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A review on development of wet latent fingerprints by small particle reagent

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***Abstract*---**Small particle reagent technique is a method which is used to develop fingermarks on moist and smooth surfaces. It consist the theory of adherence of fine particles which is suspended in a treating solution to the oily or fatty components (water insoluble) present in in latent fingermark residue and gives a grey colored deposit. It is also considered as belonging to the family of powder dusting. The effectiveness of this technique can be increased by using fluorescent dyes in it's treating solution which can also detect faint fingermarks on multi-colored surfaces. Small particle reagent involves the use of synthetic detergent which was here replaced by saponin extracted from the fruit of Sapindus mukorossi as natural detergent. The other ingredient used in the formulation is black charcoal powder. This composition develops sharp and clear fingermarks on non-adsorbent surfaces like glass, metal sheet, plastic, laminated wood, ceramic tiles and compact discs after these were immersed in water for variable periods of time. The ability of the present formulation to detect weak chance prints not only enhances its utility, but also its potentiality in forensic investigations. The raw materials used to prepare the SPR are easily available and cost-effective. It is also necessary to standardize SPR formulation testing.

***Keywords*---**small particle reagent, latent fingerprints, detergent, suspension particles, molybdenum disulfide.

Introduction

Sweat from pores on the friction ridge surface of the hands forms fingermarks. The sweat pores on the finger ridges are numerous. When any finger touches a surface, sweat out of these pores is deposited in the form of contours that mirrors the ridge patterns (1). These latent fingerprints have occasionally been exposed to various environmental conditions that make them more difficult to be developed. One such situation is the presence of latent or invisible fingerprints on water-damaged objects. Small particle reagent is the most efficient and widely used

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method for creating such prints (SPR). The object is immersed in a fine powder which is suspended in a dilute aqueous solution of a surfactant, usually a detergent, accompanied by repeated washings with water (2). Small particle reagent is a popular new method for developing fingerprints. It can leave marks on the surface of porous or nonporous surfaces, as well as wet, dipped in water, and sticky surfaces. It is possible for the substance to develop sweat latent or invisible fingerprints, sebum latent fingerprints, blood latent fingerprints, and various types of glair fingerprints. However, our country's current small particle reagents are all dark in color, such as molybdenum disulfide small particle reagent, iron peroxide small particle reagent, and ferric oxide small particle reagent. Because single color small particle reagents are limited to certain surfaces, we developed a series of different color small particle reagents to develop fingerprints on various colored surfaces.

The small particle reagent (SPR) technique is useful for developing latent fingerprints on moist, non-porous surfaces. The method works by allowing fine particles of treating solution to adhere to the oily or fatty constituents of latent fingerprint residues. It interacts with the insoluble sebaceous constituents of latent fingerprint residues in water. SPR is typically made up of a suspension of fine molybdenum disulfide particles in an aqueous medium containing a detergent solution (as surfactant). These particles bind to the fatty constituents of latent fingermark residues, forming a grey deposit. This method can be used to create latent fingermarks on a variety of surfaces that had been immersed in water for an extended period of time, including plastic, wood, vinyl, glass, metal, and cardboard (3,1). Small particle reagent is a wet powdering method used to develop latent fingerprints on broad spectrum of forensic evidences. It is susceptible to the lipid components of sweat from fingers and is useful for developing fingerprints on articles that have been wetted by accident or on purpose (4). As a base material, a molybdenum disulfide suspension in a surfactant is used in traditional small particle reagent.

This method is based on the fine particles adhesion to the sebaceous constituents of the fingerprint residue, similar to the simple powdering method of latent fingerprints (5). The small particle reagent is a type of suspension that contains a certain amount of powder, surfactant, and water. The ionic active reagent ions absorb the powder's surface by changing ions or pairs of ions. The powder will then have the same charge as the active reagent ion. The powders will separate in the water due to the repellent force of the same charge. Simultaneously, the powders containing the active reagent will absorb the ridges and develop the fingerprints via sorption between the lipid soluble groups and the sebum molecules or the force between the molecules surfaces. Natural detergent, rather than synthetic detergent, was used by Jasuja *et al* in two small-particle preparations (charcoal powder and basic zinc carbonate based) for the development of latent or invisible fingerprints on a variety of smooth surfaces. Saponin, a naturally occurring surface active compound found in the pericarp of the *Sapindus mukorossi* tree's fruit, was used in place of synthetic detergent. And it was also discovered that the new reagent produced higher-quality prints than traditional formulations and performed sufficiently even after 15 days of preparation (6).

