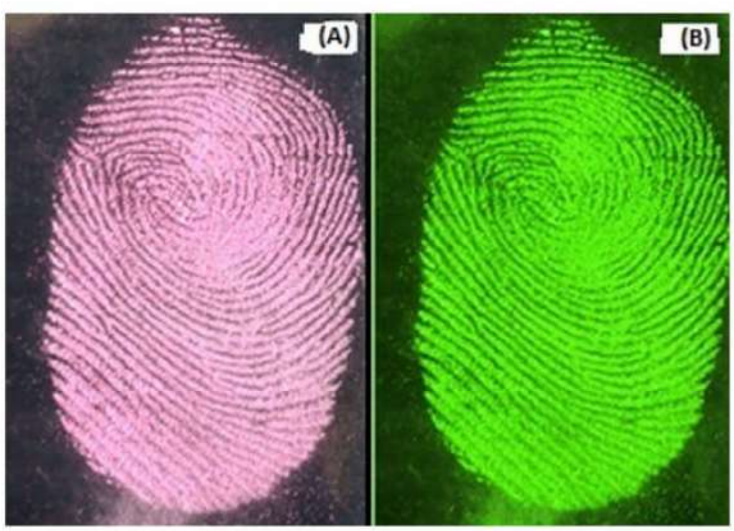

Fig. 2: Fingerprints developed on glass using ST-R (A) under White light, (B) under Fluorescent light

upto 12 months, when the reagents were stored in aluminium foil covered beakers.

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