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Latent fingerprint stability on non-porous surfaces at low temperature

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Abstract
At cold areas where there are heavy snow fall, mass number of people are covered by avalanche and are needed for individualization. Sometimes it is also important in cases where criminals often hide their weapons inside the ice or snow, and these evidences or weapons may often contain the fingerprint of the victim or the culprit. As for this we need to develop fingerprint for the identification and individualization of the culprit or the victim.Thus, this present study has been conducted to give an overview of the current fingerprints methods available to assimilate the outcome of the visualisation of the latent fingerprint and to find out the best method suitable for the development of latent fingerprint on non porous surfaces (aluminium and plastic) at different low temperature (-5 ^{0}C,-1 ^{0}C, 0 ^{0}C, 1 ^{0}C, 5 ^{0}C). 80 samples were taken, out of which 16 samples (8 for aluminium, 8 for plastic) were taken for each different temperature which was developed with both physical and chemical method for the development of latent print. The method used includes Black powder, Red and Green magnetic fluorescence powder, Iodine fuming method, Ninhydrin method, Cyanoacyrlate method, Silver nitrate method and Small particle reagent method. Despite of the different low temperature, the result obtained for development of fingerprint is same for all temperature and no variable result is shown for different temperatures. The best methods was given by Iodine fuming, Cyanoacyrlate and SPR for aluminum and for plastic the best result was given by black powder and and SPR.

Keywords: Latent fingerprint, visualisation, non porous surfaces, low temperatures

1. Introduction
Fingerprint evidence found at a crime scene may be described as visible, plastic (impression) or latent. Latent fingerprints are the most commonly encountered type at crime scenes and are not readily visible. Visualisation techniques are a common place tool employed to enhance such fingerprints, enabling them to be recorded and identified. A wide array of chemical, physical techniques is used including ninhydrin, cyanoacrylate (superglue) fuming and powdering etc. [4] Many methods are used to determine latent fingerprints on non porous surface such as Small particle reagent method composition develops clear sharp and detailed fingerprint on a large number of non porous items. The fluorescent nature of the reagent helps enhance weak, fragmented and chance fingerprint that are often found at the crime scenes [8]. Developing fingerprint at different low temperature is a challenging one. Usually these type of developing fingerprints are required at cold areas where most of the years are covered by snow, in which mass number of people are being covered by avalanche and are needed for individualization. Sometimes it is also important in cases where criminals often hide their weapons inside the ice or snow, and these evidences or weapons may often contain the fingerprint of the victim or the culprit. As for this we need to develop fingerprint for the identification of the culprit or the victim for further investigation The process of identification is based on the fact that two fingerprint impressions can never be the same; even two impressions recorded immediately after each other from the same hand may be slightly different. If the basic patterns are different, then the impressions are undoubtedly of different individuals. This research has been carried out to find out whether latent fingerprint can be develop after the samples were kept at low temperature and also to find out which method will give the best result on non porous surfaces at low temperature. In the present study various available methods for developing fingerprint were used to assimilate the outcome visualization of the latent fingerprint on non porous surface at low temperature.

2. Methodology

2.1 Collection of the sample

80 Samples of fingerprints from volunteers were taken by rubbing their fingers on hair or forehead to take the oil and by slightly pressing their fingers onto a clean surfaces of both aluminium and plastic surfaces. Both aluminium and plastic sheets were cut into small pieces 3 ×7 cm approximately. Then, the fingerprints were taken on the clean surfaces of aluminium and plastic sheets. Out of 80 samples, a set of 16 samples (8 samples on aluminum, 8 samples on plastic) were taken for each different temperatures respectively i.e – 5 ^{0}C, -1 ^{0}C, 0 ^{0}C, 1 ^{0}C, 5 ^{0}C. The methods that were carried out include black powder, red and green magnetic fluorescence powder for physical method and for chemical method iodine fuming method, ninhydrin method, cyanoacyrlate method, silver nitrate method and Small particle reagent This work was carried out with the objective to find out the development of latent fingerprint print at low temperature and to find out which method gives the best result of latent fingerprint at low temperature on non porous surface

2.2 Procedure for the development of fingerprints.

2.2.1 Black powder method

Black powder was carefully applied to the surface with a light brushing action. The excess powder was removed with a gentle, smooth motion until the clear fingerprint has been developed. After it was developed, photograph was taken and the photograph should contain all necessary information.

2.2.2. Fluorescent magnetic powder method

Green and red fluorescence magnetic fluorescence powders were applied carefully on the surfaces using magnetic wand and the developed fingerprint was photographed.

22.3. Iodine fuming method

The Iodine fuming chamber was set up and a glass of water was kept inside the chamber. The Iodine crystal was put in porcelain and the porcelain was kept in the heater inside the chamber. The samples were kept suspended from stiff wire on the top of the chamber, with the print side toward the interior of the chamber. Then, the switch of the heater is on and the iodine crystal is allowed to heat and fumed inside the chamber with violet vapor. The fuming is allowed to continue till the ridges are evident in the developing print, the samples are then quickly removed and photograph since the iodine fuming stain are temporary.

