

<b>SUBJECT</b>	<b>FORENSIC SCIENCE</b>
<b>Paper No and Title</b>	<b>Paper No 3; Fingerprints and Other Impressions, Including Biometry</b>
<b>Module No.</b>	<b>Module No 14; Cyanoacrylate method for detection of latent fingerprints</b>
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**Forensic Science**

**PAPER No. 3; FINGERPRINTS AND OTHER IMPRESSIONS**

**Module No. 14; Cyanoacrylate Method for Detection of Latent Fingerprints**

## 1. Learning Outcomes

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

- The significance of the cyanoacrylate method, a fuming technique of fingerprint detection.
- The methodology of cyanoacrylate fuming.
- The mechanism of fingerprints detection by cyanoacrylate technique.
- The importance of enhancing the fingerprints developed by cyanoacrylate vapors.

## 2. Introduction – Cyanoacrylate Method

Cyanoacrylate method, also called the Super Glue technique, of detecting latent fingerprints is a vapor phase procedure. It is a versatile technique since it works on a broad spectrum of crime scene evidence.

The principle underlying this method depends on the fact that when alkyl 2- cyanoacrylate reagent is allowed to vaporize it undergoes polymerization. The polymerized ester gets adsorbed on the sweat residue, imparting a white color to the ridge pattern. The color contrast may be improved by various post-treatment methods.

Cyanoacrylate ester does not fix any specific constituent of sweat. It becomes deposited on the entire sweat residue. Thus, even if a particular sweat component is present in trace amounts, the Super Glue method still gives good result. This is not true of conventional methods. The powder dusting, for example, is ineffective in developing old prints because the moisture and oily components tend to evaporate with the passage of time. The ninhydrin method often gives weak prints because amino acid content of sweat residue is extremely small. Hence, post-treatment methodologies are invariably exercised with ninhydrin reagent.

Most conventional fingerprint development techniques are surface-specific, for example, powder method is largely used on non-absorbent surfaces, while the ninhydrin reagent is normally used on absorbent surfaces. Cyanoacrylate fuming is successful on both types of substrates. It has been successfully used for the development of latent prints on diverse surfaces like plastics, electrical tape, polythene bags, carbon paper, aluminum foil, polished and raw wood, rubber, cellophane and metals.

Before the chemical developing reagents are applied to a surface, the latent fingerprints are visually searched. The relevant spray or powder formulation is then applied. With cyanoacrylate fuming, however, there is no need to first scan the surface. The object bearing the fingermarks is suspended in a fuming cabinet and the polymerized cyanoacrylate on its own gets preferentially adsorbed on the sweat deposits, revealing the ridges.

### 3. Methodology

A china dish, containing a few drops of cyanoacrylate ester, is placed in a fuming cabinet. The object bearing the latent prints is suspended from the roof of the cabinet. The item is exposed to the cyanoacrylate vapors for about 2 hours until whitish colored fingerprint pattern develops.

For successful processing of prints, the design of the fuming cabinet has been modified from time to time. Care is taken that the cupboard has a proper ventilation system. One such variety is shown in Fig. 1.



Fig. 1 A cyanoacrylate fuming chamber

Cyanoacrylate ester, is commercially available in polymeric bottles (Fig. 2).



**Fig. 2 Commercially available cyanoacrylate reagent**

However, being a liquid, it is difficult to handle. Hence it is often incorporated into different matrices so that it can be used with ease. Most commonly, cyanoacrylate ester is impregnated into a gel matrix, which is then placed in a reusable foil pouch. A cyanoacrylate gel matrix is depicted in Fig. 3.



**Fig. 3 Cyanoacrylate impregnated in a gel matrix**

There are two broad techniques by which the developing time of cyanoacrylate fuming may be reduced:

- ❖ Fume circulation and
- ❖ Heat acceleration

These techniques serve to convert the ester into vapors at an accelerated pace and thereby increase the rate of its polymerization. The two techniques may be used in concert with each other.

The fume circulation technique requires a small battery-operated fan (Fig. 4) or an air circulation pump in the fuming cabinet. When the fan or the pump is turned on, the motion of the fumes increases. By this method the latent prints may be developed in 1 hour as against 2 hours required for natural fuming.



**Fig. A battery-operated fan for fume circulation**

The heat acceleration technique requires a heating device, such as a light bulb, a portable heater, a hot plate or a hair dryer in the fuming cabinet. Under the influence of heat, the monomer volatilizes and polymerizes faster, thus reducing the development time to about 30 minutes. Sample heating devices are shown in Fig. 5.



