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1. Learning Outcomes

After studying this module, you shall be able to know

- The significance of the iodine method, a vapor phase technique of fingerprint detection.
- The methodology of iodine fuming.
- The mechanism of fingerprints' detection by iodine technique.
- The role of fixing reagents to prevent the fading out of iodine-developed prints.
- A critical assessment of iodine method for developing latent fingerprints.

2. Introduction

The iodine fuming technique for visualizing latent fingermarks has been used for almost a century. Iodine is a crystalline solid, which upon heating sublimes into violet vapors. The vapors are absorbed by the sweat deposition of the latent imprint thereby revealing the ridge pattern.

Initially, it was believed that iodine can be added chemically and reversibly, to double bonds of the unsaturated fatty acids present in the fingerprint residue. However, it was later suggested that the mechanism of the reaction involved physical absorption of iodine on the fatty acid content. The iodine-fatty acid interaction imparts a yellowish brown color to the ridge pattern. Iodine fuming is a simple procedure of developing latent fingerprints. A sample fingerprint developed by iodine fuming method is shown in Fig. 1.

Fig. 1 A sample fingerprint developed by iodine fuming method

3. Methodology

Latent fingerprints may be developed by iodine fuming technique by one of the following experimental procedures:

a. Fuming Gun Method

An iodine-fuming gun is made of either glass or plastic. The butt-end of the gun contains a dehydrating agent, usually calcium chloride. There is also a mouthpiece for blowing air at this end. An iodine-fuming gun is displayed in Fig. 2.

Fig. 2 An iodine fuming gun

Near the nozzle-end of the gun about 0.5 g iodine crystals are placed. Air is blown though the mouthpiece and the gun nozzle is moved above the surface impinged with the latent prints. The optimum distance between the gun and the surface is 2 cm.

As soon as the latent fingerprints begin to appear, the iodine fumes are concentrated over the imprinted area. The prints so developed are photographed immediately.

b. Fuming Cabinet Method

A china dish containing about 1g iodine crystals is placed in a fuming cabinet. The object bearing the latent prints is suspended from the roof of the cabinet. Iodine crystals are gently heated to about 50° C using a heating block. After a few minutes latent fingerprints begin to appear. The object is exposed to the fumes till maximum contrast has been achieved between the prints and the background. The developed fingerprints are immediately photographed. An iodine fuming cabinet is shown in Fig. 3.

Fig. 3 An iodine fuming cabinet

c. Powder Dusting Method

Iodine crystals are pulverized into a fine powder. The power is spread out over the surface bearing the latent fingerprints by a camel hair brush (Fig. 4).

Fig. 4 Developing latent fingerprints by iodine powder

The excess powder is blown off. This method does not require any equipment and is, therefore, both simple and cost-effective. However, it exposes the user to the toxic fumes of iodine. As a result, this method is now obsolete.

4. Post-treatment of Developed Fingerprints

Fingerprints developed by iodine are not permanent in nature. These tend to fade out on standing. In presence of air the fading of prints is accelerated. For this reason the iodine developed prints have to be photographed immediately. Nevertheless, it is possible to fix the prints by using iodine in conjunction with other chemical reagents.

Iodine is known to react with starch giving a stable, deep blue complex. Thus, post-treatment of iodine-developed fingerprints with starch solution gives long-lasting blue impressions. The fading problem may also be avoided by pressing a silver foil onto the iodine-developed fingermarks. The interaction of iodine, absorbed on the fingerprint residue, with silver produces yellow colored silver iodide. The latter, on exposure to light decomposes into finely divided silver, revealing the ridge pattern as a stable, black deposition.

Iodine exposed fingerprints by may be fixed post-treatment with a solution of N,N,N',N'-tetramethyl-4,4'-diaminodiphenylmethane (Fig. 5) in 1,2,2-tricholorotrifluoromethane.

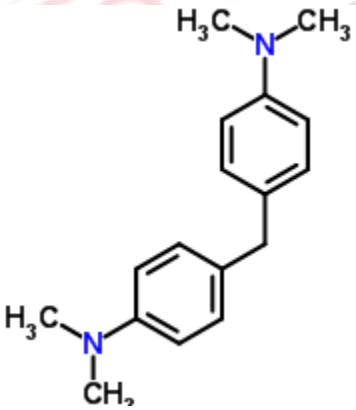

Fig. 5 Structure of N,N,N',N'-tetramethyl-4,4'-diaminodiphenylmethane

The color of the prints change from brown to green-blue. Fig. 6 shows an iodine developed fingerprint, half of which was treated with N,N,N',N'-tetramethyl-4,4'-diaminodiphenylmethane reagent. The treated part is blue in color, while the untreated part is brown.

Fig, 6 An iodine-developed fingerprint, the right half of which was post-treated

Nevertheless, the quality and clarity of post-treated fingerprints are not affected. Iodine-developed fingerprints on thermal paper may also be fixed by spraying with a hexane solution N,N,N',N'-tetramethyl-4,4'-diaminothiobenzophenone (Fig. 7) or phenothiazine (Fig. 8). With former, the color of developed prints changes to blue, while with latter, reddish impressions are obtained.