2.2.4 Ninhydrin method

1gm of ninhydrin was dissolved in a100 ml of acetone and the solution was stirred until all the ninhydrin was dissolved.. The ninhydrin solution was put in the atomizer and it was sprayed in the samples. Samples were allowed to dry and were heated in the fume hood for few minutes.

2.2.5 Cyanoacyrlate method (Superglue fuming method)

A glass of water kept in the fuming chamber to increase the moisture level in the chamber. Few drops of superglue were put in porcelain and the porcelain was kept in the heater inside the chamber. The samples were kept suspended from stiff wire on the top of the chamber, with the print side toward the interior of the chamber The heater was switch on and the glue was allowed to fume inside the closed chamber.

2.2.6. Silver nitrate method

2gm Silver nitrate was dissolved in 100 ml Methanol to prepare the solution. Then, the solution was poured in a beaker. The samples were dipped in the solution for 1-2 minutes The samples were dried before exposing to the bright sunlight After exposing the sample to sunlight for few minutes, the prints developed as dark brown.

2.2.7 Small particle reagent

7.5 g of molybdenum disulphide+ 2-3 drops of detergent in 75ml of distilled water were used to prepared the solution. The samples were dipped into the solution in the beaker for 1 minute. After the sample was taken out it was slowly washed under the tap water The sample was then allowed to dry and a black color fingerprint was developed

3. Results

After keeping the samples at different temperature for 10 days it was treated with different methods and the results obtained are summarized in Table 1 and Table 2.

Table 1: Shows the results of development of latent fingerprint at different low temperatures after 10 days on Aluminium surface

Methods used	-5 ^{0}C	-1 ^{0}C	0 ^{0}C	1 ^{0}C	5 ^{0}C
Black Powder	PF	PF	PF	PF	PF
Red Magnetic Fluorescence Powder	PF	PF	PF	PF	PF
Red Magnetic Fluorescence Powder	PF	PF	PF	PF	PF
Iodine Fuming Method	CF	CF	CF	CF	CF
Ninhydrin Method	NF	NF	NF	NF	NF
Cyanoacyrlate Fuming	CF	CF	CF	CF	CF
Silver Nitrate Method	CF	CF	CF	CF	CF
Small Particle Reagent	CF	CF	CF	CF	CF

PF=Poor Fingerprint developed.
NF= No Fingerprint developed.
CF= Clear Fingerprint developed.

Table no.1 showed the results of the sample for aluminum surface kept at different low temperatures after 10 days. Samples treated with Black powder gave poor result, the fingerprint was developed but the ridges could not be seen. The visibility was poor with no ridges found. Sample developed by Red fluorescence magnetic showed poor result on being observed under UV light, no clear ridges was seen. Samples treated with Green fluorescence powder also gave same result as that of the red magnetic fluorescence. Samples carried out by Iodine fuming method, gave good result of the prints but the prints faded away within a second leaving a brown color print so quick photograph of the sample was taken.. Ninhydrin method gave no result of the fingerprint. Samples treated with Cyanoacyrlate showed a good clear fingerprint, the ridges was also clearly visible. Silver Nitrate also gave good andclear visibility of the latent fingerprint after the sample was exposed to sunlight. SPR was also gives a clear visualization of the latent fingerprint

Table 2: Results of development of latent print at different low temperatures after 10 days on Plastic surface

Methods used	-5 ^{0}C	-1 ^{0}C	0 ^{0}C	1 ^{0}C	-5 ^{0}C
Black Powder	CF	CF	CF	CF	CF
Red Magnetic Fluorescence Powder	NF	NF	NF	NF	NF
Red Magnetic Fluorescence Powder	NF	NF	NF	NF	NF
Iodine Fuming Method	PF	PF	PF	PF	PF
Ninhydrin Method	NF	NF	NF	NF	NF
Cyanoacyrlate Fuming	NF	NF	NF	NF	NF
Silver Nitrate Method	PF	PF	PF	PF	PF
Small Particle Reagent	CF	CF	CF	CF	CF

PF= Poor Fingerprint developed.
NF= No Fingerprint developed.
CF= Clear Fingerprint developed.

Table no. 2 showed results on plastic surfaces at different temperatures after keeping for 10 days. Samples on being treated with Black powder gave a clear visibility of the latent print. The print developed on plastic by Black powder was better than that of aluminum surface. Samples showed no result when treated with Red magnetic fluorescence and Green magnetic fluorescence powder. Iodine fuming on samples showed a brown color print but the visibility and the ridges of the prints was not seen. Ninhydrin mehtod and cyanoacyrlate method when applied on samples respectively gives negative results, no print was developed. Ninhydrin usually show good result on porous surfaces such as paper and Cyanoacyrlate method gave a whitish color print so because of the contrast of the background the prints was not developed. Silver nitrate on samples showed clear fingerprint on plastic surfaces but the prints developed were not completed, parts of fingerprint were missing. SPR though showed a clear black light color latent fingerprint on the samples, clear visibility of the ridges was seen only under light and hand lens.

