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Original Article

Phase Transfer Catalysis in the Aid of Fingerprint Development

تطبيق محفز انتقال الطور الكيميائي في المساعدة على تطوير بصمة اليد.

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Abstract

This paper relates to the application of a novel spray formulation for developing latent fingermarks on a wide range of crime scene evidences. The formulation is based on a xanthene dye, rose Bengal, and a phase transfer catalyst, t-tetrabutylammonium iodide. It takes just 2-3 minutes to develop optimum on a broad spectrum of fingerprint evidences of non-porous, semi porous and porous substrates. It also detects fingerprints on items that are white and multi-colored, and smooth and rough.

In addition, it develops fingerprints on a variety of adhesive tapes, including duct tape, which is used by suicide bombers to wrap explosives on their bodies.

It also detects impressions on such items that have been exposed to water and high temperatures. The spray solution is prepared in water. The ingredients of the formulation are non-toxic, cheap and easily procurable.

Keywords: *Forensic Science, Fingerprints, Catalyst, Criminalistics, Xanthene Rose bengal.*

المستخلص

ترتبط هذه الورقة بتطبيق صيغة رذاذ جديدة لتطوير إظهار علامات الأصابع المخفية والموجودة على مجموعة واسعة من أدلة مسرح الجريمة.

وتستند الصيغة إلى صبغة الكزانثين، وردة البنغال، ومحفز انتقال الطور، ويوديد رباعي بوتايل أمونيوم. حيث يستغرق الأمر فقط من ٢-٣ دقائق لإظهار مجموعة واسعة من أدلة البصمات الموجودة على أسطح غير مسامية وشبه مسامية ومسامية. كما يكتشف بصمات الأصابع على المواد البيضاء أو المتعددة الألوان؛ الناعمة والخشنة.

وبالإضافة إلى ذلك، فإنه يظهر بصمات الأصابع الموجودة على مجموعة متنوعة من الأشرطة اللاصقة، بما في ذلك الشريط اللاصق الذي يستخدمه المفجرون الانتحاريون لربط المتفجرات على أجسامهم. كما يكتشف الانطباعات الموجودة على تلك المواد التي تعرضت للماء ودرجات الحرارة المرتفعة.

يتم تحضير محلول الرش بإذابته في الماء. كما أن مكونات التركيبة غير سامة ورخيصة وسهل الحصول عليها.

الكلمات المفتاحية: علوم الأدلة الجنائية، بصمات الأصابع، المحفز، الإجرام، الكزانثين.

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1. Introduction

Latent fingerprints are formed by deposition of sweat secreted by or adhering to the fingertips on a surface with which the fingers come into contact [1]. The sources of sweat residue are the eccrine, apocrine and sebaceous glands [2]. The major contribution comes from eccrine glands which are connected to sweat pores which, in turn, are studded all along the ridges of the fingertips. A part of sweat residue also originates from sebaceous glands, since the fingertips occasionally come into contact with hair and face. Sweat contains 99% water, 0.5% salts such as sodium, potassium, chloride and phosphate, and 0.5% other components like proteins and fatty acids [3, 4].

The interaction of a chemical formulation with the fingerprint residue converts one or more of the sweat constituents into a coloured derivative.What is hidden then becomes visible and the latent print is said to have developed. We report the utility of one such fingerprint composition comprised of equimolar quantities of a phase transfer catalyst and a stain belonging to the xanthene class. t-Tetrabutyl ammonium iodide serves as the catalyst and rose Bengal as the xanthene derivative reagent [5].

Clear and sharp fingerprints develop on a broad spectrum of crime scene evidences.

2. Methodology

The chemicals were procured from Sigma-Aldrich and no further purification was carried out.

A 0.001 M solution of the t-tetrabutylammonium iodide and the Rose bengal (4,5,6,7-tetrachloro-2',4',5',7'-tetraiodofluorescein) were prepared separately in 50 mL distilled water. The contents were mixed and stirred for 30 minutes. The formulation had a shelf life of 6 weeks.

Samples of latent fingerprints were taken from several donors including students and faculty members of our group. The donors were asked to rub their fingers on their foreheads or hair before impinging these on a relevant surface. This ensured that a combination of eccrine, and sebaceous sweat residue was transferred on the substrate.

