

POSME Suspension Powder for Aged Latent Print Development: A Limited Replication Study and Review

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Abstract: In a recently published JFI article [1], the Central Fingerprint Development Laboratory or Unitat Central d'Inspeccions Oculars in Barcelona, Spain detailed the development and use of a suspension powder named Powder Suspension of Mossos d'Esquadra (POSME). This suspension was designed specifically to enhance visualization of aged latent prints on a variety of surfaces. The Omaha Police Department Latent Print Examination Squad replicated two components of this study (glass and plastic) and added a new surface, a vehicle car door. The results of this performance study supports the conclusion of the original researchers that the application of POSME suspension powder solution after the use of traditional powders enhances visualization of latent print ridge detail on certain non-porous surfaces.

Introduction

The processing of latent prints that have aged or have been exposed to temperature fluctuations and sunlight has been a challenge for Omaha Police Department (OPD) crime scene

responders when utilizing powder processing alone. Several of the most common surfaces encountered by OPD crime scene technicians such as vehicles, doors, and windows, are typically processed with powders or suspension powders alone. This limitation exists due to these surfaces being processed in situ and the operational constraints of the agency (case load and staffing levels are not conducive to the use of multiple methods for expediency's sake). The Unitat Central d'Inspeccions Oculars (UCIO)'s development of the Powder Suspension of Mossos d'Esquadra (POSME), an easily mixed suspension powder composed of the readily available lab materials (water, ethanol, polysorbate 80, and iron-oxide powder), is of unique interest to a high-volume inspection lab such as OPD.

Previous literature regarding the use of suspension powders and the efficacy of processing aged prints was provided in the original publication by UCIO [1]. To test the efficacy of the POSME suspension within the OPD operational environment, the development of aged latent prints on plastic and glass was evaluated. Based on the experience of OPD crime scene technicians, plastic bags were expected to have lower visualization of aged prints using powder alone while glass slides were expected to have higher visualization using powder alone. This study specifically explored whether the use of POSME changed the quality of the friction ridge development on these surfaces when the variables of time and extreme heat were included (similar to the UCIO original study). In addition, OPD conducted trials of the POSME suspension on aged prints placed on the exterior of a vehicle door. On each of the three surfaces (glass, plastic, and car door) the quality of the developed latent prints was compared under the following conditions:

- Black powder only

- POSME suspension only

- Black powder followed by POSME suspension.

Materials and Methods

Surfaces

The surfaces in this performance study included a set of forty (40) glass microscope slides and forty (40) polyethylene grocery bags obtained in Lincoln, Nebraska from two regional commercial stores. Additionally, a front passenger door from a tan Chevrolet Impala was provided by the City of Omaha

Impound. The exact paint blend and chemical consistency is unknown, but the typical paint applied to this type of passenger vehicle is an acrylic polyurethane enamel composed of a paint basecoat and clear topcoat.

The forty plastic bags and forty glass slides were divided into Set A (to be stored in a temperature-controlled building) and Set B (to be stored in a vehicle outside). The bags and slides in Set A were labeled 1A - 20A and in Set B were labeled 1B - 20B. A bisected rectangle was traced onto each plastic bag for uniformity in deposition of the latent prints. A line was not drawn on the glass slides out of concern that the line would obscure visualization. Participants were instructed to center the distal portion of their finger on the slide and ensure that contact was made on both the upper and lower portions of the slide. In retrospect including the line on the slides may have ensured more accurate application of powder. The car door was also sectioned into a 2 x 10 grid of bisected rectangles and the rectangles were labeled 1-20. The purpose of drawing these bisected rectangles was to be able to powder the bottom half, then apply the solution to both halves, thus creating a series of powder only (bottom half), POSME only (top half), POSME after powder (bottom half again).

Deposition and Storage

Twenty (20) donors (14 women and 6 men) from the OPD Forensic Investigation Unit (FIU) placed fingerprints on each of the above objects. Each donor was assigned a number and instructed to deposit a set of three impressions on each surface for a total of 9 impressions per individual using the same finger per surface with moderate deposition pressure. Each donor placed their index finger three times in a row on a surface, creating a depletion series on that surface. After depositing a depletion series on one item, the subjects recharged the finger with body residue to restart a depletion series on the next item. A different finger was used for each surface (e.g., right index finger on glass slides versus left index finger on plastic bags) to provide the best initial touch per surface.

In keeping with the original study in Barcelona, Spain, the test items were stored over the summer for 45 days. Set A (glass slides and plastic bags) were stored inside a cabinet in the FIU laboratory at a controlled temperature of 73 °F / 23.4 °C and 45% relative humidity from July 19 through September 1, 2023 (45 days).

