

## Comparative Study of Conventional and Fluorescent Fingerprint Powders in Forensic Science

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### Abstract

Traditional fingerprint development techniques utilizing conventional powders such as black powder, red oxide, and aluminum powder often fail to perform consistently across various surface types. This inconsistency presents a considerable obstacle in forensic investigations, as latent fingerprints (LFPs) represent a critical form of biometric evidence. Detecting LFPs those unintentionally left at crime scenes and not visible to the naked eye is critical in associating individuals with criminal activity. This article presents a comparative analysis between two main categories of powders used in fingerprint development: Conventional fingerprint powders (CFPs), which are visible under ambient lighting, and Fluorescent Fingerprint Powders (FFPs), which fluoresce under Alternate Light Sources (ALS). This article adopted a qualitative research approach, utilizing an empirical design to gain in-depth insights into how crime scene officials in South African Police Service experience, perceive, and evaluate the use of conventional versus fluorescent fingerprint powders during latent fingerprint development. The purpose of this article is to compare the efficacy of fluorescent and conventional fingerprint powders (FFPs and CFPs) in the development of latent fingerprints (LFPs) at crime scenes. Some of the findings in this article indicates that FFPs reveal more ridge detail and higher clarity on multi-coloured, patterned, or dark surfaces due to fluorescence under UV or alternate light sources. CPFs may be less effective on such surfaces but work adequately on light, non-reflective surfaces. It is recommended that crime scene examiners should use CFPs for rapid field processing on smooth, non-complex surfaces. FFPs typically reveal more ridge detail and higher clarity on multi-coloured, patterned, or dark surfaces due to fluorescence under UV or alternate light sources. Findings stated that CPFs may be less effective on such surfaces but work adequately on light, non-reflective surfaces. CPFs do not perform better on porous surfaces (e.g., paper, unglazed wood). FFPs show superior results on non-porous nor porous surface (e.g., glass, plastic, metal), especially when viewed under proper lighting.

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### Introduction

Fingerprint analysis remains a foundational technique in forensic science, with the detection and identification of latent prints playing a critical role in criminal investigations and courtroom proceedings (Champod, Lennard, Margot & Stoilovic, 2004). LFPs formed by secretions such as water,

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amino acids, fatty acids, and salts from the friction ridge skin are usually invisible to the unaided eye and must be developed through physical or chemical processes to become usable evidence (Ramotowski, 2012).

Among the many development techniques available including cyanoacrylate fuming, ninhydrin treatment, and vacuum metal deposition powder dusting continues to be one of the most accessible and cost-effective methods, especially for smooth, non-porous surfaces like glass, plastic, and metal (Lee & Gaensslen, 2012). This method relies on the mechanical adhesion of fine powder particles to the sticky components of fingerprint residues, rendering ridge patterns visible for documentation and comparison.

Fingerprint powders can be broadly categorized into two types: conventional fingerprint powders, which are visible under natural or white light, and FFPs, which glow when viewed under ALS. CFPs are typically composed of carbon black, aluminum, or titanium dioxide, and are widely used in the field due to their simplicity and affordability (Champod et al., 2004). Fluorescent powders, in contrast, contain dyes such as rhodamine or fluorescein that fluoresce when exposed to UV or blue-green light, requiring the use of ALS and barrier filters for visualization (Stoilovic, 1991).

The choice between these two types depends on various factors including surface type, environmental lighting conditions, fingerprint age, and background colour or pattern. While conventional powders are effective on clean, monochromatic surfaces, they may provide poor contrast on multi-coloured or glossy substrates. FFPs excel in these challenging conditions by producing high-contrast images even in cluttered or reflective environments (Fritz, 2002). However, their use requires specialized equipment and training, limiting their applicability in some field situations.

Given these considerations, it is essential to understand the conditions under which each type of powder performs optimally. This article provides a detailed, evidence-based comparison of fluorescent and conventional fingerprint powders, analysing their respective performance in real-world forensic applications.

