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Development of Latent Fingerprints on Latex Gloves

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Abstract

Fingerprint evidences are perhaps the most common type of physical evidences found at crime scene. Their development and identification helps to prove criminal physical presence at scene of crime. It is extremely difficult for a criminal to commit the crime without having behind his fingerprint. The latent fingerprints are the most pronounced category of fingerprints which serves as an evidence. This review paper focuses upon conventional and advanced analytical techniques used in the detection and comparison of latent fingerprints for easier decipherment. Now a day, criminals nowadays use latex gloves to hide their identity in order to reduce their chances of being sinful. Although it work act as a protective covering but when removed, they are typically peeled off preserving the fingerprints evidences on them without smearing. Thus, those prints were developed by using various physical and chemical methods and then photographed for investigation and the comparison purpose. Hence, these gloves at crime scene can serve as a direct evidence to catch the culprit. There are several non-destructive physical methods which are used for the development of latent fingerprints which includes the use of a variety of powders such as black powder (on dark surfaces), white powder(on light surfaces), fluorescent powder (Multicolored surfaces) etc. whereas the destructive method includes the chemical treatment by cyanoacrylate, small particle reagent, ninhydrin etc.Keywords: Charred/Burnt Documents; Decipherment; Ammonia Solution; Forensic Document Examination.

Keywords: Latex gloves; Sweat; Latent fingerprints; Powder.

Introduction

Fingerprints are an impression of ridge which appears on the anterior surface of fingers on the distal, middle and the proximal phalanges and on the distal and proximal of thumb. It is the reproduction of friction skin and soul of apparently these ridges are designed to provide former grasp and resistance. Each skin ridges are peculated with single row of pores that are opening for ducts leading sweat glands. Through these pores that perspiration is discharge and deposited on surface of skin. Fingerprints generally start to develop into human foetus in the embryonic stage about third to fourth month and are completed by seventh month.[6]

According to nature of fingerprints they are split into three categories:

Patent fingerprints- Patent fingerprints are those that are clearly spotted without using any techniques. They are also known as the visible prints.[1]

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Plastic fingerprints- Plastic prints are those that have been made in soft material or tissues by pressing down with the fingers or hand. E.g.: fingerprint on clay.[1]

Latent fingerprints-Latent prints are the particular fingerprints which are not visible to the naked eye but they do exist. They are created due to the tiny pores present in the fingers for the expulsion of sweat and these which pick up salts, oils.[1] According to the report of the expert working group on human factors in latent print analyzes, fingerprints found at crime scenes commonly encountered usually are latent prints. The prints are the exact replica of the friction ridges (minutiae) which contacted the surface on which print was found.[4] Therefore, special care must always be taken when handling these types of fingerprints.[3,4]

Composition of Sweat:

Sweat gland or sudoriferous gland is an epithelial skin appendage, which help in to secrete sweat. Sweat is a clear, salty liquid secreted from the skin by the sweat gland. Sweat glands are small tubular glands situated within and under the skin. The average person has 2.6 million sweat glands in their skin. Sweat glands are distributed over the entire body except for the lips, nipples and external genital organs. There are 3 types of sweat gland:

1. Eccrine gland
2. Apocrine gland
3. Apoeccrine gland

Eccrine gland is the most numerous types that are found all over the body, particularly on the palms of the hands, sole of the feet, forehead and armpits. Apocrine glands are mostly confined to the axillae and the anal-genital area. This type is typically found at the end in hair follicles rather than pores.

Composition of the primary secretion is very similar to that of plasma except that it does not contain plasma protein:

- S.G: 1.002-1.005
- Ph : 4.5 – 7.5
- Na+ : 30 – 70 mg (less)
- K+ : 0 – 5 mg (same)
- Cl- : 30 – 70 mg (less)
- Urea : 4 – 6 time higher than in plasma
- Lactic acid : higher than in plasma specially in athletes
- Glucose in a very small amount

Relative to the extracellular and plasma fluid, the concentration of Na+ ions is much lower in sweat.[1]

Many other trace elements are also excreted in sweat i.e. zinc (0.4 milligrams/liter), copper (0.3–0.8 mg/l), iron (1 mg/l), chromium (0.1 mg/l), nickel (0.05 mg/l), and lead (0.05 mg/l).[5,6] In humans, sweat is hypo osmotic relative to plasma[8] (i.e. less concentrated).[5,7,8,9]

There are some factors which also affecting in the composition of sweat:

Low sweat rate: In this the primary fluid passes through the duct very slowly. Na+ and Cl- are reabsorbed which reduces the osmotic pressure of the fluid leading to water reabsorption and concentrating most of the other constituents. Thus, at low sweating rates, the sweat produced in low in volume and is more concentrated in constituents such as urea, lactic and K+ and less concentrated in Na+ and Cl-

High sweat rate: When the sweat glands are strongly stimulated, large amount of primary secretion are formed which will flow too rapidly through the sweat duct reducing the chance Na+ and Cl- reabsorption, thus water reabsorption is also reduced leading eventually to the production of a large volume and less concentrated sweat.