Set B (glass slides and plastic bags) were stored in an open cardboard box in the front driver seat of a vehicle with doors and windows closed and parked outside in an unshaded area of the OPD Northwest Precinct lot from July 19 through September 1, 2023 (45 days). The average exterior daytime high temperature in Omaha during this time span was 87 °F / 31 °C, (Max: 102 °F / 39 °C, Min: 75 °F / 24 °C, Mode: 83 °F / 28 °C). The vehicle interior temperature and relative humidity averaged above 100 °F / 38 °C. (Note: the actual interior temperature cannot be accurately verified as the temperature gauge used was unable to record temperatures over 110 °F / 43 °C.)

The car door was stored in a non-temperature controlled enclosed biohazard processing room in the garage at OPD central headquarters. The average temperature of this room was 81 °F / 27 °C and 48% relative humidity.

The storage areas for the plastic bags and glass slides were selected to compare the performance of the development techniques on these surfaces with latent prints aged in a controlled environment to the performance on latent prints aged with temperature fluctuation, high heat, and sun. The painted metal surface (vehicle) was included in the study to assess the performance of the powder and powder suspension with latent prints aged on a painted metal surface in an uncontrolled environment (with slightly higher than room temperature heat) without exposure to elements, as may occur with latent prints deposited on a vehicle parked in a garage versus exposed to rain and hail in a parking lot.

Recovered stolen vehicles stored in a temperature-controlled environment were deemed unlikely to be encountered on a frequent basis in casework. Vehicles are frequently recovered outdoors and subject to any number of environmental conditions, including rain, hail, wind, dirt, and sun. Additional research into various environmental conditions would be beneficial, particularly in Nebraska where extreme temperature and weather fluctuations are common. This suggests an area for further study. Future tests should determine if the results are more than negligible after degradation from the elements during a hot summer. Nebraska is an ideal place for such a study due to the extreme temperature and weather fluctuations in this climate region.

Processing and Documentation

The latent prints were aged on all surfaces for 45 days. The lower half of latent impressions were processed with Sirchie Silk Black fingerprint powder using a squirrel hair brush and photographed using a Canon R5 with a 100mm macro lens.

The POSME solution was composed of Sirchie Adhesive-Side Powder Dark ®, polysorbate 80, ethanol, and distilled water. The POSME solution was mixed just prior to application on the surfaces and quality checked with a freshly deposited latent print. Of the four iron oxide powders tested by the Mossos de Esquadra researchers (Bayferrox 318M ®, BVDA Suspension Powder Black ®, Sirchie Adhesive-Side Powder Dark ®, and Synox Black 6318 ®) [1], the Sirchie adhesive-side powder was selected because it is routinely purchased by OPD.

A carrier solution for the powder suspension was prepared by mixing 600mL of distilled water with 60mL of ethanol in a glass container with a magnetic stirrer at 800 rpm for 5 minutes. While the solution stirred, 220mL of polysorbate 80 was very slowly added. The carrier solution was stirred an additional 15 minutes before being stored in a dark glass container. The POSME suspension was completed by combining 200mL of the carrier solution with 150g of Sirchie adhesive-side powder in a bottle and vigorously shaking the bottle by hand for at least a minute until all the powder was mixed [1]. The completed suspension was stored in a glass bottle. The powder suspension was applied to both halves of the rectangles using a freshly washed squirrel hair brush. Care was taken to apply the solution to the unpowdered portion first to minimize transfer of powder. The upper half of each impression (POSME development alone) and the lower half of each impression (POSME applied after black powder processing) were subsequently photographed using the Canon R5 with macro lens.

The developed fingerprint impressions were graded using a quality scale described in both the POSME article and the previous WET UCIO article published by the Mossos d'Esquadra UCIO researchers. The quality scale, shown in Table 1, is based on the surface area of the latent print developed and the quality of the ridge detail. Two latent print examiners viewed the images together and consulted to assign each latent print a score from 0 to 4. A score of 0 indicates no ridge detail was visualized, while a score of 3 or 4 indicates strong or very strong development of detail, respectively [1, 2, 3].

Score	Description
0	Null: no evidence of a mark
1	Weak: Evidence of contact but no ridge details are observed
2	Limited: Ridge detail present up to 1/3 of the fingerprint area
3	Strong: ridge detail developed between 1/3 and 2/3 of the fingerprint area
4	Very Strong: Ridge detail developed more than 2/3 of the fingerprint area

Table 1

Quality scale used to score the developed latent prints.

Results

Glass Slides

The bottom halves of the latent prints on the glass slides from Set A (inside) and Set B (outside) were processed with black powder. Figure 1 and Figure 2 are examples of latent prints developed with black powder only on the glass sides in Set A and Set B, respectively. Powder resulted in eight latent prints scoring 3 or 4 in Set A and nineteen in Set B.

