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# A Literature on Development of Latent Fingerprint by Small Particle Reagent

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***Abstract:***
*The small particle reagent is essentially a suspension of an insoluble powder in solution of a surfactant by which latent fingerprint on wet surfaces can be developed. SPR is sensitive towards the lipid constituents in the latent fingerprint residues. Adherence of fine particles suspended in a treating solution to the fatty or oily constituents of latent fingerprint residues accordingly may be regarded as a same as methods as powder dusting method. Small particle reagents consisting of suspension of fine particle (Molybdenum disulfide) in detergent the particle adhere to the fatty constituents of latent fingerprint residues. Conventional SPR contains dark grey coloured Molybdenum disulfide particles, suspended in detergent which gives effective result on non-porous surfaces. use of graphite, cobalt oxide, lead oxide, Xerox powder and monastrol blue dye has also been used. The powder suspension is commonly referred to as small-particle reagent (SPR), and the technique is essentially a wet powdering method. The powder suspension is sensitive to the sebaceous (water insoluble) components of the latent fingerprint and can be used on a wide range of non-absorbent surfaces.*

***Keywords:*** *Review of development of latent fingerprint by SPR*

**1. Introduction**

Most important part of forensic investigation is fingerprint examination. As fingerprints are unique to each individual and are permanent, they serve as a highly accurate way for law enforcement agencies to identify a suspect as well as potentially prove their guilt or innocence. The purpose of Fingerprint is an impression or mark made on surface by a person's fingertip. Fingerprints are still one of the most important evidences left during the commission of a crime. There are generally three types of fingerprints found at the crime scene [i].

1. Visible or patent prints.
2. Plastic or impression prints.
3. Latent prints.

Fingerprints are a reproduction of friction skin ridges found on the palm side of the fingers and thumb. These skin surfaces have been designed by nature to provide our bodies with a firmer grasp and resistance to slippage. Friction skin ridges have series of lines corresponding to hills (ridges) and valleys (grooves). The shape and form of the skin ridges have seen as the black lines of inked fingerprint impressions. Skin is composed of layers of cells the outer layer is known as epidermis and inner layer is known as dermis. The shape of the boundary of cells is made up of dermal papillae, separately these two layers, determine the form and pattern ridges on the surfaces of the skin. Once the dermal papillae develop in the human foetus, the ridge pattern will remain unchanged throughout life [ii]. Each skin ridge is populated by a row of pores, that is, opening for the duct of sweat glands (eccrine gland) the perspiration or the sweat is discharged and deposited on the surface of the skin. The secretion got mixed with the secretions from the sebaceous and apocrine glands present on other surfaces of the body, picked up by touching other parts of the body. These secretions got transferred to the surfaces, thereby leaving fingerprint impression. These prints are known as latent fingerprints as they are invisible to the naked eye [iii].Development of fingerprints involves producing sufficient contrast between the fingerprint and surface while conserving the ridge details. Methods available for visualizing latent fingerprints have been primarily formulated on the basis of constituents of the latent print residue with secondary parameters like ambient conditions, surface characteristics, age of fingerprints. Among all the methods, powder dusting and ninhydrin are the most commonly employed processing techniques [1]. Apart from these, other methods are also used including Small Particle Reagent, Physical developer, Vacuum metal deposition Cyanoacrylate fuming etc. [iv]. Conventional SPR contains dark grey coloured Molybdenum disulfide ($MoS_2$) particles suspended in detergent, which gives effective result on non-porous surfaces. The powder suspension is sensitive to the sebaceous (water insoluble) components of the latent fingerprint and can be used on a wide range of non-absorbent surfaces [v]. The SPR solution has been successfully used to develop latent prints on porous and nonporous surfaces [vi]. However, the results depend upon the amount of residue deposited by finger. The

time of exposure of finger marks to the effect of water also influences the number and quality of developed marks. So, further and wider research should be therefore undertaken, in which other variables should be introduced such as different substrates, other type of liquid, environmental and time factor [vii]. So, it is becomes necessary to conduct a discussion of small particle reagent technique to examine latent prints on difficult substrates and conditions, which may be helpful for forensic examiner. In this study, an endeavor has been made to review various studies conducted by different workers to investigate and evaluate different formulations of SPR used to develop latent fingerprints under different conditions.