To develop latent fingermarks on different types of nonporous moist surfaces, Jasuja *et al* compared various small-particle reagent mixtures consisting of zinc carbonate (as the suspension material) and six various types of fluorescent dyes. They recommended using a small-particle reagent formulation based on cyano blue for the development of latent or invisible fingerprints (7). Traditional SPR uses dark grey Molybdenum disulfide (MoS2) particles suspended in detergent to achieve effective results on non-porous surfaces. This powder suspension is delicate to the latent fingerprint's sebaceous (water-insoluble) components and can be used on a variety of smooth surfaces (8). The SPR solution has been used successfully used to develop latent fingerprints on porous and smooth surfaces (9). However, the results are affected by the amount of residue transferred by the finger. The amount of time that finger marks are exposed to the impact affects the quality and number of developed marks.

As a result, additional and broader research should be conducted, in which other factors such as various surfaces, different types of liquid, environmental, and time factors should be introduced (10). The traditional Small Particle Reagent (SPR) is a dark grey Molybdenum disulfide suspension with a fine crystalline structure that has proven to be useful for successful fingerprint development. A particle of molybdenum disulfide was suspended in detergent. As a surfactant (surface active agent), detergents were used, and Molybdenum disulfide was used as a suspension material. Its particles bind to the sebaceous constituents of sweat deposition, giving it a grey deposit. Molybdenum (IV) sulphide is an undissolved salt that is toxic and irritating to the skin. The particles adhere to the fatty components of latent fingerprint residues, forming a grey Molybdenum disulfide deposit (8).

Composition of SPR

SPR can detect latent fingerprints by detecting the reaction between hydrophobic tails of certain chemicals and fatty acid residues in traces. A colored precipitate is formed when metal salts are connected to a hydrophilic head. A common insoluble powder is metal oxide or sulphide, depending on the application. Molybdenum disulfide particles are traditionally suspended in a surfactant solution using small particle reagents (11). On dark-colored surfaces, fingerprints are difficult to see because the grey base material lacks contrast. Using a white basic zinc carbonate-based formula that leaves dark-colored items with crisp fingerprints can help prevent this (12). A small particle reagent formulation can also be made using titanium dioxide. To make the mixture even more fluorescent, crystal violet dye was included (13). Traditional SPR formulations include a surfactant and a suspending agent. SPR formulations would be incomplete without surfactant. On the surface, it appears to have some sort of impact. As the surface tension of the water decreases, more moisture can be found on the water's surface. As an additional benefit, it ensures that the suspension material is evenly distributed on the wet surface (3).

A surfactant is added to the wetting solution in order to keep the powder in suspension. As a key component, surfactant is necessary for SPR to function properly. Because too much surfactant leads to underdeveloped prints and too little surfactant leads to excessive accumulation and clumping of the powder, surfactant solubility is critical (8). Using surfactant is a bad idea because it contains organic compounds that may be harmful to humans and the environment. A print's concentration and solubility can be affected by the SPR composition. To avoid shaky prints, keep your concentration to a minimum (8). When suspension material adheres to the material, fatty residue is tinted by the colouring. Latent fingerprints on dark surfaces are created with the help of titanium dioxide or zinc carbonate particles (1).

Working

To make a suspension, you need to mix powder and surfactant together (SPRs). In addition, water is vital. Make sure your solution is completely clear by shaking it thoroughly after dissolving it in distilled water and adding 3 drops of surfactant. The treatment solution must not contain any clumps of suspension material (1). Quality, contrast, and efficiency are all affected by the SPR's composition. All non-porous surface samples were fingerprinted both before and after they were soaked in various solutions. We used acetic acid, sodium hydroxide, sodium chloride (w/v) concentrations of 10%, 30%, 50%, and 70%, as well as tap water, for a total of five soaking solutions. Each solution was used for 30 minutes. The results were compared with one another (14). Different development times have been observed depending on the surface characteristics and the quality of the fingerprints. There is a long and interesting history to this place. In post-processing, the item was given a gentle water rinse (15).