**(A)**

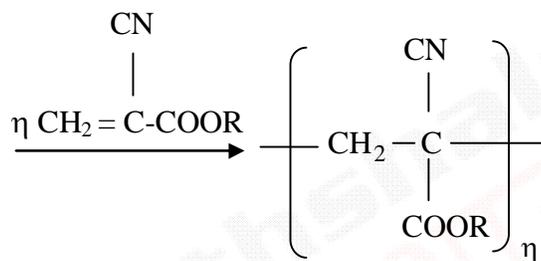
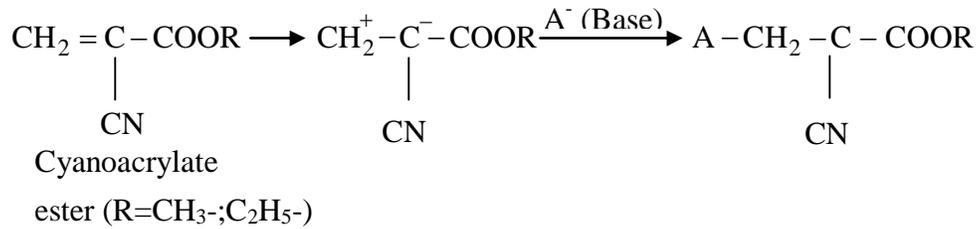


**(B)**

**Fig. 5 Devices for heat acceleration: (A) hot plate; and (B) heating blocks**

#### 4. Mechanism of Technique

The mechanism leading to the polymerization of cyanoacrylate ester is depicted in the Fig. 6.



**Fig. 6 Mechanism of cyanoacrylate ester fuming**

The reaction initiates with the abstraction of a proton from the alkene carbon by a base (A). Even if no alkali is added, the reaction still proceeds since the water molecules, present as moisture, act as Lewis base. Therefore, at times two heating systems are simultaneously used in the fuming chamber, one to transform cyanoacrylate ester into vapors at a fast pace and the other to generate water vapors. One such set up is depicted in Fig. 7.



**Fig. 7 A fuming chamber equipped with two heating systems**

Alternately, the polymerization is speeded up if a base is added to the reaction mixture. Thus, when a cotton pad, soaked in cyanoacrylate and a 0.5 N solution of sodium hydroxide, is placed in the evaporation dish, the fingerprints developed within 30 minutes to 1 hour.

## 5. Post-treatment of Developed Fingerprints

Even though cyanoacrylate fuming is a convenient and reliable method of detecting latent fingerprints, the developed imprints are white in color and, therefore, lack contrast (Fig. 8).



**Fig. 8 Cyanoacrylate reagent develops white colored fingerprints**

In order to improve their clarity, the developed prints are often further treated with a chemical reagent. The post-treatment procedures not only increase the contrast, but also enable detection of impressions on elusive surfaces.

The most common post-treatment method is to dust the cyanoacrylate-developed prints with a regular fingerprint powder. Such formulations contain a resinous polymer for adhesion and a colorant for contrast. The adhesive gets adsorbed on the moisture and oily components of the sweat residue, while the colorant gets adsorbed on the adhesive. In this manner the ridge pattern is visualized. Since moisture and oily contents of sweat tend to evaporate with the passage of time, conventional powder dusting technique is incapable of developing old prints.

However, old prints may be developed by cyanoacrylate method, followed by treatment with a powder composition. The polycyanoacrylate deposition has a tendency to absorb the powder. For example, using a Sudan black based formulation for post-treatment of cyanoacrylate-developed prints; it is possible to develop fingerprints on several items, including cement matrix.

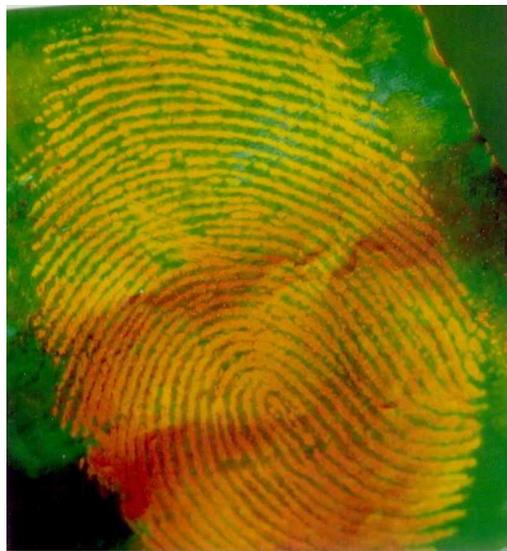
The fingerprints developed by cyanoacrylate fuming may also be enhanced by post-treating them with a luminescent dye. Such stains fluoresce or phosphoresce upon exposure to ultraviolet or laser light. This post-treatment procedure is useful for visualization of latent prints deposited on multi-colored surfaces. Moreover, it can be used for developing weak prints. When luminescent stains alone are used for print processing, the results are not satisfactory.

