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Development of Aged Latent Fingerprints from Non-Porous Surfaces using Molybdenum Disulphide

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Abstract:

Molybdenum disulfide (MoS_2) is one of the most commonly utilized small particle reagents (SPR) for revealing latent fingerprints on wet, non-porous surfaces like glass, metal, steel, aluminum, and plastic. Its high surface concentration, lubricating properties, and strong adhesive qualities with fingerprint residues give MoS_2 a distinct advantage over surfaces that are typically too slippery or reflective to yield results with traditional fingerprint powders. This study focused on developing latent fingerprints from various non-porous surfaces that had been submerged in water. Samples were collected from these surfaces and exposed to environmental conditions. A total of 15 samples were collected to assess the effectiveness of MoS_2 over different time intervals. The objective was to evaluate the performance of MoS_2 in revealing aged fingerprints.

Keywords: *MoS2, Fingerprint, Non-Porous Surfaces, Ageing Studies, Latent Prints.*

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Introduction

Fingerprints are one of the most dependable types of personal identification in forensic science since they are unique and remain constant throughout an individual's life **(Carter *et al.*, 2020).** The identification and development of latent fingerprints is critical in forensic investigations, especially on non-porous surfaces where standard fingerprint powders may be useless **(Verma *et al.*, 2021)**. Molybdenum disulfide (MoS_2) is a well-known small particle reagent (SPR) that has excellent adhesion to fingerprint residues on difficult-to-remove surfaces such as glass, metal, aluminium and plastic **(Sodhi and Kaur, 2012)**. It is lubricating characteristics and high surface concentration make it an excellent choice for creating prints on surfaces that are frequently too reflective or slippery for traditional procedures **(Passey *et al.*, 2021)**. The identification and development of latent fingerprints is critical in forensic investigations, especially on non-porous surfaces where standard fingerprint powders may be useless. Molybdenum disulfide (MoS_2) is a well-known small particle reagent (SPR) that has excellent adhesion to fingerprint residues on difficult-to-remove surfaces such as glass, metal, aluminium and plastic. It is lubricating characteristics and high surface concentration make it an excellent choice for creating prints on surfaces that are frequently too reflective or slippery for traditional procedures.

Recently, Molybdenum Disulphide (MoS_2) has received interest for its possible use in forensic examination of old latent fingerprints. This substance is a transition metal dichalcogenide (TMD) with special features that make it extremely successful in detecting latent fingerprints, even ones that have aged and deteriorated **(Singh, 2022)**. MoS_2 may absorb fingerprint remnants and interact with oils and perspiration, improving the contrast of fingerprint ridges under certain light sources **(Zhang *et al.*, 2019).** This study examines how MoS_2 may help in developing latent fingerprints under different environmental circumstances, such as water. Fingerprint samples obtained from various non-porous surfaces at different time intervals were analyzed **(Sahani *et al.*, 2020).**

Materials and Methodology

Preparation of Working solution

The working solution was prepared by taking a clean beaker and 3 gm of Molybdenum Disulphide (MoS_2) was added to the same. Then, 50 ml of distilled water was added to the beaker to form the base of the solution. 3 to 4 drops of commercial liquid were added to disperse the MoS_2 particles in the solution. Then, 10 drops of Crystal Violet dye were further added to enhance the prints and to make more visible prints. The entire solution was mixed well for 10-15 minutes.

Methodology

Latent fingerprints were collected on various surfaces and marked, to identify the latent print. The samples were submersed in water filled chamber. The sample surfaces chosen include- glass slide, Compact disc, aluminium cover, plastic lid, and metal piece. The samples were submersed for various time intervals – 24 hours, 48 hours and 72 hours. The samples were removed from water after the specified time interval and the solution of MoS2 was sprayed. The solution was left on the surface for 5 minutes to bind to the latent print. Excess solution was washed with the help of running water.

Result

MoS_2 demonstrated high-quality developmental results on glass surfaces for the period of 15 days. (Grade 5). It provided a long-term efficacy on plastic lid and compact disc surfaces with a Grade ranging from 2-5 after 24 hours. Metal surfaces was found rusting due to the contact with water after 24 hours decreasing the quality of development to its lowest grade of 1. MoS_2 was observed to develop finger marks from aluminium surfaces and the grade of development was observed to be 4.

Table No. 1: Grades for developed fingerprints on wet non-porous surfaces.

surface	24 hours	48 hours	72 hours
glass	5	5	5
plastic lid	2	4	5
aluminium cover	1	3	4
compact disc	3	4	5
metal piece	4	2	1

Table No. 2: Finger marking quality scale

Grade	Description
0	No visible prints
1	Very poor quality, no visible ridges or very few visible ridges
2	Poor quality, some ridge details visible or partial mark with limited characteristics
3	Reasonable quality, ridge-details and, identification possible
4	Good quality prints, ridge-details and characteristics visible, probable identification
5	Excellent quality, clear prints, identification assured

The study evaluated the effectiveness of MoS_2 in creating latent fingerprints on wet, non-porous surfaces across different time periods. The quality of the produced fingerprints was evaluated after 24, 48, and 72 hours of exposure. The ratings for the developed fingerprints are summarized in Table 1.

