Latent Fingerprint Detection on Rough Surfaces by Magnetic Powder and Commercial Glues Available in Thailand

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ABSTRACT: Latent fingerprints, which are found at the crime scene or on materials associated with the crime, can identify both the offenders and victims when sufficient ridge characteristics and clarity are available. Such availability depends upon both preservation and subsequent resolution. Good quality latent fingerprints have been recovered by using Tex-Lift glue and magnetic powder dusting, but Tex-Lift is an expensive imported product. The purpose of this study was to evaluate the ability to detect latent fingerprints on rough surfaces using magnetic powder dusting and eight low cost commercial glues (Tex-Lift, Bennon, Horse, Nanmee, Office Centre, Paper-Mate, Scotch, Staedtler and UHU) available in Thailand. The results, detected by an Automated Fingerprint Identification System (AFIS), show the detection of a high number of minutiae in the latent prints with all eight tested glues. The best quality (94.9%) of latent fingerprint detection was obtained from Nanmee and UHU glues on a plastic surface and dried with a hair dryer. Interestingly, a higher quality of latent prints was detected by most of these cheaper commercial glues than that obtained with the expensive Tex-Lift under the same conditions. Therefore, the eight commercial glues, instead of Tex-Lift, can be applied for latent fingerprint detection on rough surfaces in forensic science, attaining better quality prints at a lower cost.

Key words: Latent fingerprint, glue, magnetic powder, rough surfaces, Tex-Lift

INTRODUCTION

Fingerprints, which can be used as evidence to identify individuals, are made by the minute ridge formations or patterns of the fingers that are unique to each person. Since no two persons have exactly the same patterns or ridges, and that these patterns do not change over the individuals lifetime they are highly useful for identification of individuals at crime scenes.(1) Consequentially, fingerprint evidence remains the most positive means of personal identification in forensic science.

However, the potential use of fingerprints requires a sufficient quality of print as to be able to discern enough patterns of the ridges to allow unambiguous identification, which is a product of various factors including the ability to visualize the prints. Latent fingerprints are those that are present but invisible, and so especially are critically sensitive to visualization techniques.(2, 3) Moreover, on a rough surface, latent fingerprints are more difficult to develop than others. Although, magnetic powder and Tex-Lift can typically generate an excellent latent fingerprint, Tex-Lift is a high cost consumer product, and has to be imported into Thailand. The purpose of this study then was to evaluate the ability of eight commercial glues that are readily and cheaply available in Thailand, but which have never been used for tape lifting before, to replace Tex-Lift in the detection of latent fingerprints on rough surfaces using the standard magnetic powder dusting and tape lifting procedure.

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MATERIALS AND METHODS

Fingerprints were impressed on samples made from plastic file, tile, polymer computer desk and cupboard wood (Fig. 1.) All fingerprints are whorl pattern from the same left index finger which allowing the materials to be compared across on four different dry rough surfaces.

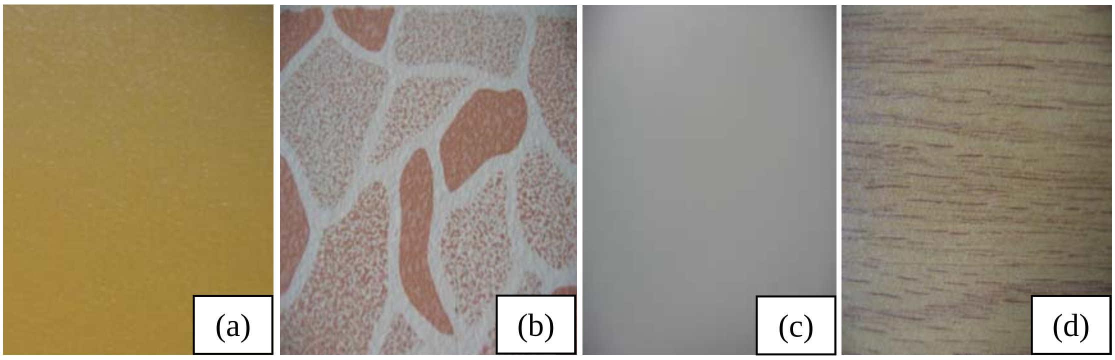


Figure 1. Four different types rough surfaces. (a) plastic file, (b) tile, (c) polymer computer desk and (d) cupboard wood