The reason being that the dye solution tends to wash off the sweat residue. However, when stains are used in conjunction with cyanoacrylate fuming, this problem is avoided. The cyanoacrylate polymer stabilizes the latent prints, so that solution dye staining does not wash it away.

Luminescent dyes such as gentian violet and coumarin 540 are generally used for improving the contrast of weak prints developed by cyanoacrylate method. These stains get selectively adsorbed on the polymerized Super Glue and thus revealed the ridges. While gentian violet is suitable for developing imprints on transparent polythene surfaces, coumarin 540 works on reflective surfaces like aluminum foil and chrome.

In the latter case, further enhancement is achieved by observing the post-treated fingermarks under a laser. Rhodamine 6G treated prints are also suitable for laser examination. The stain gets preferentially adhered to the polycyanoacrylate deposition. Moreover, the absorption spectrum of the stain matches with the blue-green illumination of the argon laser.

Fig. 9 shows a cyanoacrylate-developed fingerprint, post-treated with fluorescent eosin Y stain.



**Fig. 9 A cyanoacrylate-developed fingerprint post-treated with fluorescent eosin Y stain**

Staining the cyanoacrylate-developed prints can be carried out with Androx dye dissolved in freon-113 solvent. Observing the post-treated imprints under ultraviolet light remarkably improves the contrast. Cyanoacrylate-staining dye procedure is one of the few techniques, which can develop blood prints. Bloody fingerprints are often found on weapons, victims' bodies and other articles removed from the scene of crime. For detecting such prints, the blood protein must first be denatured and fixed on the surface. This is done by baking the sample in an oven for about 5 minutes. Cyanoacrylate fuming, in combination with Coomassie blue stain, is effective in developing bloody fingerprints on plastic items. However, the method does not work on metallic or glass surfaces.

Post-treatment of cyanoacrylate-developed prints by sublimating dyes also gives good impressions. The stains, 1-amino-2-phenoxy-4-hydroxyanthraquinone and 1, 4-bis (ethylamino) anthraquinone, are particularly useful for vapor-staining of fingerprints detected by cyanoacrylate procedure. The former stain produced red-purple imprints, while the latter gives blue ridge pattern. Fingerprints as old as 3 months may be developed on white, non-porous objects by this method. Arnon Alpha, another sublimating dye, may be used in combination with cyanoacrylate technique to develop prints on PET card. Complexes of lanthanides, especially those of europium (III) or terbium (III) may be used instead of staining dyes for post-treatment operations. These complexes show luminescence via intramolecular energy transfer. Moreover, the lifetime of the luminescence is much larger than that of the surface fluorescence. The complexes are, therefore, suitable for time-resolved luminescence imaging. Post-treatment of cyanoacrylate-developed prints give excellent luminescence intensity, a Stokes shift of 262 nm and suppressed surface fluorescence.

Cyanoacrylate fuming may also be used in concert with the ninhydrin method of fingerprint detection. The ninhydrin reagent fixes the amino acid content of the sweat residue, giving a purple compound, called Ruhemann's purple, which becomes deposited on the ridges. Ruhemann's purple may be converted into a fluorescent complex by treating the ninhydrin-developed prints with a solution of zinc chloride. The luminescent deposition gives sharp and clear prints under laser light. Fingerprints developed with cyanoacrylate are immersed in the ninhydrin solution, air dried, and then treated with zinc chloride solution. Finally, these are examined under a laser.

## 6. Summary

- ❖ Cyanoacrylate method is a vapor phase technique for developing latent fingerprints on a host of crime scene evidence.
- ❖ The vapors of alkyl 2-cyanoacrylate polymerize on being exposed to air.
- ❖ The polymerized product settles on the latent fingerprint and visualizes the ridge pattern. The reagent works on a broad spectrum of surfaces, absorbent and non-absorbent; white and multi-colored.
- ❖ Enhancement of weak fingerprints is possible by post-treating cyanoacrylate-developed impressions with reagents, which fluoresce on being illuminated by different light sources.