It was possible to remove any potential interference by using xenon source lights and filters based on the wavelengths used to examine the quality of papillary traces on the specimens (16). When using SPR or powder dusting procedures, it was formerly recommended that you employ volatile bases such as ethanolamine or triethylamine to prevent acidic non-porous surfaces from acquiring latent fingermarks (17). The working solution can be sprayed or dipped into the object, depending on its size and form, to create a unique fingerprint. Dips and sprays are the most effective treatment methods for both small and large items. Submersion was discovered to be the optimum method for making finger prints on electrical and duct tape with SPR-White (SPR-W) (18). The most effective method of washing was to take a gentle dip in a clear suspension liquid or clean water (15). Purified water should be used to rinse the treated area to ensure that the powder is completely removed (1). Paper towels should be used to wipe down non-porous substrates prior to the SPR process (19). Multiple recycling cycles may be possible depending on the number of items processed and the level of contamination in the suspension during processing (15). When evaluating fingerprint development, the Fingermark Quality Scale was used (20).

Assessment of SPR method

Using the Small Particle Reagent, wet porous or non-porous surfaces can produce latent fingerprints (SPR) (SPR). Latent fingerprints of sweat and sebum, as well as blood and various glair fingerprints, were created using this method. A surfactant and a powder make up the SPR aqueous suspension for use in the body. They absorb the powder and then change its properties by changing the ions or pairs of ions on its surface. The powder has the same charge as the powder if the active reagent ion is present. As a result of the repulsion of a similar charge, the active reagent powder, which contains lipophilic groups, is suspended in water along with the other powder, resulting in ridge impressions and fingerprints. Fingerprints were created on a variety of surfaces and in a variety of colors using various SPR solutions (21).

Reagent for removing fingerprints from the adhesive side of clear plastic tape. Latent fingerprints were improved by utilizing gentian violet and the powder approach, although researchers were not unsuccessful. When the tape was put up to the light, a high-quality latent fingerprint that had been there for a long time was revealed. Suspension material was used to print residue with the aid of Small Particle Reagent (SPR) Sealing, packaging, and even scotch and duct taping were all done with various shades of SPR to make fingerprints stand out (22). Creating a latent fingerprint from an arson simulation using a small particle reagent. Some methods for developing fingerprints have been reported to have been exposed to high temperatures or arson. SPR suspension was applied for two minutes, followed by a gentle stream of water for 30 seconds, followed by a normal air drying procedure. High-temperature and fire-resistant fingerprints were created using a brand-new zinc carbonate formulation (23).

Latent fingerprints can be created using Small Particle Reagent (SPR), which has a very low sensitivity to firearm analysis. Choline chloride and tergitol 7 were dissolved in distilled water to create a surfactant stock solution. After dissolving the molybdenum disulfide (MoS2) powder in the surfactant stock solution, mix in the grey paste. The final step in the preparation of the reagent was to mix the paste with distilled water. The firearms were cleaned with SPR by immersing them in the solution and then removing them to be cleaned with surfactant after they were rinsed. SPR, rather than cyanoacrylate ester fuming and black powder, was better suited to latent prints (24). The traditional Small Particle Reagent is molybdenum disulfide, which has a fine crystalline structure is used as a suspension material in SPR. The fatty components of the latent fingerprint residues bonded to the Molybdenum disulfide particles, forming a grey deposit. The surfactant will produce faint prints if it is not sufficiently soluble in the SPR solution, and if the concentration is too low, an incorrect ridge structure will develop. The use of ROCOL-AS powder and Molybond has yielded positive results (8).

A modified Small Particle Reagent (SPR) formulation has been developed to improve the contrast of developed latent fingerprints on dark surfaces. It was simple to use and was made of a white or light-colored substance. A white zinc carbonate (ZnCo3) was used in place of conventional SPR and dark-colored molybdenum disulfide. The formulation included zinc carbonate (0.66 g), water (20 ml), tergitol (0.06 g), and dimethyl ether (55 g) (25). A molybdenum disulfide-based SPR composition with tergitol-7 detergent and choline chloride was proposed (8). “Choline chloride was not required in SPR compositions, but the use of It was also suggested that xerox powder, lead oxide, cobalt oxide, and graphite be used instead of molybdenum disulfide particles” (8). SPR in tergitol based on titanium dioxide can also be used to develop latent fingermarks on wet plastic bottles (27). Using titanium dioxide-based SPR compositions, researchers have developed latent fingerprints on glass, plastic, and metal surfaces (28). Using

