A novel, fluorescent small particle reagent for detection of latent fingerprints: A preliminary study on submerged aluminium foils

Jasjeet Kaur [1] and Gurvinder S Sodhi [2 *]

[1]*Department of Chemistry, Shaheed Rajguru College of Applied Sciences for Women (University of Delhi), Vasundhara Enclave, Delhi-110096, India*

[2]*Forensic Science Unit, S.G.T.B. Khalsa College, University of Delhi, Delhi-110007, India*

Abstract

We have formulated a novel small particle reagent comprising of a mixture of basic zinc carbonate and boron nitride as the base material; basic yellow 40 as the colorant; and a commercial liquid detergent as the surfactant. The formulation develops clear and sharp fingerprints on aluminium foils that have remained submerged under water for variable periods of time. The florescent nature of the composition assists in developing weak and fragmented latent impressions that are often collected from crime scenes. A mechanism based on hydrophilic-hydrophobic interactions has been proposed for the detection procedure. The reagent is cost-effective and non-toxic.

Keywords: Fingerprints; Fluorescent; Latent impressions; Mechanism; Sweat residue; Wet powdering

Introduction

Small particle reagent (SPR) – also called *wet powdering* – is one of the very few techniques used for developing latent fingerprints on moist, non-porous surfaces [1]. The conventional SPR comprises a suspension of molybdenum(IV) sulfide in a water-surfactant mixture. The base material tags the water-immiscible components of sebaceous sweat, mainly fatty acids and lipids, and imparts a dark gray color to the ridge pattern [2]. However, there are a few disadvantages associated with this formulation. Firstly, it is non-fluorescent and therefore faded prints, as well as those impinged on multicolored surfaces cannot be enhanced by this technique. Secondly, the dark hue of molybdenum(IV) sulfide precludes the integration of a luminescent stain into the composition. Thirdly, the reagent is toxic in nature [3].

To overcome these problems, Frank & Almog [4] substituted molybdenum(IV) sulfide with basic zinc carbonate – a white compound which may be used concertedly with a luminescent dye. A fluorescent variety of basic zinc carbonate SPR involving crystal violet dye has been used to develop fingerprints on a number of non-porous items, such as aluminium foils, ceramic tiles and glass slides, after immersing these in clean and dirty water for variable periods of time [5]. Yet another formulation containing eosin blue stain developed latent impressions wet aluminium foils and lamination sheets [6].

We have further modified the SPR using a mixture of basic zinc carbonate and boron nitride as the base material which, collectively with basic yellow 40 stain and a commercial liquid detergent develops fingerprints on aluminium foils that have remained submerged in water. A mechanism has been proposed for the detection procedure.

Materials and Methods

Basic zinc carbonate and boron nitride were purchased from Sigma-Aldrich, while basic yellow 40 was procured from Neelikon Food Dyes & Chemicals Ltd., India. Genteel^{R}, an Indian brand liquid detergent was used as surfactant. As a test case, fingerprints were developed on aluminium foils which were earlier immersed in water for different spans of time. Before applying the SPR, the foils were washed with water, then air dried and finally the impression of dry fingers were impinged on each sample. The experiments were carried out during summer season when the temperature varied between 38-40°C and the relative humidity was in 35-40% range.

A mixture of 4.5 g basic zinc carbonate and 0.5 g boron nitride were suspended in 75 mL distilled water. To this suspension, 25 mg basic yellow 40 stain was added, followed by 3 drops of liquid detergent. The contents were thoroughly stirred before each application.

Aluminium foils, bearing latent impressions, were submerged in water for variable periods. These were immersed in the test solution for 2 minute and thereafter washed under a gentle stream of water for 30 seconds. Finally these were dried with a hair dryer.

The quality of the developed impressions were assessed by the grading depicted in Table 1. Fluorescence studies were carried out by illuminating the developed prints with radiation having 505-550 nm wavelength. The fingerprints were photographed and saved under JPEG format.

Table 1. Grading of developed fingerprints.

Grade	Ridge characteristics
0	Prints not developed
1	Lack of ridge clarity due to background noise
2	Number of ridge characteristics less than that required for identification
3	Clear ridges, but low intensity fluorescence
4	Good ridge clarity and good fluorescence
5	Excellent ridge clarity, optimum sharpness of pattern and good fluorescence

For gauging its shelf life, the formulation was placed in glass beakers, covered with tin foil and kept under ambient laboratory conditions. The composition remained stable for 6 weeks.

Results and discussion

One of the unique features of the present formulation is that its ingredients are non-toxic in nature. Basic zinc carbonate is used in antacid formulations, as well as to treat skin problems [7]. Boron nitride is incorporated in cosmetics to enhance sheen [8]. Basic yellow 40 is a fluorescent textile dye [9] which, in this study has been used to enhance week fingerprints.

The reagent visualized latent fingerprints on aluminium foils that had remained immersed in water for different durations. Grade 5 prints were obtained for an immersion time up to 5 days; Grade 4 level impressions were developed for the time span 6 to 11 days; Grade 3 from 12 to 22 days. Thereafter, the quality of developed fingerprints became questionable. Representative fingerprints are depicted in Figure 1.