### **Research Methodology**

This article adopted a qualitative research approach, utilizing an empirical design to gain in-depth insights into how crime scene examiners in South African Police Service experience, perceive, and evaluate the use of conventional versus fluorescent fingerprint powders during latent fingerprint development. Non-probability purposive sampling was used to select nine (9) participants who possessed relevant knowledge and practical experience in using both types of fingerprint powders, the researchers achieved this by getting permission from South African Police Service and ethical clearance from University of South Africa to interview participants to explore their experiences with conventional and fluorescent fingerprint powders. This approach was appropriate as it enabled the assessment of both types of powders based on key performance indicators, including clarity of developed prints, surface compatibility, cost, and equipment requirements. The evaluation focused not only on technical performance but also on practical considerations such as required training, and equipment costs, thereby providing a comprehensive understanding of the powders' suitability for forensic use. The researchers obtained permission from South African Police Services (SAPS) and also got ethical clearance from the University of South Africa (UNISA) to ensure compliance.

*\* The following section provides a comparative analysis of fluorescent fingerprint powders and conventional fingerprint powders, evaluating their respective properties, effectiveness, and suitability for forensic applications.*

### **Discussion**

#### **Conventional Fingerprint Powders (CFPs)**

Numerous popular traditional powders have positive attributes. They look "greasier" and softer than the special powders and have very fine grains. But they do have certain drawbacks. They frequently get lumpy because they are hygroscopic and/or fine-grained. Some powders are referred described as "greasy" because they have a tendency to stick excessively to both the brush's extremely

soft hairs and the surface. As a result, too much powder sticks to the LFPs, causing them to become blurry when brushed (Wang, Li, Yu, Zhu, Yang & Mao, 2017:4-7). According to Saferstein (2016), traditional fingerprint powders are specialized materials forensic experts use in developing LFPs on different surfaces. They are powders that, when applied to a surface, stick to the natural oils and other residues left by a person touching it. These powders are usually made up of carbon-based compounds or other very fine materials that have good contrast when applied to prints. The surface colour and texture determine the colour of the powder: for light surfaces, black powder is used, and for dark surfaces, white or grey powder is recommended. The powder is then carefully brushed onto the surface containing the LFPs, making them visible. The prints can then be picked up with some adhesive tape for closer inspection. According to Boonyaras, Boonpang and Dangudom (2023:1-3), and Harshita, Rai, Raikwar, Kamle and Mia (2022:45-48), the valuable powder method can be applied on almost all types of surfaces, such as paper, glass, plastic, metal, and even skin. This versatility is helpful in many investigative settings. When used correctly, fingerprint powdering is a dependable technique for developing a latent print.

### **Selection of Conventional Fingerprint Powder**

The method used on the surface on which LFPs are developed depends on different factors, including colour, condition, nature, and texture. Powder dusting is a straightforward, fast, and efficient method of enhancing LFPs on non-porous, dry surfaces. It consists of dusting a powdered solution on the residue and brushing off or fanning off the excess powder. It is based on the mechanical adhesion of the fingerprint powder to the moisture and greasy constituents of the remains of the latent finger marks. The adhesion characteristics of powders are affected by the shape and size of the powder particles. Larger coarse particles bind to the contact surface poorly compared to smaller fine particles. So far, there is no single powder formulation widely applicable in the detection of latent finger marks on any surface type (Lohar, Aseri, Godara, Kumari, Nagar, Pandit, Chopade, Singh, Awasthi, Sankhla, Kaur, and Singh, 2022:848-853).

Bagale and Patole (2024:8166) state several factors influencing the selection of Conventional Fluorescent Fingerprint (CFPs).

- i) Fineness* : The powder needs to be fine enough to reveal the fingerprint's intricacies. In order for the powder to stick to the fingerprint residue and not the rest of the surface, where it would hide the print, it must exhibit the proper degree of adherence.
- ii) Adhesion* : Adhesion is how well powder particles coats a surface.
- iii) Sensitivity* : Adhesion, or how well a powder sticks to a surface, is correlated with sensitivity. Aluminium flake, for instance, is more responsive than aluminium powder, however this sensitivity isn't always a good thing.
- iv) Colour* : The colour of the fingerprint powder needs to match the surface in question.
- v) Flow* : Less importantly, the powder must be able to flow and not cake into a solid block, which would make it unusable.

### **Advantages of Conventional Fingerprint Powders (CFP)**

As noted by Kim, Lee, Park, Seo and Choi (2019:197), the powder method for LFPs development remains widely employed at crime scenes due to its simplicity, affordability, and the minimal equipment it requires. Lohar et al. (2022:848-853) further assert that this technique offers a rapid and effective means of visualizing LFPs across both porous and nonporous surfaces, making it a versatile choice for on-site forensic work. In alignment with these observations, Saukko and Knight (2017:543-544) emphasize that the method's effectiveness on multiple surface types has led to the establishment of standardized procedures and protocols for its implementation. Collectively, these

scholars underscore that the powder technique continues to be a foundational component of LFPs detection in both field and laboratory contexts.

