

SUPERGLUE FUMING FOR THE CHEMICAL ENHANCEMENT OF LATENT FINGERPRINTS

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Abstract. The acceptance of fingerprint evidence by the courts has always been predicated on the assumption that no two individuals have identical fingerprints. Fingerprints (visible or latent) are often found at a scene of crime. Latent prints however, are difficult to locate and require the utilization of techniques that will visualize the prints. This study involved the application of chemical techniques to the visualization of latent fingerprints. The more recent superglue fuming technique was compared to two other techniques using ninhydrin and eosin as chemical reagents. The chemical enhancement of the three techniques was found to be dependent upon the nature of the surface on which the prints were deposited. Results showed that superglue fuming and eosin technique were capable of enhancing latent fingerprints on non-porous surfaces which have been kept for up to three months. The ninhydrin technique was found to be effective only for latent fingerprints on porous surfaces.

Keywords: latent fingerprints, superglue fuming, ninhydrin, eosin

Abstrak. Penerimaan bukti cap jari oleh mahkamah lazimnya berdasarkan kepada anggapan bahawa tiada dua individu mempunyai cap jari yang sama. Cap jari nampak atau cap jari pendam sering dijumpai di tempat kejadian jenayah. Walau bagaimanapun, cap jari pendam adalah sukar dikesan dan memerlukan penggunaan teknik yang dapat memperlihatkan kesan cap jari. Kajian ini melibatkan penggunaan teknik kimia bagi penyerlahan cap jari pendam. Kaedah pewasapan gam jenis *superglue* dibandingkan dengan dua kaedah lain menggunakan reagen ninhidrin dan eosin. Penyerlahan bagi ketiga-tiga kaedah didapati bergantung kepada jenis permukaan yang mengandungi cap jari. Keputusan menunjukkan bahawa pewasapan *superglue* dan teknik eosin berupaya menyerlahkan cap jari pendam pada permukaan tidak berliang yang telah disimpan sehingga tiga bulan. Teknik ninhidrin pula didapati berkesan bagi cap jari pendam pada permukaan yang berliang.

Kata Kunci: Cap jari pendam, Pewasapan *superglue*, ninhidrin, eosin

1.0 INTRODUCTION

There is little need to mention the importance of obtaining fingerprints in criminal investigation. Fingerprints have long been considered as one of the most valuable types of physical evidence that can be found at a crime scene. The tip of a finger is far from being either smooth or symmetric. It is completely covered with tiny ridges that form a pattern that is virtually unique. Even identical twins will have different ridge patterns. It is this pattern of ridges that is called the fingerprint [1]. When the fingertip comes in contact with something, a layer of sweat containing amino acids in the shape

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of that fingerprint will be left on the object. The fact that these latent prints can often be recorded combined with the fact that no two fingerprints are the same is what makes fingerprint practical.

In most cases fingerprinting requires far more than a general dusting for prints. Dusting can only be used by itself on non-porous surfaces, and only if the prints are still fresh otherwise, other techniques must be employed, and the particular technique used must be carefully selected to work with the existing conditions, using the incorrect method can destroy latent print evidence. One common technique is the use of gaseous superglue [2-4]. While the sweat in the latent print will dry after a relatively short time making dusting for fingerprints pointless, the amino acids in the print can remain for months or more given the right conditions. Superglue has an affinity for these amino acids, and as such super glue can naturally cluster and solidify around them, leaving a sticky image of the fingerprint.

Most liquid superglues are either methylcyanoacrylate or ethylcyanoacrylate. Less common types of superglue are butylcyanoacrylate and isobutylcyanoacrylate. Superglue reacts with traces of amino acids, fatty acids and proteins in the latent fingerprint and the moisture in the air to produce a visible sticky white material that forms along ridges of the fingerprint. The resultant image of the latent fingerprint can be photographed directly, or after further enhancement [1].

The human skin possesses three types of sweat glands, namely the eccrine, apocrine and sebaceous, whose secretions contribute to a fingerprint deposit [5]. Eccrine glands are widely distributed throughout the body and are particularly numerous on the palms of the hands and the soles of the feet. Besides its water content, eccrine sweat contains 1 % of other substances of which about half are inorganic salts. The most abundant ions are sodium and chloride. Potassium, magnesium, calcium, sulphate, and phosphate ions are also present, together with traces of iron, copper, manganese, iodide, bromide and fluoride. The other half consists of organic derivatives, such as amino acids, urea, creatinine, choline, lactic acid, sugars, uric acid and fatty acids.

The constituents of sweat could be selectively fixed by using different chemical reagents in order to make the latent fingerprints visible. Several techniques included the powder method, ninhydrin reagent, iodine fuming and superglue fuming [1].