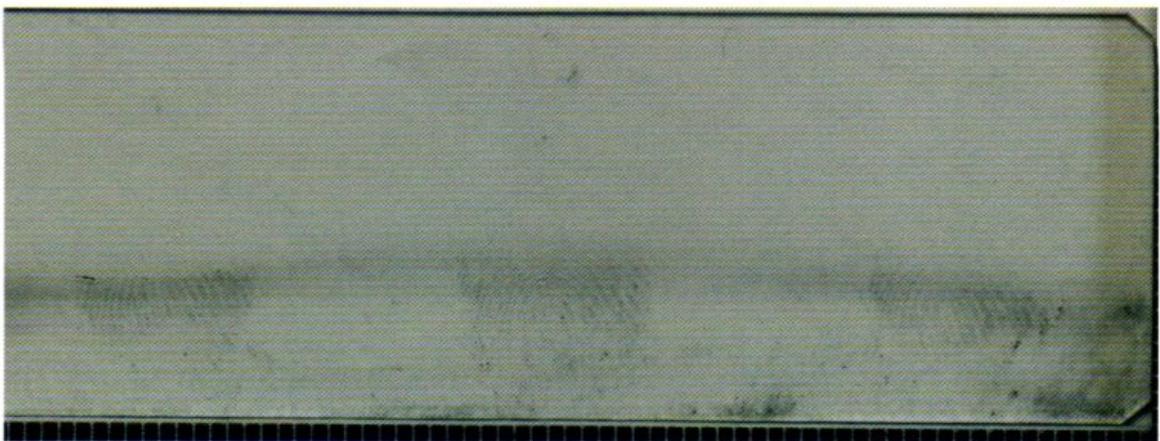


Figure 1

Examples of powder development of the bottom halves of latent prints on the glass slides in Set A (stored inside).



Figure 2

Examples of powder development of the bottom halves of latent prints on the glass slides in Set B (stored outside).

The latent prints on the glass slides in Set A (inside) and Set B (outside) were processed with POSME to evaluate of the quality of the ridge detail in the top half of each latent (POSME only) and the bottom half (POSME after powder). Figure 3 and Figure 4 are examples of latent prints developed with POSME on the glass sides in Set A and Set B, respectively.

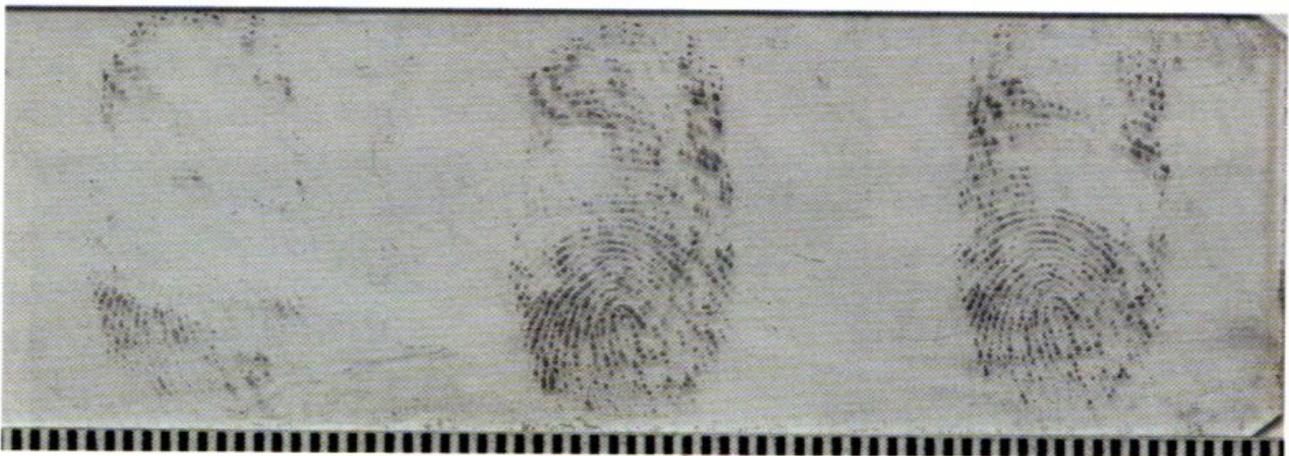


Figure 3

Examples of POSME development of latent prints on the glass slides in Set A (stored inside). The top half of each latent print is POSME only, while the bottom half is POSME after powder.



Figure 4

Examples of POSME development of latent prints on the glass slides in Set B (stored outside). The top half of each latent print is POSME only, while the bottom half is POSME after powder.

The top halves of the latent prints in Figure 3 and Figure 4 represent POSME only. POSME on the top halves resulted in thirty-one latent prints scoring 3 or 4 in Set A and thirty-five in Set B. POSME after powder (bottom halves of latent prints) resulted in forty-five latent prints scoring 3 or 4 in Set A and forty in Set B.