The professional criminals are getting hi-tech with the advancement in the technology and increasing awareness related to the different types of evidence recovered at crime scene followed by the means of destroying them or using them to create a fake crime scene or misguide the direction of investigator. Many perpetrators or criminals who are already in crime may have or they have the knowledge about the fingerprints which they can unintentionally leave on crime scene which can be a major evidence to set them behind the bars. Therefore, the use of latex gloves at crime scene came into existence but after committing the crime they may leave or throw their gloves on primary or secondary crime scene or a piece of glove may stuck somewhere, which may be helpful for a investigator in solving the mystery as fingerprints are unique and no two person can have the same fingerprint and the fingerprints can be recovered/ developed from them.

Developing suitable ridge detail on the interior side of latex gloves was infrequently and identifying ridge detail was even more unusual.[5]

Composition And Prepration Of Latex Gloves

Latex is a colloidal suspension of very small polymer particles in water and is used to make rubber. There are mainly 2 types of latex: natural and synthetic. The gloves made up of natural latex are mainly used in medical and surgical items, household and industrial gloves, boots and balloons. Natural latex is produced from Hevea brasilienesis rubber tree and most synthetic rubber is created from two materials, styrene and butadiene.

Polychloroprene and carboxylated nitrile latexes are mostly used for manufacturing gloves by a coagulant dipping process. The synthetic latex is produced by a process known as emulsion polymerization, starting from monomers and various ingredients whose chemical nature is described. This composition is complex and varied.

The *synthetic latexes* are produced by a process known as emulsion polymerization, starting from monomers and various ingredients whose chemical nature is described in this article. Their composition is complex and varied. The formulations used in emulsion polymerization evolve regularly with the demands of the applications and with the progress in the techniques of polymerization.[9] Latex disposable gloves offer excellent protection and performance in a variety of applications and across a broad range of industries. Latex disposable gloves are a popular choice in both the Industrial and Medical industries and are widely used in applications in medical and dental, child care and senior care, food service and food processing, janitorial and sanitation, automotive and manufacturing industries.[12]

The most profound type of gloves manufactured is 1, 2, 3, by coagulated dipping process and emulsion polymerization respectively. The composition is varied and complex.

History of Latent Fingerprints

19th century techniques

- IODINE FUMING: In 1863 Paul jean Coulier uses a mixture of sand and iodine to detect document alterations and notices latent print developing formed by Pierre Aubert in 1876uses iodine to detect latent prints, used mostly in solids form during 19th century and most of the 20th centuries.[2]
- SILVER NITRATE: In 1873 Italian scientist Camillio Golgi used mixture of potassium dichromate and silver nitrate to stain tissue samples. In 1877 when Pierre Aubert uses silver nitrate to detect latent prints, his reagent concentration varied between 1-10% and in 1981 Kerr et al. evaluate Perchlorate and chromate silver salt.[2]
- POWDERS: Nearly all powders used in the 19th century were very toxic. Colorants included lampblack, antimony, and mercuric oxide. Adhesive materials included sulphide, lead. Silica gel. Fine particulate dust was both an acute and chronic health hazard. Brushes were animal hair (e.g.- feather, squirrel, camel).[2]

20th century techniques- 21st century

Once the development process of latent prints started it began flourishing. Various techniques started in developmental procedure and named luminal, Ninhydrin, Amido black, vacuum metal deposition, Cyanoacrylate fuming, DFO.[2] Many perpetrators or criminals who are already in crime may have or they have the knowledge about the fingerprints which they can unintentionally leave on crime scene which can be a major evidence to set them behind the bars. The use of latex gloves at crime scene came into existence but after committing the crime they may leave or throw their gloves on primary or secondary crime scene or a piece of glove may stuck somewhere, which may be helpful for a investigator in solving the mystery as fingerprints are unique and no two person can have the same fingerprint. Developing suitable ridge detail on the interior side of latex gloves is infrequently and identifying ridge detail is even more unusual but Harris county sheriff's department responded to a crime scene in April 27, 1999 where the lady was killed and from the crime scene they recovered the piece of latex glove.[5]

Materials and Methodology

Sample Collection

A rating system was developed using test prints which was then used to rate any prints that were developed during research.