Magnetic powder was applied to develop the latent fingerprints on both the control and test samples. The samples were coated with Tex-Lift (TL) as a reference sample, or one of the eight commercial glues as test samples: Bennon (B), Horse (H), Nanmee (N), Office Centre (OC), Paper Mate (PM), Scotch (SC), Staedtler (ST) and UHU (U). Each print-substrate type-glue type combination was further dried under one of seven different drying conditions, that is dried by a hair dryer (Panasonic TURBODRY: EH5281, 1000W) which was adjusted at the highest level and held 2 inches above the samples for 1 – 2 min, or air dried for 20, 30, 45, 60, 70 min or 1 day. The experiment was performed in the 27ºC laboratory room. After the glue-coated prints were completely dried, they were lifted by transparent Scotch® 3M 600 tape (size 24 × 33 mm). The fingerprint pattern was captured on the tape and placed on white A4 paper. The control samples were not coated with any glue but were just subject to tape lifting. A total of 1,120 samples were investigated. Each experiment was repeated four times.

The number of minutiae (ridge characteristics) of each fingerprint obtained using either Tex-Lift or each of the eight commercial glues under each condition, including the no-glue control, were obtained by Automated fingerprint identification system (AFIS) software and are presented as a percentage.

RESULTS

The visualized minutiae in each glue-coated fingerprint recovered from each of the four different substrate types (plastic, polymer, tile and wood) were analyzed by AFIS and the results are presented as the % maximal coverage in Table 1 and Fig. 2. With a few exceptions, the details of the ridges in the control (uncoated) prints could not be identified at all, and even these exceptions were so poor (only 2.6 – 7.7% of minutiae being resolved) as to be of no real forensic use. With a few exceptions the best results were obtained after drying with a hair dryer, which is logistically an advantage allowing quick processing times, especially in crime scenes that are unstable / unsafe or where many prints are required to be taken. For those exceptions, where better prints were obtained after air drying for 60 min or 1 day, either better quality prints could be obtained with a different glue dried by the hair dryer (Polymer N and OC vs. ST; Plastic PM vs. N and B) or almost as good results could be obtained (Wood N and OC). Thus, overall, with the correct glue-substrate sample matching, drying by hair dryer is optimal. As to the optimal combinations, from Table 1 the best resolution was obtained with ST for polymer and tiles, OC for wood and U for plastic.

With respect to the substrate surfaces, most of the highest quality print images were obtained from the plastic surface using a hair dryer, whilst prints from tiles were typically the worst, except for wood and glue ST (Tables 1 and 2; Fig. 2). With respect to the glues, each glue and drying condition was suitable, although not necessarily optimal, for at least surface (Tables 1 and 2).

As already mentioned, the best glue – drying combination for recovery of latent prints from each of the four substrate surfaces was not Tex-Lift in all cases. Indeed, the best quality prints on all four types of rough surface from the eight experimental glues were higher than those from Tex-Lift. The results showed that UHU was good for plastic when dried by a hair dryer, tiles and wood when air-dried for 60 min.

OC with air-drying for 60 min and ST when dried by a hair drier were suitable for polymer. ST with a hair dryer and U when air-dried for 60 min were both good for tiles. B and OC with a hair dryer, and H and U when air-dried for 60 min, were good for lifting prints from wood. For Tex-Lift, the best quality print was seen on polymer under a hair dryer (Tables 1 and 2).

DISCUSSION

Recovering latent fingerprints on rough surfaces by photographing and tape lifting revealed unsatisfactory results and was subsequentially replaced by glue to recover the latent prints from rough surface; a simple technique that provides excellent results when used properly.(4) Furthermore to detect oil-contaminated fingerprints on plastics the use of magnetic powder dusting and lifting with Tex-Lift was established as the routine system.(5) Presenting this study the quality of latent fingerprint ridge details on rough surfaces was found to depend on the glue (characteristics of glue and drying condition), type of surface, fingerprint, magnetic powder dusting and technical skill for fingerprint development.