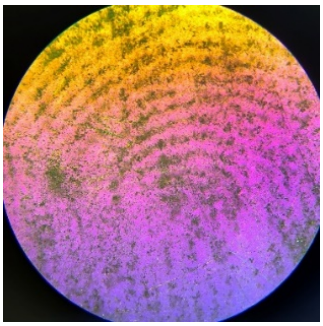

Figure No. 1: CD of 72 hours

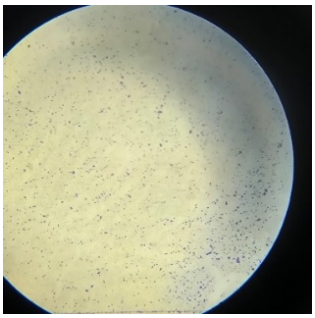

Figure No. 2: Plastic lid of 48 hours

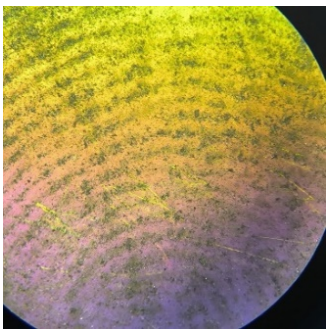

Figure No. 3: CD of 48 hours

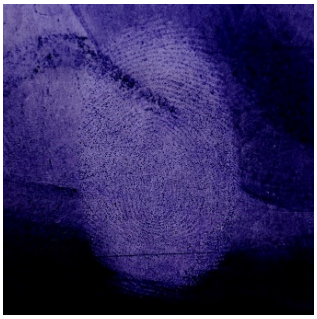

Figure No. 4: plastic lid of 72 hours

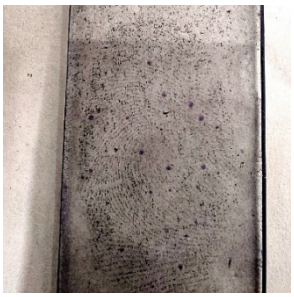

Figure No. 5: glass slide of 72 hours

Figure No. 6: aluminium cover of 72 hours

Discussion

The study found that MoS_2 is successful in producing latent fingerprints on moist non-porous surfaces, however print quality varies by surface and time. Throughout all time intervals, glass surfaces produced constant excellent-quality fingerprints (Grade 5). Previous research, like **(Kukucka *et al.*, 2020),** have found MoS_2 to be highly effective on smooth, non-porous surfaces. Glass surfaces have a relatively smooth texture, which promotes fingerprint adherence and growth, resulting in high-quality prints even after lengthy exposure.

Fingerprint quality on plastic lids and compact discs increased with time, with ratings ranging from 2 to 5. This shows that MoS_2 may perform better on specific materials when the reagent has more time to adhere to

the surface. **(Johnson and Riemen, 2018)** observed that the efficiency of MoS_2 is tied to its surface features, which improve with time as the chemical interaction between MoS_2 and fingerprint residues improves. These findings are consistent with our findings. Aluminium covers and metal parts, on the other hand, revealed a considerable reduction in fingerprint quality with time (Grade 1 after 72 hours). Metal surfaces may not effectively hold MoS_2 particles due to reflective qualities and surface features, resulting in a reduction. **(Zhang *et al.*, 2019)** observed a decrease in quality on metal surfaces due to decreased MoS_2 adhesion over time.

Comparison with Prior Research: Our results reinforce the conclusions of previous studies regarding MoS_2's effectiveness but also provide additional insights into surface-specific variations **(Madkour *et al.*, 2017)**. The study by **(Kukucka *et al.*, 2020)** showed consistent results on smooth surfaces like glass, but our study further emphasizes the role of time in developing fingerprints on more complex surfaces like plastic and metal. MoS_2's superior performance on plastic and glass supports its potential as a useful SPR for forensic applications.

Conclusion

This study concludes that the Small Particle Reagent (SPR) methodology is an effective method for developing latent fingerprints on a variety of wet non-porous surfaces, with the exception of metal surfaces, where the quality of the generated prints decreased over time. The study found that SPR, using Molybdenum Disulphide (MoS_2), can produce fingerprints up to 72 hours old, making it a useful tool for forensic investigations on submerged or damp surfaces.

These findings highlight the efficiency of MoS_2 in forensic applications, particularly in recovering fingerprints from wet and non-porous surfaces, which are typically challenging for traditional fingerprint powders.

Future study might improve the dependability of MoS_2 in forensic investigations by applying it to a wider range of surfaces and environments. Combining MoS_2 with other dyes may enhance fingerprint recovery from complicated and polluted surfaces, broadening its use in crime scene investigation and forensic science.

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