Participants wore size large powder free latex exam gloves for 15 minutes, with a period of at least 15 minutes before wearing the next pair of gloves

While on the hands, the tips of the fingers were outlined surrounding the primary part of the fingerprint region.

Gloves were removed by peeling off from the cuff at a moderate/slow and relaxed speed and a circle was drawn in the middle of the palm region

on the now inverted glove where a print was then laid down.

Gloves were separated into 8 different age groups: 1 day, 3 days, 1 week, 2 weeks, 3 weeks, 4 weeks, 5 weeks and 6 weeks.

Remember that when removed, these gloves are often turned inside-out. Careful examination, using an oblique light source, can often reveal which side is the interior of the glove. For purpose of development and photography, the gloves should be inside out so the surface in contact with the palm and fingers is on the outside. Attention should be paid to the entire surface of the glove: the palm, the back, and both the inside and outside of the cuff. Development of latent fingerprints on latex gloves can be achieved using standard, non porous development techniques; however some techniques are more effective than others.[6] The methods adopted for the development procedure are-

Fig.1: (1.1) Patent print, (1.2) Plastic print, (1.3) Latent print

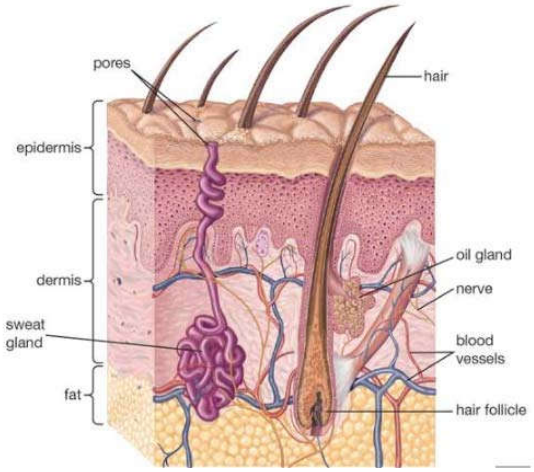


Fig. 2: Sweat gland

Results and Discussion

Physical Methods

Traditional and Magnetic Powders

Fingerprint powders attach to sweat and oil residues left on the inside of the glove. Some success was achieved but when latent prints were fresh. Using the magnetic brush to draw the powder across the surface of the glove brought out clearer, more readily identifiable prints.[6] White powder latex glove shows some white fingerprint ridges but no classification on the interior portion can be done.

Fig. 3: Latex gloves

Flourscent Powders

Fingerprint powders that fluoresce when illuminated by alternate light source or a laser are very effective on their own and also when combined with cyanoacrylatefuming. But they require special equipment they can visualize very faint latent fingerprints using small amount and also the sharpness and vivid contrast is achieved photographing the evidence.[6] Ultra blue 2000 florescent magnetic powder detect excellent print from glove.[7]

Fig. 4: Magnetic powder on a piece of latex gloves

Physical Method Observations:

Chemical Methods

Ninhydrin Method

Ninhydrin somehow revealed satisfying results

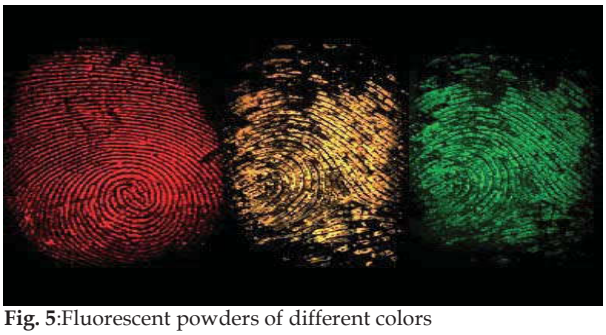


Fig. 5:Fluorescent powders of different colors

Fig. 6: Latex gloves treated with ninydrin method of chemical treatment

Fig. 7: Latex gloves treated with Cyanoacrylate method.