CFPs have been widely utilized in forensic investigations for over three decades, serving as essential tools in the development and visualization of LFPs. According to Omar and Ellsworth (2012:499–504) and Kim et al. (2019:196–208), these powders remain a standard technique in crime scene processing due to the following several key advantages.

*i) Cost-Effective:*

CFPs are relatively inexpensive when compared to more advanced methods like FFPs or chemical treatments. This makes them an affordable option for crime scene examiners, especially in environments with budget constraints.

*ii) Simplicity and Ease of Use:*

These powders are easy to apply and require minimal training. Crime scene examiners can apply them using basic tools like brushes, puffs, or magnetic wands. This makes them very user-friendly, even for those with limited experience or in high-pressure field environments.

*iii) Wide Availability:*

CFPs are widely available and are commonly stocked by forensic labs, law enforcement agencies, and private forensic service providers. They are a staple tool for many forensic investigations, ensuring easy access whenever needed.

*iv) Versatility Across Different Surfaces:*

These powders are suitable for use on a wide variety of surfaces, including non-porous (glass, metal, plastic) and some porous materials. They work well for visualising prints on a broad range of objects at crime scenes.

*v) No Special Equipment Required:*

Unlike FFPs, which require UV light sources for visualisation, conventional powders do not need special lighting. This is a significant advantage for fieldwork, where such equipment may not always be available. Examiner can apply the powder and immediately visualise the prints in normal lighting conditions.

*vi) Quick Results:*

The application of conventional powders typically provides immediate results, which is crucial for on-the-spot fingerprint detection. Examiner can quickly assess and photograph the LFPs, which helps speed up the crime scene investigation process.

*vii) Effective on Common Surfaces:*

Conventional powders are particularly effective on surfaces that are commonly encountered in everyday crime scenes, such as paper, plastic, wood, and metal. They provide clear and distinct prints, especially when applied to smooth or matte surfaces.

### **Disadvantages of Conventional Fingerprint Powders (CFPs)**

Wang et al. (2017:4-6) clearly explain that CFPs, such as black, white, and magnetic powders, are widely used in forensic science to visualise LFPs on various surfaces. However, they come with several disadvantages:

*i) Reducing Contrast on some Materials:*

Conventional powders particularly black and white powders may demonstrate poor contrast on specific surfaces (i.e., dark, reflective, or glossy surfaces). This can obscure and hinder the fingerprint from being perceived properly, giving rise to less noticeable specifics, particularly in poor lighting or troubled foundations (Lohar et al., 2022:848-853).

*ii) Risk of Disfiguring & Disturbing the Print:*

Conventional powders must be handled carefully while applying. If used too liberally or on uneven surfaces, powders can smear or smudge the fingerprint. Moreover, the powder particles could

scratch and damage delicate prints on sensitive substrates, thus reversing the quality of the prints (Kim et al., 2019:196-208).

iii) Environmental Conditions and Surface Compatibility:

Conventional powders are suitable for non-porous surfaces (e.g., glass, metal) but unsuitable for porous materials (e.g., paper, cloth) or irregular surfaces. Powders may not stick as well on porous surfaces, and the fingerprint may be less clear (Alvarez, 2023:1-22).

iv) Insensitive to Dim Light Scenario:

Traditional powders do not improve sensitivity in dim illumination scenarios. However, they do not tend to depend on specific light sources to enhance visibility; therefore, there is a limitation on dealing with prints that are not visible to the naked eye (Lohar et al., 2022:848-853).

V) Potentials for Background Contamination:

Conventional powders risk contamination of the crime scene or background with excess powder, resulting in spurious or false results. This problem may be further exaggerated in complex or busy crime scenes where there are competing interests between print and background material (Kim et al., 2019:196-208).

vi) Health and Safety Concerns:

Omar and Ellsworth (2012:499-504) caution that traditional fingerprint powders, particularly those containing carbon-based materials, pose occupational health risks to forensic practitioners. They contend that the fine particulate matter in these powders can be easily inhaled, especially in inadequately ventilated environments, leading to potential respiratory complications. Supporting this concern, Kim et al. (2019:196-208) emphasize that prolonged or repeated exposure to such powders, without the use of appropriate protective equipment, increases the likelihood of adverse health outcomes. Taken together, these findings indicate a critical need for forensic agencies to implement strict health and safety protocols when using conventional powders, including the use of personal protective equipment and effective ventilation systems.