**2. Literature Review**

The conventional Small Particle Reagent (SPR) is a suspension of dark grey Molybdenum disulfide that has fine crystalline structure which proved to be critical for effective fingerprint development. Molybdenum disulfide particle was suspended in detergent. Detergents were used as a surfactant (surface active agent) and Molybdenum disulfide were used as a suspension material. The particles adhered to the fatty constituents of latent fingerprint residues and formed a grey Molybdenum disulfide deposit. Results obtained by using molybdenum disulfide from different sources were strongly influenced by variations in their structure. In SPR solution, the surfactant should be sufficiently soluble to achieve the optimum working concentration as excess of it would be result in development of faint prints and low concentration would develop improper ridge structure. Good result has been obtained using ROCOL-AS powder and Molybond [v].

Development of latent fingerprints on wet firearms and variety of water soaked items. Latent fingerprints were developed by Small Particle Reagent (SPR) with negligible effect on firearm analysis which could be a valid technique for developing latent fingerprint. Six different firearms, each composed of different materials, were immersed in water at different time interval ranging from 8 to 35 days. The surfactant stock solution was prepared by combining 4g of choline chloride and 8 ml of tergitol 7 in 500 ml of distilled water. The working solution was prepared by adding 10g of Molybdenum disulfide ($MoS_2$) powder to 50 ml of surfactant stock solution to form a grey paste in which all the dried powder is wetted. The paste was then added to 900 ml of distilled water to complete the preparation of reagent. All six weapons were immersed in water for eight to fourteen days. The firearms were processed with SPR in two steps. In the first step, the firearms were immersed in SPR for 45 to 60 seconds allowing the particles to settle on the firearm. In the second phase, firearm was removed and rinsed with surfactant. Preservation of the suitable prints was achieved through photography and lifted by adhesive tape. Overall, SPR yielded more suitable latent prints than cynoacrylate ester fuming followed by black powder. In some instances, processing with SPR revealed suitable impressions after the firearms were submerged in water for one month, whereas processing with cynoacrylate fuming followed by black powder revealed fewer impressions when the firearms were submerged for only one week. SPR preserved the individual characteristics of a firearm better than cynoacrylate ester fuming followed by black powder [viii].

Modified Small Particle Reagent (SPR) formulation is to improve the contrast of developed latent fingerprints on dark surface. It was based on the substance that is white or light coloured and was easy to apply. Zinc Carbonate ($ZnCo_3$), a light colour material was used to replace substance that gives conventional SPR and dark colour molybdenum disulfide. The formulation was: Zinc carbonate (0.66 g), water (20 ml), tergitol (0.06 g), and dimethyl ether (55 g) that gives better contrast result on dark surfaces [ix].

Small Particle Reagent for the development of latent fingerprints on dark multicoloured surfaces. Fluorescent SPR was prepared with the addition of a fluorescing agent, Brilliant Yellow 40 (BY-40) for improving contrast of developed fingerprints on dark or multicoloured background under excitation in blue range of spectrum. BY-40 was mixed with SPR stock solution and was then diluted to a working suspension. SPR stock and working suspension were prepared according to the procedure suggested by the manual of fingerprint detection technique. Prints were placed on various types of multicoloured objects such as multicoloured glossy paper, multicoloured cola cane, black polythene and glass slide. The BY-40 SPR suspension was sprayed on the surface. Developed prints were examined in white light and with the Rofin Polylight 300 watt light source. Excitation was made at 450 nm, 505 nm and 530 nm with observation above 549nm [x].

The methods of developing latent fingerprints on unignited incendiary bottles, a surface that had been washed by accelerant fluid and soot covered incendiary glass surface of ignited incendiary bottles. SPR was used for developing latent fingerprint on the soot-covered glass surface of ignited incendiary bottle. Latent finger prints were recovered from glass surfaces washed by accelerant fluids with a 65% success rate. Different compositions of SPR suspensions were tested to optimize the method. A suspension of 0.4-0.6 ml tergitol detergent and 10 g Molybdenum disulfide particles in 50 ml water gave the best result with fresh and 10-days-old fingerprints [xi].