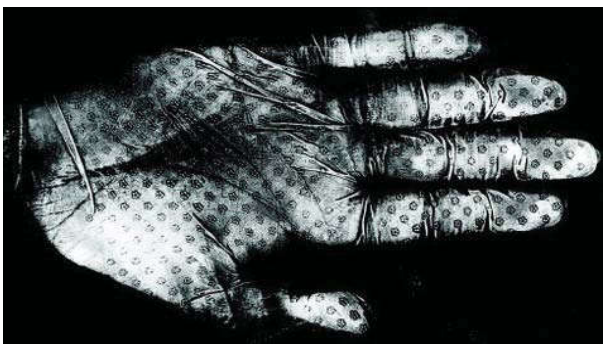


Fig 8: Latex gloves treated with iodine fuming method

which are visible but on fresh prints, time may be a challenge to this method.[7] Ninhydrin produced no identifiable prints and consistently produced less ridge detail throughout the entire experiment. .Ninhydrin also produced significant background staining of the glove which could have affected the visibility of results.[9]

Cyanoacrylate Fuming

Excellent results can be achieved using cyanoacrylatefuming.[7] The latex gloves are placed in a fuming chamber with the chemical and a buildup of cyanoacrylate esters occurs. The care must be taken to avoid overdevelopment. The results are visible, white fingerprints. These visible fingerprints can be further treated with fluorescent dyes[6] but according to Cyanoacrylate builds up a residue on the latex glove and does not develop any print. The residue adds to the disturbance caused by the powder that can be present on the glove.[8]

Small Particle Reagent

Small particle reagent method is used to develop latent fingerprint on non-porous surfaces including glass, tiles, metals, plastic, polished wood adhesive sides of tape and sometimes may be used on wet surfaces. This method is based upon the adherence of fine particles of the SPR solution to fatty acids/oily components present in sweat. But experimenting on latex gloves showed poor result overall.[6]

Iodine Fuming

It is the most useful on porous surfaces such as papers cardboard, leather; plaster wall, raw wood etc. Iodine crystals are taken in a glass chamber and heated; the suspect surface containing latent print gloves are also kept inside the chamber. Then the iodine vapors cone in contact with the latent prints. The oily substrate of the; print physically absorbs the iodine fumes and a brownish ting is developed. Since iodine is volatile at room temperature, it evaporates and the print disappears. But on latex

Table 1: Physical And Chemical Methods

Series Number	Physical Methods (Powder and brush method)	Chemical Methods (Chemical Treatment)
1	Black Powder	Ninhydrin Method
2	White Powder	Iodine Fuming
3	Fluorescent Powder	Silver Nitrate
4	Magnetic Powder	Small Particle Reagent
5	Grey Powder	Cyanoacrylate Fuming

Table 2: Rating Scale Cyanoacrylate, Ninhydrin, Fluorescent Powder From 0-3 Level.

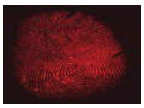
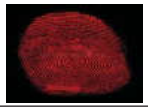
Level	Discription	Cyanoacrylate	Ninhydrin	Fluorescent Powder
0	No finger mark or print present, or a mark which lacks all levels of detail in sufficient quality.			
1	A mark which lacks third level detail and which has second level detail present but not sufficient to make an ID.			
2	A print with sufficient second level detail to make an ID, but lacking in either first or third level detail.			
3	A print with good clarity in first , second , and third level detail allowing for an ID			

Table 3:

S. No.	Physical Method	Observations (development of fingerprints on latex gloves)
1	Traditional Powder	**Black powder:** some prints but on fresh prints. **White powder:** only on fresh print.
2	Magnetic Powder	Shows good result on fresh print and showed some ridges on old prints.
3	Fluorescent Powder	Ultra blue 2000 show effectively good result under alternating light source.

Table 4: Chemical Method Observation:

S. No.	Chemical Method	Observations (development of fingerprints on latex gloves)
1	Ninhydrin	Showed satisfying result with fresh prints but stained the gloves.
2	Cyanoacrylate	Excellent result obtained further can be treated with fluorescent dyes.
3	Small Particle Reagent	Showed poor result.
4	Iodine Fuming	Stained the whole glove.

gloves it did not revealed any print but did discolor the glove and also it spoils the prints on gloves. As chemical methods are destructive techniques.[8]

Conclusion

Cyanoacrylate with magnetic powder and the gel lifter methods seemed equally effective at developing latent prints on latex gloves. However, the gel lifters captured more prints with third level detail which would make it more ideal. Ninhydrin proved to be quite unsuccessful at developing latent prints and is not recommended for use on latex gloves. Further research was done to optimize other methods for use with latex gloves such as comparing powders, dyes and alternative light sources after cyanoacrylate fuming, or by focusing on the different degrees of texture to see if any methods work well on gloves which are more textured Time can be an important factor; some of the clearest prints can be developed using only fluorescent powder shortly after the gloves are removed. The nature of these gloves, and of their removal, makes them an excellent source of clear, identifiable fingerprints. Special care must be taken in photographing this evidence, as the irregular shape can mean unusable comparison photographs for the latent print examiner. The biggest factor in the quality of results obtained was the fit of the glove.[9]

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