Importantly, for each of the four substrate types tested, wood, tiles, plastic and polymer, the traditional expensive Tex-Lift was found to be inferior to at least one of the other glues tested. However no single one-for-all glue was found that was optimal for all four substrates, but rather three different glues were required to optimally cover all four substrates. This would entail crime scene personnel to have to carry and correctly use three different glues (ST for polymer and tiles, OC for wood and U for plastic), which is not unreasonable. Indeed, even with the risk of misuse of the wrong glue by mistake, it would likely still result in reasonable results, except for OC or U on tiles and ST on wood.

The large variance in the quality of the recovered prints and the glue used, method of drying and substrate taken from can be considered as follows:-

(i) ***Glue viscosity*** would likely affect the ridge detail of latent prints. The low viscosity glue-coated prints could be relatively easily be damaged by drying with a hair dryer. Thus, although Nanmee (N), the lowest viscosity glue, was best for plastic (94.9%) when dried with a hair dryer, for the other three substrate surfaces superior results were obtained with the more gently air-drying and optimal when air-dried for 60 min, whereas very poor results were obtained from N on polymer and tiles when dried with a hair dryer. In accord, Tex-Lift was the highest viscosity glue and gave the best results when dried with the harsher hair drier.

(ii) ***Drying condition*** would also likely affect the quality of the latent prints. Good latent prints were obtained from drying with a hair dryer or air-drying for 60 min. The ridge characteristics of glue-coated prints when air-dried within 60 min showed a slight increase in clarity. However, if the prints were left longer in the environment, they were typically adversely affected by natural temperature, humidity and dust. Nevertheless, some types of glue still gave better results after air-drying for 1 day, such as N on wood, OC on tiles and PM on plastic, whilst good results were obtained from ST under dryer conditions on plastic, polymer and tiles (Table 1).

(iii) ***The type of the rough surface*** *(substrate)* was observed to affect the quality of the recovered latent prints. All experimental glues gave good results on *plastic* (Table 2), but only OC and ST were good for *polymer*. ST and U were good for tiles (Table 1). It was noticed that the rather smooth surface of the tiles rendered them to have a rather poor ability to be glue-coated.

(iv) ***The amount of grease or sweat on the finger and magnetic powder dusting*** would also affect the clarity of the latent fingerprint. Too much or too little oil or grease could produce smudged or unclear prints, respectively. Moreover, if excess magnetic powder was used, the fingerprint ridge would be destroyed while coating glue. Gently dusting and proper amount of powder were necessary for producing the high quality of latent fingerprints.

All eight commercial glues were low cost consumer products (0.13 - 0.54 Baht/ml) available in Thailand, whereas Tex-Lift (8.33 Baht/ml) must be imported.

Table 1. The quality of developed latent fingerprints coated with each glue on each surface.

Glue/ Surface	Quality of Latent Prints (%)							
	Min							
	Control	**20**	**30**	**45**	**60**	**70**	**1 d**	**Dryer**
Tex-Lift (TL)								
Plastic	0	7.7	18.0	28.2	38.5	-	28.2	61.5
Polymer	0	0	10.3	38.5	51.3	-	38.5	69.2*
Tile	0	7.7	18.0	23.1	38.5	-	41.0	61.5
Wood	2.6	5.1	23.1	41.0	48.7	-	56.4	64.1
Bennon (B)								
Plastic	0	-	5.1	7.7	46.2	-	30.8	71.8
Polymer	0	-	-	0	23.1	69.2	41.0	69.2
Tile	0	-	5.1	33.3	35.9	-	35.9	56.4
Wood	0	12.8	18.0	41.0	61.5	-	64.1	74.4*
Horse (H)								
Plastic	0	-	7.7	53.9	74.4	-	53.9	79.5*
Polymer	0	-	2.6	23.1	61.5	-	53.9	66.7
Tile	0	-	7.7	20.5	41.0	-	30.8	59.0
Wood	2.6	-	5.1	41.0	79.5*	-	76.9	66.7
Nanmee (N)								
Plastic	0	2.6	30.8	56.4	87.2	-	64.1	94.9*
Polymer	0	-	0	25.6	66.7	-	53.9	35.9
Tile	0	2.6	38.5	46.2	56.4	-	41.0	10.3
Wood	0	-	0	53.9	66.7	-	74.4	69.2
Office Centre (OC)								
Plastic	0	-	20.5	30.8	74.5	-	71.8	82.1*
Polymer	0	-	12.8	25.6	76.9	-	48.7	61.5
Tile	0	-	7.7	51.3	53.9	-	56.4	38.5
Wood	7.7	-	25.6	69.2	76.9	-	59.0	79.5