Fingerprint powders are commercially available in a variety of compositions and colours. These powders, when applied lightly to non-adsorbent surface with a fiber-glass brush, will readily adhere to perspiration residues and/or deposits of body oils left on the surface. Powders that afford the best colour contrast with the surface being dusted are normally used. Gray and black powders are often used for most latent print work. The gray powder, composed of aluminium dust is often used on dark coloured surfaces. The black powder, composed basically of black carbon or charcoal is often applied to white or light coloured surfaces. Fluorescence powders are also used to develop latent prints. These powders will fluoresce under ultraviolet light.

The development of latent fingerprints with ninhydrin is dependent on its chemical reactions to form a purple-blue colour with amino acids present in trace amounts in perspiration. Ninhydrin is commonly sprayed onto the porous surface from an aerosol can. Iodine fuming is the oldest method used for visualizing latent prints. Iodine is solid crystals that sublimed upon being heated. Most often, the suspect material is placed in an enclosed cabinet along with iodine crystals. As the crystals are heated, the resultant vapour will fill the chamber and combine with the constituents of the latent prints to make it visible. Although it is generally believed that iodine fumes combined with the fatty oils, there is also evidence to show that iodine may actually interact with residual water left on a print from perspiration [6,7].

Many methods however have their drawbacks. The powder technique of developing latent prints is the most common, but it works only in the presence of moisture. This means that old prints cannot be developed. Ninhydrin reagent can be used to develop prints as old as 15 to 16 years, but it has to be dissolved in an organic medium. Spraying of the reagent onto a document bearing oil-based ink will affect the calligraphic script. The prints obtained by iodine fuming are not permanent and tends to fade with time, unless fixed. The toxicity of iodine also limits the use of this method. The application of cyanoacrylate was reported to be restricted by circumstances such as difficulty to accomplish the required and uniform concentration and vapours in fairly big volumes and the fact that cyanoacrylate polymerized not only on the ridges of latent fingerprints, but also on the whole surface of the object. The resultant coating was linked with the surface by chemical bonds, rendering it difficult to remove, and the object became useless [3].

Calcium ions, after being deposited along the ridges are converted into insoluble oxide or carbonate. Any further reaction of these insoluble salts, if they occur at all, would be too slow to have any practical use. A technique using a phase transfer catalyst to fix the calcium ions in sweat has been reported [5]. *t*-Tetrabutylammonium iodide was used as the phase transfer catalyst that accelerated the reaction between the insoluble solution of a complexing agent, the disodium salt of eosin.

This work was undertaken to find the conditions necessary for effective use of superglue fuming, ninhydrin reagent and eosin reagent to the enhancement of latent fingerprints in the Malaysian environment. The methods were tested using various surfaces and age of prints.

2.0 EXPERIMENTAL

2.1 Chemicals

t-tetrabutylammonium iodide and ninhydrin were obtained from Fluka Chemie, Switzerland, while eosin ($C_{20}H_6Br_4Na_2O_5$) from BDH Limited Poole, England. Commercial cyanoacrylate (superglue, by Tokai Chemical Industri Co Ltd Tokyo Japan and distributed by G.L Stationery Sdn Bhd) was purchased from a grocery store in

Skudai, Johore. Distilled water was prepared in the laboratory. Solvents of ethanol, ethyl acetate, acetic acid and heptane were laboratory grade from a range of suppliers.

2.2 Apparatus

Apparatus for the enhancement of latent fingerprints consisted of a covered plastic container (250 mm × 390 mm) and a mosquito repellent electric mat heater (Ridsect) used to fumigate the container with cyanoacrylate. Plastic basins (230 mm × 320 mm) were used to immerse sample matrices bearing latent prints. A Nikon focusing camera (model FM 2-Lens Macro) used to record the enhanced fingerprints, was loaned from the Education Faculty, Universiti Teknologi Malaysia. A ruler (150 mm) with centimeter scale was used in the picture taking of the prints.

2.3 Sample Materials

The materials used as sample matrices were white writing paper (A4 80 g, 150 mm × 210 mm), manila cards (125 mm × 160 mm), transparent plastic bags (87 mm × 145 mm), white plastic wrapper (100 mm × 125 mm), glossy flash cards (80 mm × 125 mm and 125 mm × 160 mm), sheets from aluminium can (85 mm × 105 mm) and glass petri dishes (diameter 90 mm).

2.4 Procedure

2.4.1 Preparation of latent fingerprints

Latent fingerprints were prepared by slightly pressing the right hand fingers onto a clean surface of the sample matrix. The selection of sample matrices was dependent upon the suitability of the surface matrix for chemical enhancement using the three reagents under study (Table 1).

Table 1 Use of reagents on suitable sample matrices.