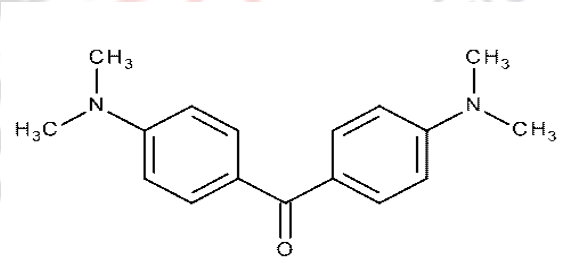

Fig. 7 Structure of N,N,N',N'-tetramethyl-4,4'-diaminothiobenzophenone

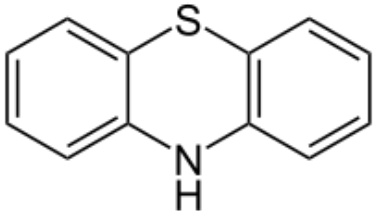

Fig. 8 Structure of phenothiazine

The most common reagent for fixing iodine-developed prints is 7,8-benzoflavone, the structure of which is shown in Fig. 9. A mixture of 2 ml of 10% 7,8-benzoflavone solution in dichloromethane and 100 ml of 0.1% iodine solution in cyclohexane is used for this purpose.

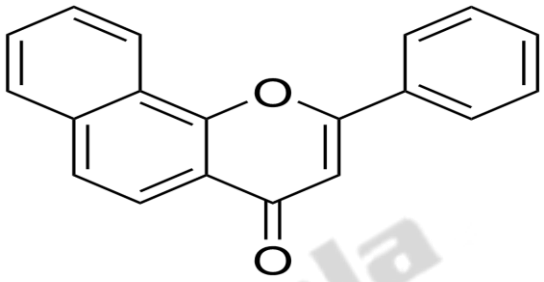

Fig. 9 Structure of 7,8-benzoflavone

Iodine in combination with 7,8-benzoflavone reagent may be used for developing old latent fingerprints on porous surface, such as bond paper, newsprints and facial tissue paper. The composition is non-destructive and the documents remain unaltered.

Sublimable or low boiling organic reagents may also be made to interact with and fix iodine absorbed on the latent fingerprints used in vapor state. For example, iodine interacts with α-naphthyl amine to form a red colored charge-transfer complex. Although free iodine does not possess a natural dipole moment, yet in concert with an aromatic system, it acquires an induced dipole. The combination of electron-rich aromatic compounds and dipolar iodine results in charge-transfer complexation (Fig. 10).

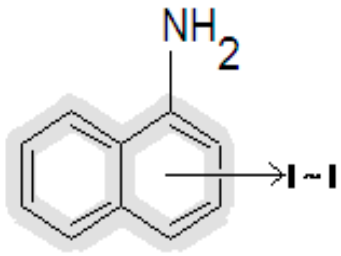

Fig. 10 Charge-transfer complex between iodine and α-naphthyl amine

The charge transfer complex is non-volatile in nature and hence it does not evaporate from the frictional ridges. As a result, the developed prints do not fade out with passage of time. Representative fingerprints developed on different items are depicted in Fig. 11.

Fig. 11 A sample fingerprints developed on Photostat paper by iodine - α-naphthyl amine combination

5. Assessment of Iodine Method

The iodine method for detecting latent fingerprints has the following advantages:

a. The procedure is very simple to use and requires only a meager degree of skill and experience.

b. With conventional chemical developing reagents, the latent fingerprints, on the surface in question, are first visually searched and then the relevant spray or powder formulation is applied. However, while using the iodine method, there is no need to first scan the surface. Iodine vapors on their own get preferentially absorbed on the fingerprint residue, revealing the ridges.

c. A number of chemical fingerprint development methods, such as ninhydrin, cyanoacrylate and silver nitrate require instrumental detection techniques, such as laser and neutron activation analysis, and therefore cannot be used for on-the-scene investigations. The object bearing the latent fingermarks has to be carried to the fingerprint laboratory if any of these methods is desired to be used. However, iodine in conjunction with 7,8-benzoflavon, may be used for detection of fingerprints at the scene of crime.

d. Iodine fuming is a sensitive method for developing latent fingerprints on porous surface, such as paper and paper products. The other reliable method for porous surface is the ninhydrin technique. However, good results are obtained by ninhydrin only after the developed fingerprints are treated with metal salts, following by laser examination. No such costly equipment is required with iodine.

e. Iodine fuming develops both fresh and relatively old prints.

f. Iodine fuming is one of the techniques, which can develop fingerprints on human skin. The area of skin suspected to be impinged with latent print is treated with iodine vapors. Once the impression appears, these are pressed on to a silver plate. Exposure of the plate to light reveals permanent fingermarks.

g. If in a particular casework investigation, iodine method fails to detect fingerprints on crime scene evidence, other techniques like ninhydrin method may still be tried out.

Iodine method suffers from the following shortcomings:-

a. The iodine developed fingerprints fade out in a short time. Hence these have to be fixed using a suitable reagent. Yet, it is pertinent to state here that other fingerprint detecting techniques, such as powder dusting, ninhydrin spraying and cyanoacrylate fuming too give good results only after post-treatment operations.

b. Iodine is toxic and poses occupational hazards to the user. Nevertheless, by observing some simple safety precautions, this problem may be eliminated.

6. Summary

- Iodine method has traditionally been very popular for processing imprints on porous surfaces.
- The method relies on the physical absorption of iodine vapors on the fatty acid content of fingerprint residue.
- Several post-treatment options are available to enhance the stability of developed prints.
- In case prints fail to develop by iodine method, other methods of fingerprint detection may still be tried out. The reverse is not true.