### **Fluorescent Fingerprint Powders (FFP)**

FFPs are specifically designed to develop LFPs on various colored surfaces, offering advantages over conventional powders by providing greater contrast against complex backgrounds. Boonyaras et al. (2023:1-3) and Alvarez (2023:1) assert that FFPs require examination under ALS to effectively visualize the developed prints. Wang et al. (2017:7) further explain that FFPs function by amplifying the fluorescent signal, enhancing the visibility of ridge details compared to traditional high-agenda fluorescent emissions. Moreover, Prabakaran and Pilay (2021:1856-1885) emphasize that FFPs perform particularly well on dark or multicolored surfaces, with enhanced ridge details becoming clearly discernible when illuminated using ALS. This body of research collectively underscores the critical role of FFPs in improving latent print detection in challenging forensic contexts.

As Fee (2015:1) notes, when a print is difficult to separate from its substrate, bright granules are utilized. These powders work incredibly well on raw surfaces like woodwork in homes, convenience store counters, and multi-coloured non-porous objects where conventional universal powders might paint or clog the surface. They are made to be used with a wide range of alternative light sources, from tiny 1-watt UV lights to multi-watt lasers. These FFPs colouring ingredients are a kind of processed dye that responds to UV light and the visible light spectrum's purple and blue bands, which are frequently used in forensic and crime scene investigations. Particle colours can be changed to match the wavelength of the light source being used and the colour of the treated surface. This coupling will mitigate or eliminate any background noise accompanying surface pigmentation or contaminants.

All of the above agree that FFPs are specially designed powders specifically for forensics that aid in the visualization of LFPs. FFPs differ from traditional fingerprint powders that need contrast

with the surface on which they are used; FFPs will fluoresce when illuminated with either ultraviolet (UV) or blue light. This makes them especially helpful for rendering prints on patterned or multicoloured substrates.

### **Chemical composition and properties of Fluorescent Fingerprint Powders (FFP)**

Wang et al. (2017:2) exhibited that FFPs included acridine yellow, acridine orange, crystal violet, Nile blue, Rhodamine B, and Rhodamine 6G, where FLSs were excited and barrier filters were also correctly used. FFPs have been recommended for use on any surface when it is not possible to visualise fingerprints developed by other non-FFPs, especially on multicoloured surfaces or surfaces with patterned background colour or texture. As stated by Smith (2021:1), "Fluorescent reagents are often used to recover these marks, especially when good background contrast cannot be observed or the substrate is compromised (e.g., immersed in water, embedded in extreme weather, fire-damaged/recovered, etc.). It enables greater visual enhancement in marks that may be otherwise "invisible." Fluorescent reagents are most effective for LFPs, prints that remain in the sebum (oil) or sweat that the fingertips leave behind. Fluorescent fingerprints must be viewed under the stimulation of an ALS and a viewing filter for them to be visible. In the article, a formulation of a FFPs was developed utilizing Rhodamine B, a fluorescent chemical and biological staining agent, and a few other component.

Devonport (1969:131-133) state several factors influencing the selection of Fluorescent Fingerprint Powders (FFPs):

- (a) The powder's fluorescent color must be clearly visible in ultraviolet light to ensure that the police officer and the thief are certain of the powder's origin;
- (b) To make the items to be marked nearly invisible to the thief, the powder's color (in daylight) should blend with the items' color. To achieve this, it could be required to combine the powder with an inert substance, like powdered graphite or starch, without significantly reducing the powder's luminous properties;
- (c) The luminous colour must be able to be distinguished from other materials that can be met; for example, white and pale blue fluorescent colours should be avoided as they can be mistaken for the different "whiteners" included in washing powders;
- (d) The powder should have strong enough adhesive qualities to stick to the thief's hands and clothes for a while. As a result, the powder ought should feel like flour when rubbed between the fingers rather than grainy; and
- (e) If required, the powder must be easily and swiftly analysed in small quantities in the lab; consequently, mixes including multiple complex materials that may take a while to identify should be avoided.