Reagent	Surface Type	Sample Matrix
Superglue	Non-porous	Aluminium sheet Transparent plastic bag Glass petri dish
Ninhydrin	Porous	White writing paper Manila card
Eosin	Non-Porous	Glossy flash card White plastic wrapper

2.4.2 Chemical Enhancement Techniques

Superglue Fuming

The experiment was performed using a closed plastic container which was placed in a fume cupboard. A wire was placed in the top middle of the plastic container so as to permit the sample matrices to be hung. Drops of super glue were placed in a boat-shaped aluminium foil and positioned on top of the electric mat heater (Figure 1).

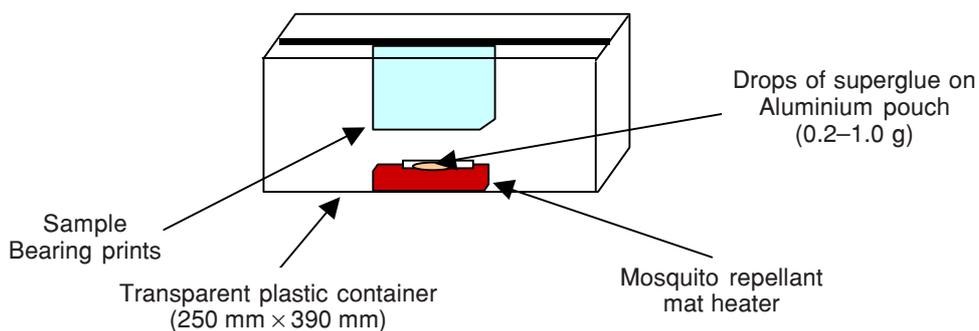


Figure 1 Experimental set-up for superglue fuming

Sample bearing fingerprints were taken out of the container when it was sufficiently exposed to reveal the white prints. The resultant prints were photographed using two distant focusing, one for overall view and the other for closeups (0.25 m).

Ninhydrin Reagent

5 g of ninhydrin was dissolved in a mixture of ethanol (75 mL), ethyl acetate (25 mL) and acetic acid (3 mL). Prior to dissolution, the granular ninhydrin was made into a fine powder using a pestle and a mortar. The solution was stirred until all the ninhydrin dissolved and heptane (1 L) was finally added to it.

The resultant solution was applied by brushing it using a facial tissue onto the sample matrix. The sample was then left overnight in the dark for the enhancement to take place. The developed purple print was photographed at a distance of 1.5 m and 0.25 m.

Eosin Reagent

Disodium eosin salt (yellow) and *t*-tetrabutylammonium iodide was used without further purification. Disodium salt (1.8 g) and *t*-tetrabutylammonium iodide (0.8 g) was weighed and each dissolved in distilled water (100 mL) to form a solution containing 1.8 % disodium salt and 0.8 % *t*-tetrabutylammonium iodide. The resultant solution was poured into a plastic basin with an adequate size to immerse the sample

matrix.

Sample matrix bearing prints were immersed in the basin for 5-10 mins. The sample was lifted and allowed to dry for 1 minute. Excess reagent was washed off by rinsing the sample under a gentle stream of distilled water. The surface was allowed to dry before being photographed.

3.0 RESULTS AND DISCUSSION

3.1 Superglue Fuming

The use of cyanoacrylate or superglue in the enhancement of latent fingerprints were found to be affective on non-porous surfaces such as plastic, aluminium and glass surfaces. The quantity of liquid cyanoacrylate used and heating time is as shown in Table 2. In initial experiments, the exact heating time was found to be dependant on the size of the tank and humidity of the air. In this study, a fixed size tank was used and the humidity of the tank was the same as that of ambient conditions without the use of an open container of water in the tank. According to Lee and Gaensslen [8], the boiling points for most superglue varied between 49-65°C depending upon its chemical reaction. However in this study, the heating temperature of superglue fuming was found to be in the range of 40-50°C, presumably due to the different nature of commercial superglue used.

Cyanoacrylate in the liquid form, when heated is converted to the vapour form which reacts with the eccrine and oils found in the latent fingerprint to form a polymer

Table 2 Amount, temperature and time taken for cyanoacrylate fuming.

Sample	Amount (g)	Heating time (min)	Temperature (°C)
Aluminium	0.4	15	42-44
Transparent plastic bag	0.4	10	40-46
Glossy flash card	0.4	10	40-46
Glass	0.4	15	34-50

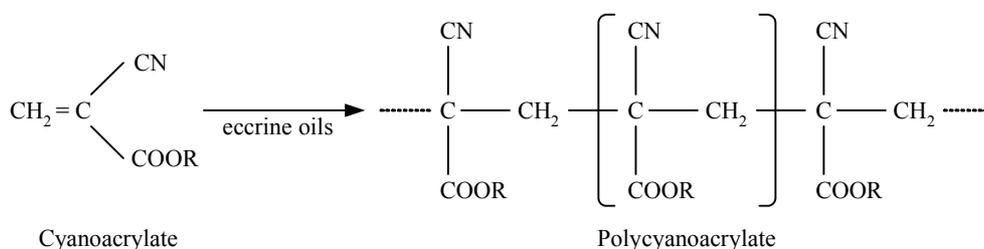


Figure 2 Reaction of cyanoacrylate to form a white polymer.

