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1. Learning Outcomes

After studying this module, you shall be able to know –

- The significance of the most widely used, powder technique of fingerprint detection.
- The mechanism of fingerprints' detection by powder compositions.
- The broad classification of powders used for detecting fingerprints.

2. Introduction

The powder technique for detecting latent fingerprints involves the application of a finely divided formulation to the fingermark impression, generally with a glass-fibre or a camel hair brush. The power gets mechanically adhered to the sweat residue defining the ridge pattern. The furrows which are devoid of the fingerprint residue do not adhere the power onto them. The final outcome is that the power formulation sticks to the ridges, but is easily blown off the furrows. Since the powder is normally colored, the ridge pattern becomes visible and the latent print is said to have developed.

3. Historical

The use of fingerprint powders dates back to the last decade of the 19th century. Sir Edward Richard Henry (1850-1931), who devised the finger-print classification formula, recommended the use of mercury-based and graphite-based powders.

The former formulation, called hydrargyrum cum creta, was composed of one part of mercury and two parts of chalk, by weight. The power was suitable for developing latent prints on non-absorbent surface such as glass and dark-painted or lacquered utilities. However, the formulation was withdrawn in 1967 because the mercury content could be a health hazard. Moreover, it was ineffective for developing prints on gold ornaments as mercury reacted with gold and marred its surface.

The graphite-based power was very useful for developing imprints on silver-painted objects. However, even this powder was withdrawn since it was messy to use, particularly if the examination was to be carried out in open and a high wind was blowing.

4. Mechanism of Technique

The application of finely divided material and the sub-sequent removal of the excess power by brushing, blowing or tapping has been the universal method of intensifying fingerprints on non-absorbent surfaces since the early days of fingerprint technology (Fig. 1). The technique relies on the mechanical adherence of fingerprint powder to the moisture and oily components of the skin ridge deposit.

Fig. 1 A of different hue and shades kit containing fingerprint powders

The adhesion of powder formulation to fingerprint residue is governed by the pressure deficit mechanism. If a powder particle is wetted only on its lower side by the sweat deposition then owing to the curvature of meniscus there will be a pressure deficit inside the droplet, causing the particulate to adhere. The electrostatic attraction between the sweat residue and the powder particles, resulting due to frictional charges, also play a role in adhesion, albeit a minor one.

The effectiveness with which the powder adheres to the ridges depends on the size and shape of the particles that compose the formulation. Small, fine particles adhere more easily than large, coarse ones.

Therefore, most formulations are composed either of very fine, rounded particles (about 1 µm in diameter) or of fine flake particles (about 10 µm in diameter). Of late nanoparticle size powder compositions have proved to be very effective in lifting fingerprints. A sample fingerprint developed with the aid of a nanoparticle-based composition incorporating crystal violet stain is depicted in Fig. 2.

Fig. 2 A sample fingerprint developed by nanoparticle-size composition based on crystal violet stain on a steel article

As the age of the fingerprint residue increases the moisture and only components tend to evaporate, leaving the deposition more viscous. The same phenomenon is observed in warm climates. Thus, aged prints in tropical climates are relatively difficult to develop by power technique. The drying rate, however, is not dependent on the relative humidity indicating that the sweat residue has low water content near the surface.

5. Application Procedures

Before the application of powder formulation, the surface should be searched visually for the fingerprint impression. This is usually done with the aid of an intense light source in concert with a magnifying glass (Fig. 3).

Fig. 3 Equipment for visual searching of possible latent impressions

The print should first be photographed using an appropriate filter. Next, the relevant power should be applied with in a circular motion by a fingerprint brush (Fig. 4).

Fig. 4 A fingerprint brush

Care should be taken to prevent the smudging of the imprint. The excess powder should then be removed by dusting the surface with a gentle tapping. The developed print should once again be photographed. Finally, it should be lifted with a tape and preserved for record Fig. 5).

Fig. 5 Lifting a developed fingerprint by a tape

Application of power to fingerprint by brushing is a well-established technique but has one disadvantage: contact of the brush with the fingerprint has an inevitable destructive effect so that a degree of caution is required by the fingerprint expert. It has been estimated that about 10% of latent fingerprints developed at crime scenes using convention powder dusting procedures, are difficult to identify. Powder may be applied without using a brush. An electrostatic depositor (Fig. 6), atomizer or aerosol spray may be used instead.

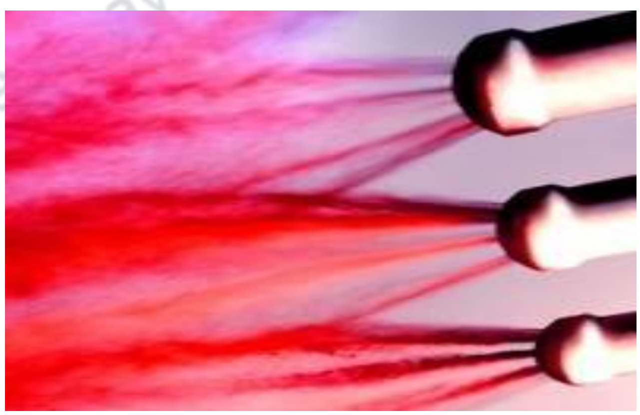

Fig. 6 Electrostatic depositor for spraying fingerprint powder

For electrostatic deposition, the power is placed on the surface of an electrode held about 2.5 cm above the surface impinged with the fingermark. A potential gradient of about 12 kV is maintained between the electrode and the surface. The powder on the electrode becomes charged to the polarity of the electrode and is accelerated towards the surface, where it is discharged and acquires the polarity of the surface. The excess power is attracted back to the electrode and is discharged there.