Kodak photo-flo 200 and a titanium dioxide-based SPR composition, both the adhesive and non-adhesive sides of the tape were treated with the composition (18). Latent fingerprints were created on wet, dark surfaces and the adhesive side of black electric tape using a composition of rutile titanium dioxide and SPR(29). For making bloody marks on dark, smooth, non-porous surfaces, a wet powder suspension based on titanium dioxide was suggested. Following presumptive blood tests, this substance was found to have no effect. Because it minimizes the amount of DNA detected in produced prints, this approach should be used only when additional DNA profiling from blood is not required (30). Blood stains do not interfere with STR typing after using the SPR technique (31). If you don't want to use amido black 10b and acid yellow 7, you can substitute SPR-W. It may be used to make both fresh and ancient blood prints on black-handled blades.(32).

When it comes to making latent fingermarks on smooth surfaces, the iron oxide-based SPR compositions outperformed the molybdenum disulfide-based SPR compositions (33). In a separate investigation, iron oxide-based SPR was discovered to be less sensitive than molybdenum disulfide-based SPR, which was discovered to be more sensitive. (34). When iron oxide-based powder was utilized on a smooth plastic surface, there were some changes in how latent fingerprints were processed and how well developed the prints were. (35). Terizide was also discovered to have black and silver fingerprint powder-based SPR compositions (36). Fingermarks that are not visible when the glass or plastic is wet can be created using the SPR method with some lysochromes (sudan black and oil red O) (37). Silver-gray SPR can create latent fingerprints on simulated vehicle-based improvised explosive devices that are not destroyed (IEDs)(38). Surfactant is a synthetic detergent that contains chemical compounds that might irritate your skin. People or the environment may be jeopardized (8). “Saponin, a natural detergent, can be employed in two suggested SPR formulations of charcoal powder and basic zinc carbonate to create latent fingerprints on a variety of surfaces, including compact discs. It has a lengthy shelf life and produces high-quality prints”(39).

The effectiveness of SPR formulations for detecting latent fingerprints on non-porous surfaces is being studied. Eleven SPR formulations were tested for latent fingerprint detection on wet nonporous surfaces, including three from the published reference and eight new modified ones. The salts and particles MoS2, Fe3O4, TiO2, and ZnO were used in each formula to create a variety of contrasts. The amount of particle and detergent were adjusted to achieve the best results. Before and after soaking in various soaking solutions, each set of non-porous surface samples (metal plate, glass, plastic, and ceramic) was imprinted with fingerprints. Fingerprint-covered objects were sprayed with each formula of the SPR to compare the eleven SPR formulations shown in the table (40). Latent fingerprints have been developed using unlit incendiary bottles, accelerant fluid-washed surfaces, and soot-covered incendiary glass surfaces. SPR was used to fingerprint the soot-covered glass surface of an incendiary bottle. Accelerant fluids were used to recover latent finger prints from glass surfaces with a success rate of 65 percent. To see if SPR suspensions of various compositions could improve the method, researchers tested them. “Fresh and 10-day-old fingerprints yielded the best results when a 50-ml water suspension of 0.4-0.6 ml tergitol detergent and 10 g Molybdenum disulfide particle was used (41)”.

During the investigation, fingerprints on compact discs were created using SPR, cyanoacrylate fumigation, and black powdering. Depending on the brand, data recovery and rewriting on CDs that have been treated with these techniques varies (25). An SPR combination of basic zinc carbonate and the dye eosin Y was applied to the surface of various types of compact discs while writing. On surface of it, a commercial liquid detergent was applied. The latent finger marks could be observed when the discs were played again. As a result, the discs did not suffer any degradation or damage during the transfer process. If the capacity of these compact discs was increased, more data could be stored on them (42).

To avoid a contrast problem with the normal SPR composition while developing prints on dark and wet surfaces, a zinc carbonate-based composition was recommended. The size of zinc carbonate powder influences how well developed markings are and how well zinc carbonate powder adheres to newly generated fingermarks (12). Print development quality is affected by compositional variables such as particle size in SPR composition. Researchers discovered that larger particles produced better results than smaller particles, with the latter producing disappointing results (11). On non-porous surfaces, latent fingermarks were formed by heating them to _900 _C for an hour before exposing them to an SPR mixture of basic zinc carbonate and eosin B. In terms of the quality and intensity of the fluorescent print, an SPR composition based on eosin B was superior. (43). Researchers discovered that applying high temperatures (_900 C) for an hour before processing improved bloodied marks on a variety of smooth surfaces (44).