### **Advantages of Fluorescent Fingerprint Powders**

#### *i) Fluorescence under UV Light:*

The primary characteristic of FFPs is their ability to emit visible light when exposed to ultraviolet (UV) radiation. Chavez, Garcia, Oliva, and Diaz-Torry (2020:10-47) explain that specific fluorescent dyes impart distinct hues—such as green, blue, or orange to the powders, which enhances the visibility of LFPs against various background surfaces. Prabakaran and Pillay (2021:1856-1885) further emphasize that this fluorescence significantly improves the contrast of LFPs, making FFPs particularly effective on challenging substrates like dark or glossy materials where traditional powders often fail to produce clear impressions.

#### *ii) High Sensitivity:*

FFP offer high sensitivity, able to identify even feeble or LFPs that conventional powders may miss. This sensitivity is especially beneficial in instances where the fingerprint residue is low or deteriorated (Wang et al., 2017:7).

#### *iii) Increased Contrast:*

FFP offer significantly higher contrast compared to conventional black or white powders, particularly under ultraviolet or UVG lighting conditions. Wang et al. (2017:7) and Chadwick, Cvetanovski, Ross, Sharp and Moret (2021:1-2) note that this enhanced contrast makes FFPs highly effective for developing LFPs on dark or multicoloured surfaces. However, these authors also caution against the use of FFPs on certain substrates, such as dark-coloured objects, glass, or shiny metals, where the fluorescence may produce undesirable effects or reduce print clarity.

*iv) Surface Compatibility:*

Blazing powders exhibit versatility by being applicable to a broad range of surfaces, including both porous and non-porous materials. Yamashita and French (2010) emphasize their effectiveness, particularly on smooth, non-porous surfaces such as glass, plastic, and metal. Similarly, Wang et al. (2017:7) and Barros and Stefani (2019:137-146) concur that while these powders can be used on porous surfaces, their efficiency often depends on specific factors, including the condition of the surface and the nature of the fingerprint deposit.

*v) Non-Invasive:*

Oleiwi, Hussain, McWhorter, Sutton, and King (2017:32-37) and Aggarwal (2024:40-46) maintain that FFPs, like traditional powders, are relatively non-destructive to the substrate when applied with care, thereby rendering them appropriate for sensitive investigations where preservation of the scene is paramount.

*vi) Particle Size:*

Yamashita and French (2010), Wang et al. (2017:7:1), and Wang, Zhou, Liu, and Song (2018:32859–32866) argue that the fine particle size of FFPs is crucial for producing detailed and crisp ridge impressions, as these particles adhere effectively to the fingerprint ridges without obscuring essential features.

### **Disadvantages of Fluorescent Fingerprint Powders (FFP)**

*i)* The developed fingerprint must be always irradiated with ultraviolet light to be observed. Therefore, two individuals must be present for the correct photographic processing. This also carries the risk of the photograph being ruined by surfaces that may also react to ultraviolet lights, such as writing paper, which have optical whiteners (Alvarez, 2023:2).

*ii)* According to Champod et al. (2004), the application of FFPs in forensic investigations require expensive specialized equipment, including ALS units and appropriate optical filters, to visualize latent prints effectively. These powders are generally more costly than traditional fingerprint powders and demand adequate storage conditions, as well as operator training to ensure proper handling and application. Furthermore, fluorescent fingerprint powders exhibit limited efficacy when applied to porous substrates, such as paper or untreated wood, reducing their utility in certain forensic contexts.

### **Comparison Analysis**

The primary distinction between FFPs and conventional powders lies in the enhanced contrast and visualization capabilities that FFPs provide across a variety of surfaces. According to Chadwick et al. (2021:2), as well as Wang (2017:4–7), FFPs exhibit the unique property of emitting visible light when exposed to specific wavelengths, such as ultraviolet light. This characteristic renders them particularly effective for developing LFPs on complex or multi-colored backgrounds, where conventional powders often fail to sufficiently distinguish the print from the substrate. However, it should be noted that this advantage is accompanied by the necessity of employing specialized alternative light sources to visualize the developed prints effectively (King, Hallet, & Foster, 2015:21–26; Lian, Meng, Wang, & Zhang, 2020:2–4). Thus, while FFPs offer superior visualization in challenging contexts, their use requires additional equipment and expertise.