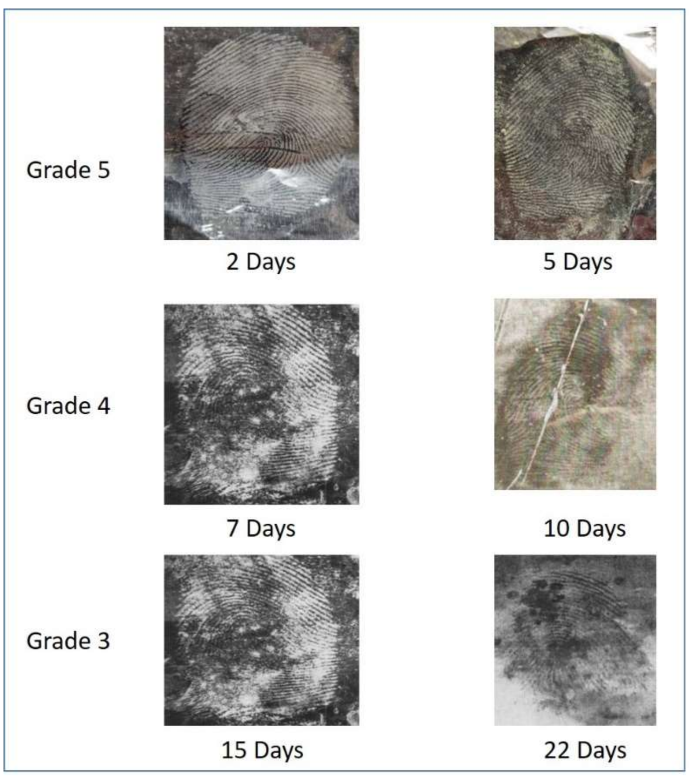

Figure 1 Fingerprints visualized on submerged aluminium foils.

Illumination with 505-550 nm radiation imparted fluorescent character to the developed prints and enhanced the weak impressions. The method is simple enough to be operated upon by an amateurish hand. The test solution has a shelf life of 6 weeks.

The detergent, used as a surfactant in this study, has a hydrophilic end in form of carboxylate anion, and a hydrophobic end in form of hydrocarbon function. The hydrophilic end interacts with the ionic base materials, basic zinc carbonate and boron nitride, while the hydrophobic end interacts with the lipid and fatty acid contents of sweat residue. The hydrophilic-hydrophobic interactions thus bring about a liaison between the base material and the sweat residue. The adduct gets deposited along the ridges and the stain gets adsorbed on it, imparting color/fluorescence to the pattern. Taking lipids as a representative sweat component, the hydrophilic-hydrophobic mechanism is shown in Figure 2.

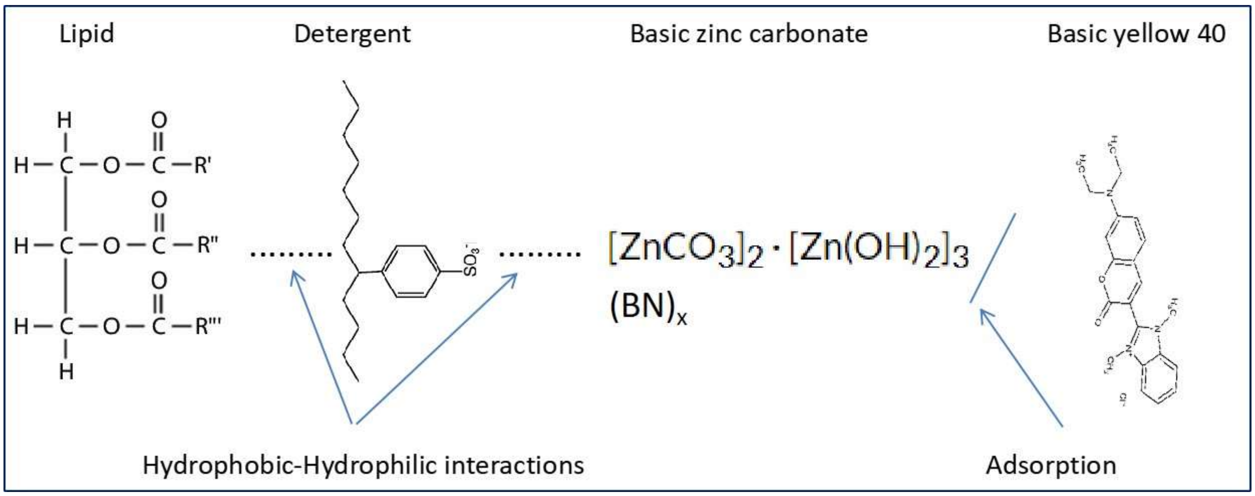

Figure 2 The hydrophilic-hydrophobic mechanism of SPR formulation.

Since the fatty acid and lipid constituents of latent deposition are immiscible with water, the formulation is able to develop fingerprints on those items which have been deliberately or unintentionally wetted.

Conclusion

In this preliminary study, an effort has been made to develop latent impressions on aluminium foils which had remained submerged in water with a novel, fluorescent SPR formulation. The fact that optimum quality of fingerprints could be detected even after 22 days of immersion suggests that other non-porous surfaces, such as glass, tiles and hard plastics too may be tried to gauge the true value of the reagent. This work is in progress.

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