Magna-brushes (Fig. 7) and magna-powders (Fig. 8) may also be used to avoid the problem of smudging. Magna-powders are made by incorporating coarse, spherical iron particles in the conventional powders. The magnetic iron acts as a carrier for the non-magnetic formulation, forming a brush when the powder is picked up with a magnetized applicator. On brushing the imprint impression, only the fine particles of the formulation adhere to the fingerprint residue. Once the print has been developed, the excess powder can be detached from the applicator by withdrawing the magnetized steel rod.

Fig. 7 A magna-brush

Fig. 8 A sample magna-powder

To better the performance of magnetic applicators, the magna-powder may be replaced by magnetic flake particles. In such formulations, the coarse iron particles are replaced by magnetic flakes that are attracted to magnetic applicator. Unlike standard magna-powders, which contain only about 1% of fine particles that can adhere to the fingerprint residue, all the magnetic flakes lifted by the applicator are available for fingerprint development. The magnetic flakes are specifically useful for print development on rough or porous surface, such as painted walls, polythene and paper.

6. Regular Powders

Regular fingerprint powders consist of a resinous polymer for adhesion and a colorant for contrast. The adhesive gets adhered to the moisture and oily components of the sweat residue by the pressure deficit mechanism, while the colorant gets adsorbed on the adhesive. In this manner, the ridge pattern is visualized. The commonly used adhesives are starch, kaolin, rosin, and silica gel. The colorant may be an inorganic salt or an organic derivative.

Formulation containing ferric oxide and rosin, manganese dioxide and rosin, titanium and kaolin, lamp-back and fuller's earth are some of the common examples of inorganic-based fingerprint powders. The working performance of the composition may be improved by coating the power onto fine quartz or plastic particulates. A black powder containing iron oxide, quartz, kaolin and carbon soot is an example of coated dusting formulation.

Over the years, it became evident that commercial fingerprint powers containing inorganic salts of mercury, cadmium, titanium, lead, manganese, etc. pose an occupational hazard to the user. As a result, the organic-based formulations became more popular. These formulations generally contain an organic day as the colorant. For improved results fluorescent and laser-active dyes are used. Formulation containing fluorescein, eosin Y and rhodamine B are some of the common examples of organic based fingerprint powers. A sample fingerprint developed on glass by an eosin Y-based powder is shown in Fig. 9.

Fig. 9 A sample fingerprint developed on glass by eosin Y-based composition

7. Metallic Powders

Powder formulations containing meshed metals have been in use for a considerable time. Their advantage is that they longer shelf lives as compared to the organic-based powers. Their disadvantage is that the metallic components elicit toxic effects to the users.

Silver powder, containing aluminum flake and quartz powder; gold powder, containing bronze flake and powdered quartz; and gray powder, containing meshed aluminum and kaolin are some of the examples of metallic dusting compositions. Further, fine lead powder has been used for latent detection with X-ray electronography and autoelectronography.

A good number of powder formulations contain natural or synthetic organic derivatives that fluoresce or phosphoresce upon exposure to ultraviolet light or laser light. The advantage of such compositions is that they are useful for visualization of latent prints deposited on multi-colored surfaces that would present a contrast problem if developed with conventional powders. Moreover, these can be used for developing weak prints.

Their disadvantage is that these can be rarely used in field work. Fig. 10 shows the fluorescent characteristics of a developed print.

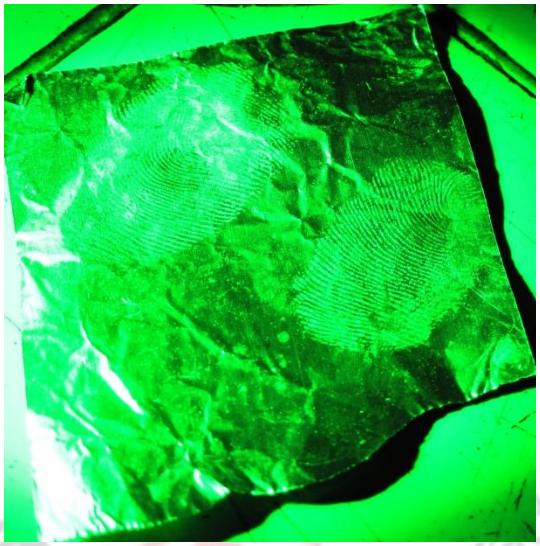

Fig. 10 Fluorescent characteristics of developed fingerprints

Some common organic compounds which have been used for powders are acridine yellow, acridine orange, coumarin 6, crystal violet, Nile blue, rhodamine B and rhodamine 6G.

Luminescent powders containing lanthanide complexes in place of organic derivatives have also been formulated. Lanthanide complexes offer several advantages, including benefits from large stokes shifts, long luminescence lifetimes, narrow emissions, ability of sequential assembly of complexes and chemical variability of ligands. Moreover, such powders are suitable for detection of latent fingerprints on difficult surface such as wood, masking tape and polythene.

8. Summary

Powder dusting is the simplest and most commonly used procedure for developing latent fingerprints. It is also the oldest technique to be used by fingerprint experts. It does not require any sophisticated equipment. Even an amateurish hand can develop the prints by brushing and tapping. The detection of prints may be carried out both at the scene of crime or in the laboratory. Above all, powder formulations are amenable to modification to suit the circumstances. Thus, it is possible to prepare powders which are cost-effective, non-toxic or luminescent in a wide array of particulate size, color and composition.