Because of the superior print quality of zinc oxide-based SPR compositions, many non-porous substrates can benefit from the development of latent fingerprints (both fresh and aged). The fluorescence of lithium-doped zinc oxide is higher than that of pure zinc oxide (45). Because of the low contrast, traditional SPR cannot develop latent fingermarks on multi-colored surfaces. Immersion further reduces its effectiveness. what was the length of time the object was submerged in water (s). Fingerprints can be made on wet, multi-colored surfaces using SPR mixtures containing fluorescent dye and molybdenum disulfide. In an SPR composition, zinc carbonate was used, which has a low fluorescence impact (46). This SPR mixture is made up of zinc carbonate and fluorescent dyes.

Commercial liquid detergents containing crystal violet can be used to reveal latent fingerprints on wet, nonporous surfaces (47). They also claimed that SPR formulations containing basic zinc carbonate and dye, as well as commercial liquid detergent (for up to 36 hours), could aid in the appearance of fingermarks on a range of wet, multi-colored smooth surfaces (48). On wet, non-porous surfaces, an SPR mixture of basic zinc carbonate and titanium dioxide was utilized to create latent fingermarks (up to 10 days old). Marks were also created using zinc stearate and brilliant blue R-dye (49). When you combine basic zinc carbonate (ZnCO3), rhodamine B dye (Rh), and commercial liquid detergent (CLD) to generate a luminous SPR combination, chemical fingerprints are left behind, as shown below: (50). They sometimes employed fluorescent SPR to create fingerprint prints on aluminum foil, laminate sheets, and CDs that would stay even after being immersed in water or soil for extended periods of time (51). Basic zinc carbonate, crystal violet dye, and commercial liquid detergent were used to create latent fingerprints on wet and smooth surfaces that were both wet and smooth. These three things were combined to form an SPR combination. The quality of created prints is affected by the quality of the water used to make them (new or old) (52). Scientists devised a method for creating latent fingerprints in a variety of hues on wet, nonporous surfaces. They developed an SPR that made advantage of luminous cyan blue (53). The superior quality of prints made with basic fuchsin as opposed to compositions based on crystal violet (54).

In a comparison study, cyanoacrylate fuming was found to be more effective than SPR or powdering in developing latent fingerprints on glass and metal surfaces immersed in stagnant water. The method used to create fingerprints, as well as the amount of time they spend in stagnant water, can have an impact on their quality (55). In the development of latent fingermarks on dry surfaces, SPR is beaten by cyanoacrylate fuming (27). SPR is more effective than cyanoacrylate at developing water-soaked fingerprints, and it doesn't interfere with subsequent firearms analysis (56). "A study looked at how to obtain latent fingermarks on a variety of meals using the cyanoacrylate fuming, ninhydrin, SPR, and white powder suspension procedures. It was suggested that black magnetic powder and black powder suspension be employed (57). SPR formulations with zinc carbonate and dyes outperform cyanoacrylate fuming and powder dusting, two alternative methods for creating latent fingermarks on photographic film (58). Powder suspension was found to be superior than vacuum metal deposition for creating latent fingermarks on wet, non-porous surfaces such as glass".(59).

Conclusion

In criminal investigations, fingerprints are now widely accepted as a modern and accurate method of determining a person's identity. It's critical to use visualisation methods that focus on both the fingerprint's surface and the order in which it's displayed when dealing with wet latent fingerprints, which are frequently found at crime scenes. The SPR method is widely used due to its convenience, economy, and effectiveness. Using the SPR solution, we developed latent prints on paper, cardboard, and rusted metal. During the production of SPR, surfactant is used to suspend MDS particles in a dark grey solution. Other powder formulations have been tested in addition to iron oxide and molybdenum disulphide (MoS2). On dry or adhesive surfaces, the SPR formulation can be used for latent imaging. With latent fingerprints, SPR can detect water-damaged glass and metal surfaces. The amount of residue left behind by the finger varies greatly. The length of time the finger marks are submerged in water influences how many and how good the marks become. Using dyes that shine in the dark in Stimulated-Phase Resonance (SPR) can improve its performance. Fingerprints found on different surfaces, also on coloured surfaces. Future research should include variables such as substrates and liquids, as well as the surrounding environment and the passage of time.

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