Small Particle Reagent for development of latent fingerprint on wet nonporous and porous surfaces. SPR is a processing agent that comes in contact with the fingerprint residues in a liquid form and can be easily employed to wet non-porous and porous items for latent prints development. Latent print is composed of water, amino acid, oils and few other substances, so the addition of water on the surface compounded difficulty to develop latent prints. However, the oily component of latent print is occasionally left behind on wet surfaces. SPR has two components, one is suspension material and another is surfactant detergent solution. The two components were mixed together to form a liquid suspension. The SPR mixture could be applied by using the submersion or spray technique. SPR developed prints should be preserved as soon as possible. They should be photographed on the surface before any lifting technique is attempted. SPR was also used to develop latent prints on dry surfaces [xii].

Small Particle Reagent (SPR) for the development of latent fingerprint on dust covered plastic bottle. The formulation of SPR is based on Titanium Dioxide and tergitol (detergent). After washing, the surface was sprayed with SPR reagent to highlight latent dermal tracks on the bottle surface. Latent fingerprints present on wet non-porous surfaces were successfully exalted, as the SPR technique relies on the adherence of fine particles suspended in a treating solution to the fatty constituents of latent fingerprint residue [xiii].

Evaluation of various formulation of Small Particle Reagent (SPR) for the detection of latent fingerprint on non-porous surfaces. Objects were moistened by soaking in various solutions to represent water from different sources. Eleven number of SPR formulations were evaluated including three formulations (SPR I, II, III) from the published reference and eight new modified ones for latent fingerprint detection on wet non-porous surfaces. Each formula was different in its salt and particles used, such as $MoS_2$, $Fe_3O_4$, $TiO_2$, ZnO, and $ZnCO_3$ so as to create different contrasts. In addition, the proportion of particle and detergent was also varied in order to evaluate the best results. The fingerprints were impressed on each set of the non-porous surface samples (metal plate, glass, plastic and ceramic) before or after soaking in various soaking solutions. Soaking solutions evaluated were: acetic acid pH 5.5, NaOH pH 8.0, NaCl solution at 10, 30, 50 and 70% (w/v), and tap water, and were used for 30 min. All objects bearing fingerprints were sprayed with each formula of SPR in order to compare eleven types of SPR formulations shown in the table for various formulae of SPR with particle ratio and pH of solution [xiv].

| SPR formulae | % (w/v)particles | % (w/v) tergitol NP-7 (detergent) | % (w/v) choline chloride | Particle detergent ratio | pH |
|---|---|---|---|---|---|
| | **Dark particle** | | | | |
| SPR I | $MoS_2$-10 | 0.8 | 0 | 12.5 | 2.45 |
| SPR II | $MoS_2$-1.05 | 0.08 | 0.4 | 13.1 | 3.1 |
| SPR III | $MoS_2$-1.43 | 0.11 | 0 | 13 | 3.1 |
| SPR VII | $Fe_3O_4$-10 | 0.8 | 0 | 12.5 | 7.42 |
| SPR XI | $Fe_3O_4$-1.05 | 0.08 | 0.4 | 13.1 | 8.2 |
| | **White particles** | | | | |
| SPR IV | $TiO_2$-10 | 0.8 | 0 | 12.5 | 7.12 |
| SPR V | ZnO-10 | 0.8 | 0 | 12.5 | 6.42 |
| SPR VI | $ZnCo_3$-10 | 0.8 | 0 | 12.5 | 8.7 |
| SPR VIII | $TiO_2$-1.05 | 0.08 | 0.4 | 13.1 | 7.4 |
| SPR IX | ZnO-1.05 | 0.08 | 0.4 | 13.1 | 7.4 |
| SPR X | $ZnCo_3$-1.05 | 0.08 | 0.4 | 13.1 | 8.4 |

*Table 1*

With respect to the use of dark particles, the best quality of latent print on wet non-porous surfaces was obtained from SPR II which contains Molybdenum Disulfide tergito NP-7 and choline chloride at a pH of 3.1. Poor results were obtained from all SPR compositions containing white particles. The principle of the SPR is based on the reaction between the components in the traces and the hydrophobic tails of each specific reagent. These tails are linked to the hydrophobic heads which react with metal salt to give a precipitate. Choline chloride is one such water soluble organic compound with a hydrophilic tail. Thus the presence of choline chloride in SPR II may help to enhance the effectiveness of this formula by giving more attachment sites between the metal salt and the hydrophilic head based upon its polar property.