Fig 1: Iodine fuming method showing the latent fingerprint on aluminium surface at 5 ^{0}C.

Fig 2: Cyanoacyrlate method showing the latent fingerprint on aluminium surface at -5 ^{0}C

Fig 3: Silver Nitrate method showing the latent fingerprint on aluminium surface at 0 ^{0}C

Fig 4: Small Particle Reagent showing the latent fingerprint on aluminium surface at -1 ^{0}C

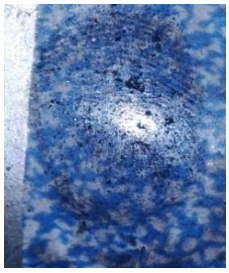

Fig 5: Black powder method showing the latent fingerprint on plastic surface at 5 ^{0}C

Fig 6: Small Particle Reagent showing the latent fingerprint on plastic surface at -5 ^{0}C

By comparing the results of latent fingerprint developed on both aluminium and plastic surface, it was found out that Aluminium surface gave better result than plastic surface. Iodine fuming, Cyanoacyrlate method, Silver nitrate method and Small Particle Reagent gave a better result on aluminium as compared to plastic. Latent fingerprint was shown clearly only by Black powder method and Small Particle Reagent on plastic surfaces.

Discussion

Samples when treated by the method Cyanoacyrlate on Aluminium gave a good, clear result of the prints and the prints develop stays for days and weeks. This was also reported by Lewis (2001) who stated "that the processes involved in the development of latent prints using the cyanoarcylate fuming method gives the rock hard impression i.e. impossible to remove" [6].

After the samples were kept continuously for 10 days under deep freezer at low temperature at moist condition Cyanoacyrlate still manage to reveal good result on aluminum surface on samples. This result was relevant to the research done by Trapecar (2012) in his research, study was done to investigate whether certain fingerprint methods can recover latent fingerprints on glass and metal surfaces submerged in water [10]. The surfaces to be examined were exposed to the influences of stagnant water during different time intervals. The best results were achieved with cyanoacrylate. In this present research also Cyanacyrlate method gives a good visualization with good and clear prints.

After the examination samples gives good result for SPR method for development of latent fingerprint on both Aluminium and Plastic non porous surfaces. This was also explained by Jasuja et *al.* (2008) who reported that Small particle Reagent (SPR) is a widely used method to develop latent fingerprints on non-porous and wet surfaces [5]. Sodhi *et al.* (2012) also suggested a novel fluorescent small particle reagent (SPR) based on Zinc carbonate hydroxide monohydra. The composition develops clear sharp and detailed fingerprint on a large number of non porous items.[8] Thus the work of Jasuja *et al.* (2008) and Sodhi *et al.* (2012) on non porous surface by SPR relates the same result with the samples developed by SPR on non porous surface at low temperatures [5, 8].

80 samples were examined for the development of latent fingerprint in which 30 samples gave positive result for different low temperature. This method were achieved by the Iodine fuming method, Cyanoacyrlate method, silver nitrate method, SPR method for aluminium surfaces and for plastic surfaces black powder method and SPR method. The samples obtained from Cyanoacyrlate method are of great advantage for developing fingerprint at low temperature since it gave very clear results and gives good result even on old prints and the print developed are permanent. The fingerprint samples achieved by Iodine fuming also gave good result on aluminium surface but the prints developed fades within a few second so it was difficult to fixed permanently, so as a result quick photographed was taken. Silver nitrate has the advantage of being inexpensive and use materials that are relatively easy to acquire and it gave good result on metallic surfaces. Developing fingerprint on samples by silver nitrate was simple and also the fingerprint developed was clear and has good visibility. SPR method gave result on both plastic and aluminium at low temperature. The prints obtained was clear and the ridges were clearly seen.

Out of 80 samples, poor result were shown by 25 samples, in these the samples showed developed print but the visibility of the not print was not clear .Powder method showed poor results on both aluminium and plastic surface since the prints were old and powder method usually shows positive only on fresh print. Iodine fuming and silver nitrate method showed poor results on plastic surface, the prints were poorly developed. Silver nitrate gave clear prints but the prints were only half developed on all the plastic samples. The remaining 25 samples showed no results. Cyanocayrlate showed no result on plastic surface because of the contrast of the background but this can be enhanced by using colour powder. Samples treated by Ninhydrin methods showed no result for both aluminium and plastic surfaces.

Conclusion

Despite of the different low temperature the results for fingerprint obtained was same for all temperature and no variable result was shown for different temperatures. The different temperatures did not vary the results obtained. According to the research, Aluminum surface gave better result as compared to plastic surface at low temperatures Thus, it can be concluded that fingerprints can be developed even when the surface are exposed to low temperature and the best methods for the development of the latent fingerprint were Iodine fuming method, Cyanoacyrlate method, Silver nitrate method, SPR method for aluminum surfaces and Black powder method and SPR method for plastic surface.

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