*i) Visualization*

Powders for fluorescent fingerprints are applied in combination with a different light source, such as lasers or low-power UV lights. It makes it possible to see LFPs that could otherwise be missed by using traditional methods. Ideal for surfaces that are dirty, abrasive, or multi-coloured, where it would not be feasible to select a traditional powder that isolates the latent print from its surroundings (Wang et al., 2017:4-8).

As noted by Boonyaras et al. (2023:1-5) and Wang et al. (2017:4-8), colourful fingerprint powders increase the visibility of latent impressions. Particularly on rough surfaces or in hard settings, FFPs frequently provide better contrast and visibility in terms of viewing. When dealing with a variety of intricate surfaces, forensic investigators find them especially helpful. Nonetheless, they do need specific tools and instruction. While conventional powders are more widely available and less expensive, they might not necessarily yield the optimum results.

#### *ii) Contrast*

The most significant challenge associated with the use of CFPs, as identified by King et al (2015:21–26), lies in selecting a powder that provides optimal contrast against the surface to which it is applied such as using white powder on a black background or vice versa. This selection process becomes particularly problematic when the substrate in question is multi-coloured, patterned, or exhibits varying levels of smoothness. Chadwick et al. (2021:2) argue that traditional fingerprint powders, which primarily rely on absorption mechanisms to generate contrast between the mark and the substrate, generally perform well under standard conditions on most surfaces. However, their effectiveness diminishes significantly when the substrate includes complex patterns or contrasting backgrounds, akin to a barcode. In contrast, luminescent powders have been demonstrated to reduce interference from the substrate and enhance contrast beyond what is achievable with conventional powders. This suggests that FFPs offer a viable solution in challenging forensic scenarios where traditional powders fall short.

#### *iii) Applications*

CFPs are typically applied using a brush to a wide range of surfaces, which underscores their versatility in forensic applications. However, Wang et al. (2017:4-6) note that a significant limitation of these powders is the necessity to carefully select the correct powder colour to ensure sufficient contrast with the background surface. This selection process demands considerable judgment and attention to detail to optimize the visibility of LFPs. Similarly, FFPs are also applied with a brush; however, as Yamashita and French (2010) and Wang et al. (2017) emphasize, a crucial distinction lies in the requirement for a dedicated alternative light source such as ultraviolet (UV) light to visualize the developed prints. Consequently, this additional procedural step renders the use of FFPs somewhat more complex, as appropriate lighting conditions must be ensured for effective detection and visualization of fingerprints.

#### *iv) Sensitivity*

CFPs may struggle to reveal faint or partially obscured prints, particularly on challenging surfaces. As noted by Wang et al. (2017: 4-6), their sensitivity can be limited, especially when the fingerprint is faint or partially obscured by dirt, oils, or surface irregularities. FFPs are generally more sensitive and capable of detecting fainter prints due to their enhanced contrast properties. According to Wang et al. (2017:7) and Lian et al. (2020:2-4), the enhanced visibility provided by FFPs, especially under UV light, allows for better detection of prints that would otherwise be difficult to see with conventional powders. The increased contrast and ability to highlight even faint residues make FFPs a preferred choice for more challenging fingerprint detection tasks.

#### *v) Liftability*

Rajan, Shamsuddin and Hassan (2019:2-4) have found FFPs to be more effective in lifting LFPs from various surfaces, especially those that are multicoloured, reflective, or have patterns. Conventional powders are more difficult to lift and transfer prints (Babu, 2021:37- 40). Askarin, Wong and Phan (2020:1) concur with the previous authors that to lift these LFPs, the conventional approach

involving the process of powdering and taping may physically damage the LFPs. Liftability of FFPs generally compares favourably to conventional powders due to their good adhesion and the potential for less contamination. The vivid contrast produced by FFPs can aid in capturing detailed prints, but this requires appropriate lifting materials designed for use with FFPs. Conventional powders are versatile and work well with a range of lifting materials, though they may face challenges on certain surfaces. Overall, the effectiveness of lifting depends significantly on the specific conditions and materials used, but FFPs often offer enhanced results in scenarios where high contrast and detail are critical.