Small Particle Reagent for the development of latent fingerprint from arson simulation. Fingerprints were exposed to extreme condition like fire or arson where electromagnetic radiations, soot deposition, and high temperature were the generated forces in fire which may affect the fingerprints at the scene. Different types of development techniques for visualisation of fingerprints exposed to arson and high temperatures were reported. Cynoacrylate fuming and aluminium powder followed by BY-40 was reported. Two formulations were prepared, that is, Zinc carbonate, Eosin B, Eosin Y, detergent and distilled water and second formulation was suspension of Zinc carbonate in distilled water, Eosin Y, and commercial detergent. SPR suspension was poured on the suspected sample and after waiting for two minutes surface was washed with a gentle stream of water for 30 sec and then allowed to dry under normal condition. Good quality of fingerprint was developed. The novel Zinc carbonate formulation was highly effective means for development of latent fingerprints exposed to high temperatures and fire [xv].

Small Particle Reagent to obtain latent fingerprints from the adhesive side of clear plastic tape. In this study, some evidence from a home invasion robbery and tape used by the suspect to bind the victim was used as substrate. The tape revealed a very good quality latent fingerprint when held up to the light. Various methods such as gentian violet and powder method were used to enhance latent fingerprint but unable to achieve good result. Then Small Particle Reagent was used and suspension material adhered to the print residue. Different colours of SPR were used for enhancing fingerprints on various types of sealed, packaging, scotch and duct tapes [xvi].

The Small Particle Reagent (SPR) for development of latent fingerprint on wet porous or non-porous surfaces. The method developed sweat latent fingerprints, sebum latent fingerprints, blood latent fingerprints, and different kind of glair fingerprints. The single colour small particle reagent has limited application so, a series of different colour small particle reagent were developed to develop fingerprint on different colour surface. The SPR is a kind of suspension which is composed of a certain quantity of powder, surfactant and some water. The ionic active reagent ions absorb the surface of the powder through changing ions or pair of ions. Then the powder carries the same charge as the active reagent ion. Because of the repulsive force of the same charge, the powder were suspended separately in the water at the same time, the powder with the active reagent absorbed by the ridge impression and fingerprint develop by the sorption between the lipophilic groups and the sebum molecules and the force between molecules. In this study most of the surfaces used were non-porous such as glasses, aluminium alloy and tiles. And semi-porous such as plastic, PVC,

and painted woods, porous surfaces such as black paper and painted paper. The substance includes sweat, sebum, grease, blood, saliva and milk. The visualization of fingerprints on glasses, aluminium alloy, tile, painted woods, PVC, plastic, black paper and painted paper with the SPR solution. Different solution of SPR was used to develop fingerprint on different surface and different colour surfaces [xvii].

**3. Conclusion**

The importance of the SPR method for visualization of latent fingerprints on porous and non-porous, wet and dry surfaces has been reported. Small Particle Reagent is a technique for developing latent prints on water-soaked items and includes porous and non-porous surfaces. The SPR solution has been successfully used to develop latent prints on paper, cardboard, metal, rusty metal, rocks, concrete, plastic, vinyl, wood, and glass. Similarly, latent prints have been developed on sticky surfaces, such as soda canes and candy wrappers. SPR reagent-developed latent prints can be lifted with clean lifting tape. The aqueous suspension of powder is sensitive to the sebaceous components of the latent fingerprints. SPR is a suspension of dark grey molybdenum disulfide particles in surfactant. Many powder formulations have been investigated that include molybdenum disulfide ($MoS_2$), iron oxide etc. Small Particle is most well known for its ability to develop latent prints on wet surfaces, such as vehicle wet with rain or even recovered from a lake or pool. This solution can even be used underwater as long as the spray bottle has sufficient force to propel it through the water. It can be used on surfaces having a residue, such as soda pop running down the side of cane. Trying to apply regular powder to the item could damage the latent print brush and/or ruin the latent print. The formulation has also been modified to develop the fingerprints on dark and multicoloured surfaces. They include SPR on zinc carbonate or titanium dioxide with or without combination of various fluorescent dyes. SPR formulation works satisfactorily to develop latent prints on dry surfaces as well as on adhesive tapes. SPR method is also proved to be more effective for developing latent fingerprints on glass and metal surfaces exposed to water from longer period. However, the results depend upon the amount of residue deposited by finger. The time of exposure of finger marks to the effect of water also influences the number and quality of developed marks. After reviewing the literature, it has been suggested that further and wider research should done in, which different variable such as different substrates, other type of liquids, environmental and time factors should be introduced.

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