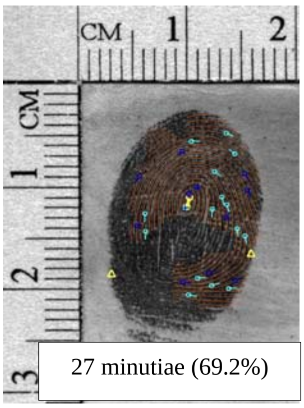
Table 1. The quality of developed latent fingerprints coated with each glue on each surface (Cont.).

Glue/ Surface	Quality of Latent Prints (%)							
	Min							
	Control	**20**	**30**	**45**	**60**	**70**	**1 d**	**Dryer**
Paper Mate (PM)								
Plastic	0	20.5	51.3	53.9	64.1	-	71.8*	48.7
Polymer	0	-	-	2.6	43.6	51.3	51.3	56.1
Tile	0	-	5.1	38.5	59.0	-	25.6	38.5
Wood	7.7	-	5.1	33.3	51.3	-	46.2	61.5
Scotch (SC)								
Plastic	0	-	20.5	28.2	66.7	-	76.7	87.2*
Polymer	0	-	7.7	53.9	56.4	-	64.1	69.2
Tile	0	-	10.3	51.3	59.0	-	56.4	69.2
Wood	2.6	-	0	51.3	69.2	-	59.0	71.8
Staedtler (ST)								
Plastic	0	-	7.7	28.2	64.1	-	53.9	87.2*
Polymer	0	-	-	12.8	25.6	56.4	48.7	76.9
Tile	0	-	20.5	41.0	46.2	-	41.0	71.8
Wood	2.6	-	18.0	25.6	64.1	-	46.2	48.7
UHU (U)								
Plastic	0	23.1	43.6	84.6	89.7	-	84.6	94.9*
Polymer	0	-	7.7	25.6	53.9	-	38.5	64.1
Tile	0	0	12.8	46.2	74.4	-	66.7	53.9
Wood	7.7	23.1	46.2	64.1	82.1	-	59.0	64.1

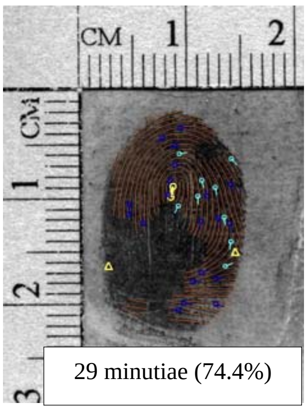
* = The best quality print; 0 = Control, the latent fingerprint was not coated with glue; - = The glue on the print was not dried or completely dry.

Table 2. The best quality and condition of all glues used on rough surfaces.

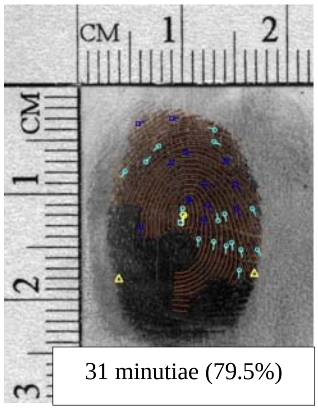
Glue	%	Number Minutiae	Best Surface	Best Condition	Glue Viscosity	Drying (min)	Baht/ ml
Tex-Lift (TL)	69.2	27	Polymer	Dryer	Very	33	8.33
Bennon (B)	74.4	29	Wood	Dryer	Moderate	40	0.32
Horse (H)	79.5	31	Plastic Wood	Dryer Air dry 60 m	Moderate	37	0.16
Nanmee (N)	94.9	37	Plastic	Dryer	Slightly	30	0.21
Office Centre (OC)	82.1	32	Plastic	Dryer	Moderate	38	0.13
Paper Mate (PM)	71.8	28	Plastic	Air dry 1 day	Marked	28	0.31
Scotch (SC)	87.2	34	Plastic	Dryer	Marked	38	0.54
Staedtler (ST)	87.2	34	Plastic	Dryer	Marked	40	0.27
UHU (U)	94.9	37	Plastic	Dryer	Marked	34	0.52