vi) *Surface-specific performance*

More surfaces can be used for print detection and recording than with conventional black powder treatments because to the employment of fluorescent chemicals and FLSs. Think about how hard it would be to dust and lift a print off of things like paper goods, concrete walls, masonry, thick plastic bags, inflexible duct tape, thin aluminum foil, and strongly grained wood. Fingerprint evidence on these and other surfaces may be ignored or even disregarded using conventional procedures due to the inability to detect them in sufficient detail (Babu, 2021:37). It is difficult to see fingerprints created by other non-FFPs, especially on multi-coloured surfaces, according to Wang et al. (2017:2), who state that FFPs have been suggested for usage on surfaces with complex background colour or texture. Due to their capacity to fluoresce under UV light, which improves contrast and visibility, FFPs work better on non-porous surfaces. Their benefits include improved fingerprint detection and high-definition photography. Although conventional powders are frequently utilized because of their versatility and extensive application knowledge, they typically do not perform better on porous surfaces.

vii) *Overall*

While CFPs continue to hold value in specific contexts, Yamashita and French (2010), Wang et al. (2017), and the North Carolina State Crime Laboratory (2019:1-2) collectively argue that FFPs are generally regarded as more sensitive and versatile. Specifically, these powders demonstrate enhanced effectiveness when applied to challenging surfaces or when a high degree of contrast is essential for the accurate visualization of LFPs.

The purpose of this article is to compare the efficacy of fluorescent and conventional fingerprint powders (FFPs and CFPs) in the development of latent fingerprints (LFPs) at crime scenes. Some of the findings in this article indicates that FFPs reveal more ridge detail and higher clarity on multi-coloured, patterned, or dark surfaces due to fluorescence under UV or alternate light sources. CPFs may be less effective on such surfaces but work adequately on light, non-reflective surfaces.

### **Findings**

- FFPs typically reveal more ridge detail and higher clarity on multi-coloured, patterned, or dark surfaces due to fluorescence under UV or alternate light sources. CPFs may be less effective on such surfaces but work adequately on light, non-reflective surfaces.
- CPFs do not perform better on porous surfaces (e.g., paper, unglazed wood). FFPs show superior results on non-porous nor porous surface (e.g., glass, plastic, metal), especially when viewed under proper lighting.
- FFPs offer strong contrast under ALS, making latent prints more visible and less reliant on ambient lighting. CFPs rely on colour contrast only (e.g., black on light surfaces, white on dark), which can be limited on complex backgrounds.
- FFPs require special lighting and filters (e.g., barrier filters) for effective photography, which could complicate field use but enhance lab results. CFPs are easier to photograph without special equipment.
- FFPs are more effective in lifting LFPs from various surfaces, especially those that are multicoloured, reflective, or have patterns. CFPs are more difficult to lift and transfer prints.

## Recommendations

- **Use CFPs** for rapid field processing on smooth, non-complex surfaces.
- Employ **FFPs** on porous or **non-porous, dark, or multicolored surfaces**, as they provide better contrast and detail under ALS.
- Forensic units should be trained in **ALS use and FFPs application** to maximize fingerprint recovery effectiveness.
- Ensure proper **personal protective equipment (PPE)** (e.g., masks, gloves) is used when applying powders, which may contain more hazardous chemicals.
- Perform a **cost-benefit analysis** before adopting FFPs and equipment at scale. While they offer advantages in some scenarios, the higher cost and complexity may not justify routine use in all cases.

## Conclusion

The choice between fluorescent fingerprint powders (FFPs) and conventional fingerprint powders largely depends on the specific requirements of the crime scene, including the type of surface involved, environmental conditions, and the level of detail needed in the developed fingerprint. FFPs are particularly useful on multi-coloured, patterned, or dark surfaces, where traditional black or gray powders may not provide sufficient contrast. Under alternative light sources such as ultraviolet (UV) or blue-green light FFPs emit a bright glow, enhancing the visibility and clarity of latent prints without interference from background patterns.

This makes FFPs especially advantageous in complex or cluttered scenes, such as on banknotes, glossy magazine pages, or painted surfaces. Additionally, FFPs can be less destructive to delicate prints, as they often require less brushing, preserving ridge detail. However, they require specialized equipment such as forensic light sources and barrier filters to view and photograph the developed prints effectively.

In contrast, CFPs typically black, white, or gray remain a practical, cost-effective, and widely used method for general fingerprint development. They are easy to apply, do not require specialized lighting, and are highly effective on smooth, nonporous surfaces like glass, plastic, and metal. For many routine investigations and straightforward surfaces, conventional powders continue to be a reliable choice.

Crime scene examiners choose the appropriate type of fingerprint powder by considering factors such as the nature of the scene, the surface material involved, and the equipment at their disposal, aiming to balance efficiency with the accuracy required for effective evidence collection.

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