(Figure 2). The prints developed as white sticky impressions within two hours (Figure 3). Care was taken not to overdevelop the prints as the chemical images of the ridges will slowly grow wider until they overlap, obscuring vital detail. Good quality prints were developed from plastic bags for up to 3 months, on aluminium sheets for up to 1 week. However, latent prints from glossy flash cards and glass could only be developed up to 2 days.



Figure 3 Fingerprints developed with superglue fuming on aluminium surface.

3.1 Ninhydrin Technique

The latent fingerprints developed using ninhydrin reagent was found to be suitable on writing papers and manila cards only that are on porous surfaces. The prints were developed as purple prints, due to the reaction of ninhydrin with the amino acids in sweat to form Ruhemann's purple (Figure 4). Generally, prints began to appear within an hour after ninhydrin application. Weaker prints were visualized after 24 hours. The ninhydrin reagent was found to be effective for developing prints as old as three months on writing papers. A problem encountered with ninhydrin was the coloured background interference due to the excess solution resulting in poor visualization of the enhanced prints on some surfaces. Hence it was found necessary to examine the prints at regular intervals until a sufficiently clear print was formed.

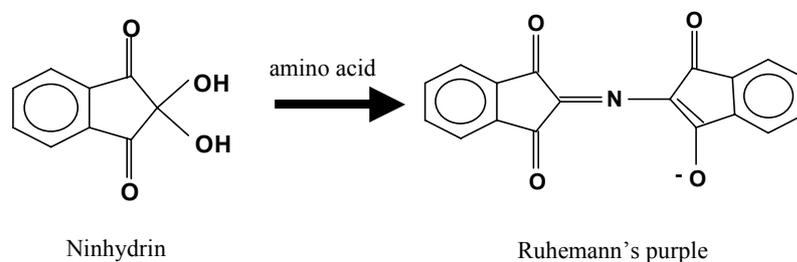


Figure 4 Reaction of ninhydrin with amino acids to form the purple print

3.2 Eosin

The latent prints developed as pink colored impressions using eosin reagent within 5-10 minutes of development time. They were clear and visible to the naked eye on white papers, but not on pink or red coloured background. The basis of this reaction is the use of *t*-butylammonium iodide to fix calcium ions in sweat and to accelerate the reaction between the insoluble calcium and eosin (Figure 5).

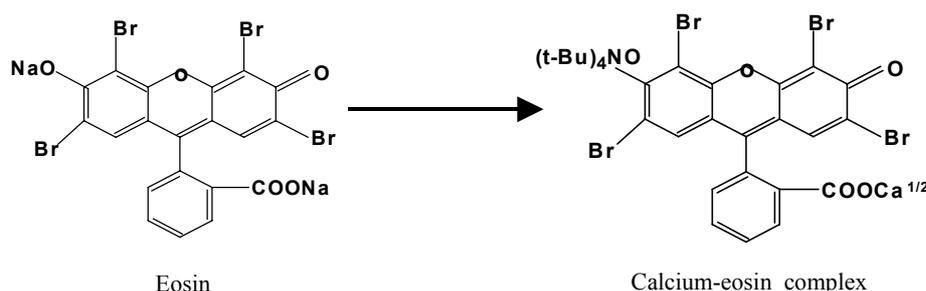


Figure 5 Reaction of eosin to form calcium-eosin complex.

Good quality prints were developed from glossy flash cards for latent prints that were 1 week old. The developed prints were found to persist over prolonged periods of time and were not distorted by rubbing or scratching. The results obtained were in good agreement as reported in another study [5]. Impressions older than a week and for up to 3 months were not very clear but could still be detected. This could be due to the possible interaction of calcium ions with the cellulose content of the paper.

Good quality prints that have been lifted from non-porous surfaces suggest that the method may be extended to obtaining fingerprints from laminated or smooth documents such as driving licenses, identity cards and credit cards.

4.0 CONCLUSIONS

The superglue fuming was effective in developing prints on non-porous and slightly porous surfaces with prints up 3 days old on glass, 7 days on aluminium and up to 1 month on transparent plastic bag. The ninhydrin technique was only applicable for porous surfaces such as writing paper. The technique was capable of developing good prints for latent fingerprints that have existed for up to 1 month old. The eosin technique was successful in developing good quality prints from non-porous surfaces such as glossy cards bearing latent prints, which were up to 3 months old. The three techniques investigated allowed latent fingerprints to be visualized on porous and non-porous materials.

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