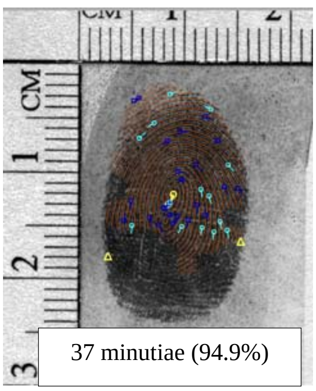
a) TL: Polymer



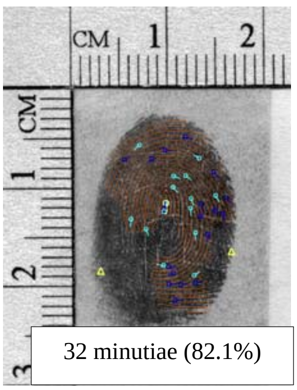
b) B: Wood



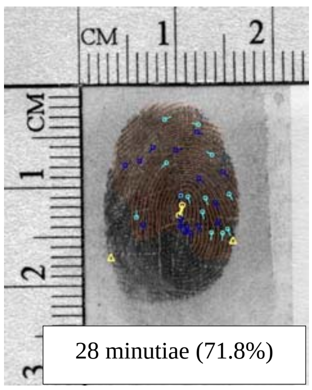
c) H: Plastic



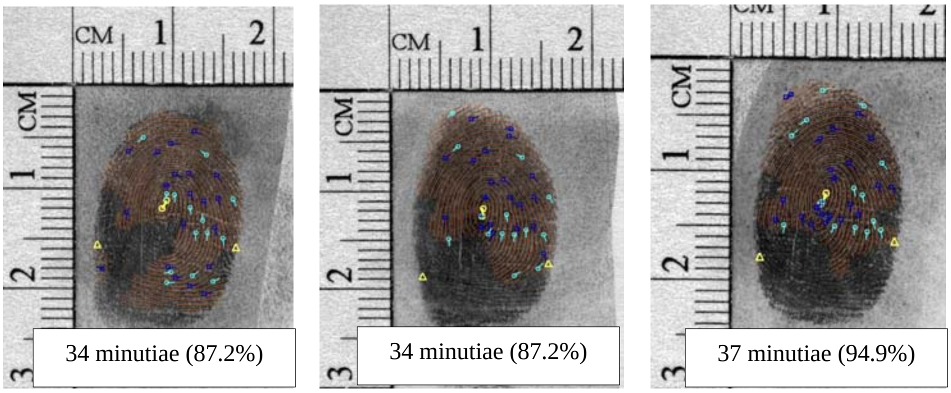
d) N: Plastic



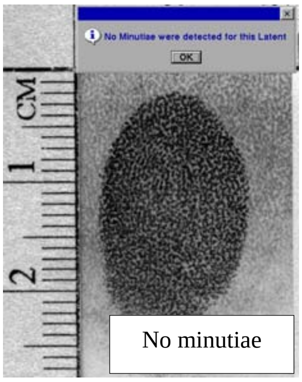
e) OC: Plastic



f) PM: Plastic



g) SC: Plastic   h) ST: Plastic   i) U: Plastic



j) Control (uncoated): Plastic

Figure 2. The best quality glue-coated prints from the nine tested glues (eight new ones plus Tex-Lift) and the no-glue control (uncoated), as evaluated by AFIS.

CONCLUSIONS

The best quality of latent fingerprint was obtained from: N and U on *plastic* when dried by a hairdryer; OC and ST on *polymer* with air-drying for 60 min and a hair dryer, respectively; and U on tiles and wood with air-drying for 60 min. Moreover, the best results from most of the commercial glues, except B, were obtained on plastic with drying by a hair dryer. The results from this study revealed that the eight commercial glues, instead of Tex-Lift, could be used to recover high quality latent fingerprint on rough surfaces.

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