Latent finger impressions were taken on 2"x2" pieces of photocopy paper, wrapping paper, OHP sheet, polythene sheet and different varieties of tapes. These were then dipped in the formulation for one minute. The paper pieces were dipped in distilled water for about 30 seconds. Other items were dried with an electrical dryer.

For relatively larger items such as bottles, switches, glassware and utensils, the composition was sprayed on the latent impression. The surface was allowed to dry naturally.

3. Results and Discussion

This novel method developed good quality latent impressions on a wide array of items, smooth and rough, porous, semi-porous and non-porous, and white and multi-coloured.

A representative fingerprint developed on glossy paper is shown in Figure-1.

Optimum quality fingerprints may be developed on lamination sheets for which the cyanoacrylate fuming method is normally used. Cyanoacrylate reagent is toxic and poses an occupational hazard to the user [6]. A print developed on lamination sheet is displayed in Figure-2.

The present composition is not only non-toxic, but it is prepared in water. In the ninhydrin method, the reagent is

Figure 1- *A fingerprint developed on glossy paper.*

Figure 2- *A fingerprint developed on lamination sheet.*

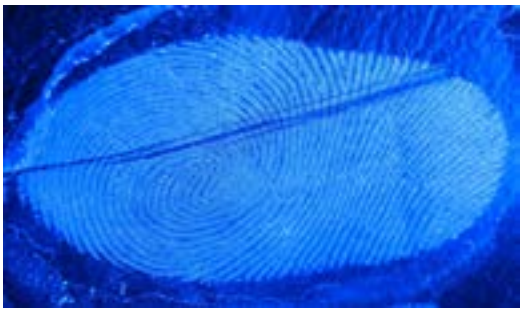

Figure 3- *A fingerprint developed on glass.*

dissolved in organic solvents, which are inflammable [7].

Fingerprints were also developed on glass items, a representative example of which is shown in Figure-3.

The uniqueness of this method is that it detects latent impressions on many varieties of adhesive tapes, including cello tape, doctors' tape, electrical tape and duct tape. The impressions on packaging tape are shown in Figure-4.

Even on rough items like thermo cool, good quality fingerprints were retrieved (Figure-5).

The reagent formulation was used to detect finger marks on two commercial varieties of recordable compact disks, viz. Maxell and Eurovision and two re-writable varieties, viz. Amkette and Moserbear. The composition developed

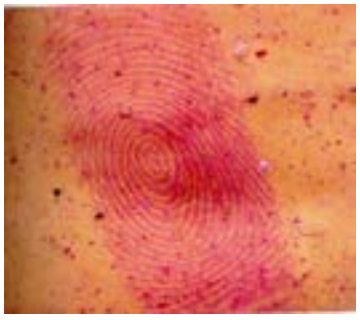

Figure 4- *A fingerprint developed on packaging tape.*

Figure 5- *A fingerprint developed on thermo cool.*

Figure 6- *A fingerprint developed on a compact disk.*

optimum quality fingerprints on all brands [8]. A sample print is shown in Figure-6. Moreover, the stored data could be retrieved from all varieties of compact disks after processing of fingerprints.

Yet another advantage of this technique is that development of fingerprints is a one-step process, taking only about 2 minutes. In contrast, multi-metal deposition method involves many steps and takes between 30 to 60 minutes to yield meaningful results [9].

The phase transfer catalyst method may be extended to detect fingerprints on evidence which has been deliberately or accidentally wetted. Figure-7 depicts a print developed on a metallic item which had remained immersed in water for 12 hours prior to development.

The present method develops better quality fingerprints on moist non-porous items than the conventional small particle reagent [10]. The reaction mechanism is being studied.

The sparingly soluble components of sweat residue do not normally react with the solution of the developing reagent. However, the phase transfer catalyst brings about a rapid interaction between these components and an aqueous solution of xanthene dye develops good quality fingerprints.

Figure 7- *A fingerprint developed on a wet item.*

4. Conclusion

The proposed method is a simple yet effective technique for developing latent impressions on a host of non-porous, semi porous and porous substrates. The formulation is non-hazardous and remains stable for 6 weeks. It detects weak, chance prints and is deemed suitable for case-work investigations.

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Conflict of Interest

No.

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