Powder only		POSME only		Powder & POSME	
Set A	Set B	Set A	Set B	Set A	Set B
8/60	19/60	31/60	35/60	45/60	40/60

Table 2

Proportions of latent prints scoring 3 or 4 on glass slides under each condition.

Plastic Bags

The bottom halves of the latent prints from the plastic bags from Set A (inside) and Set B (outside) were processed with

black powder. Figure 5 and Figure 6 are examples of latent prints developed with black powder only on the plastic bags in Set A and Set B, respectively. Powder resulted in three latent prints scoring 3 or 4 in Set A and six in Set B.



Figure 5

Examples of powder development of the bottom halves of latent prints on plastic bags in Set A (stored inside).



Figure 6

Examples of powder development of the bottom halves of latent prints on plastic bags in Set B (stored outside).

The latent prints on the plastic bags in Set A (inside) and Set B (outside) were processed with POSME to evaluate of the quality of the ridge detail in the top half of each latent (POSME only) and the bottom half (POSME after powder). Figure 7 and Figure 8 are examples of latent prints developed with POSME on the plastic bags in Set A and Set B, respectively.

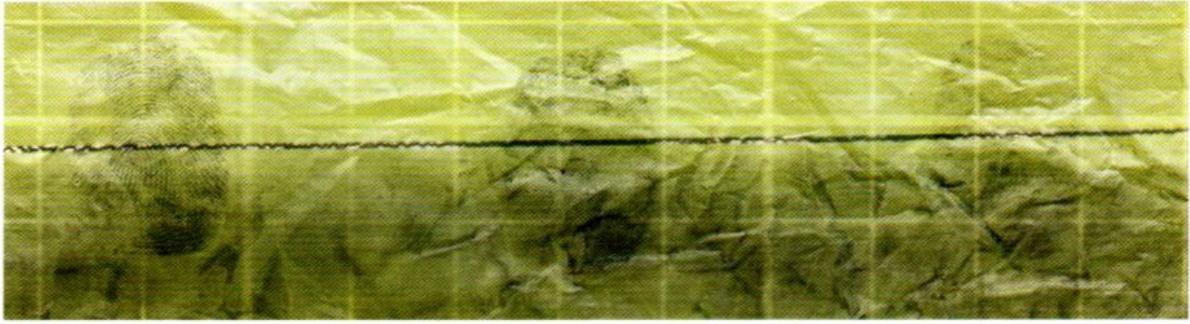


Figure 7

Examples of POSME development of latent prints on the plastic bags in Set A (stored inside). The top half of each latent print is POSME only, while the bottom half is POSME after powder.

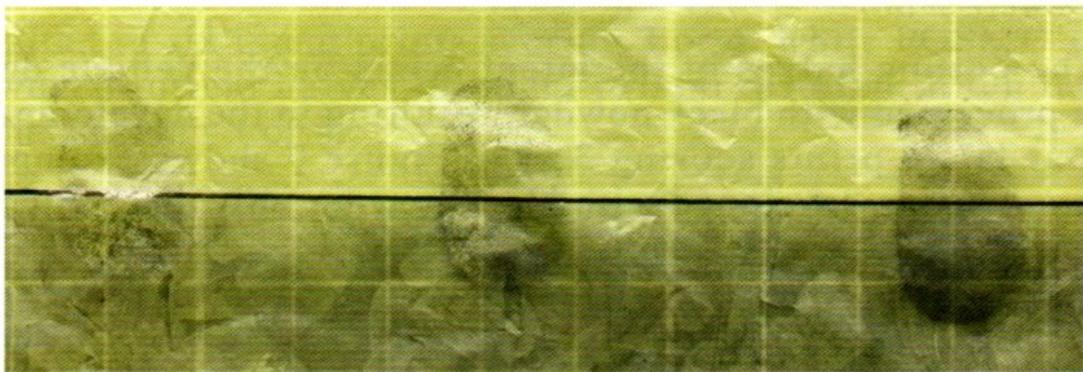


Figure 8

Examples of POSME development of latent prints on the plastic bags in Set B (stored outside). The top half of each latent print is POSME only, while the bottom half is POSME after powder.

The top halves of the latent prints in Figure 7 and Figure 8 represent POSME only. POSME on the top halves resulted in four latent prints scoring 3 or 4 in Set A and four in Set B. POSME after powder (bottom halves of latent prints) resulted in nine latent prints scoring 3 or 4 in Set A and seven in Set B

Powder only		POSME only		Powder & POSME	
Set A	Set B	Set A	Set B	Set A	Set B
3/60	6/60	4/60	4/60	9/60	7/60

Table 3

Proportions of latent prints scoring 3 or 4 on plastic bags under each condition.

Vehicle Door

The bottom halves of the latent prints on the vehicle door were processed with black powder, resulting in the development of four latent prints scoring 3 or 4. Figure 9 shows examples of latent prints developed with black powder only on the door.

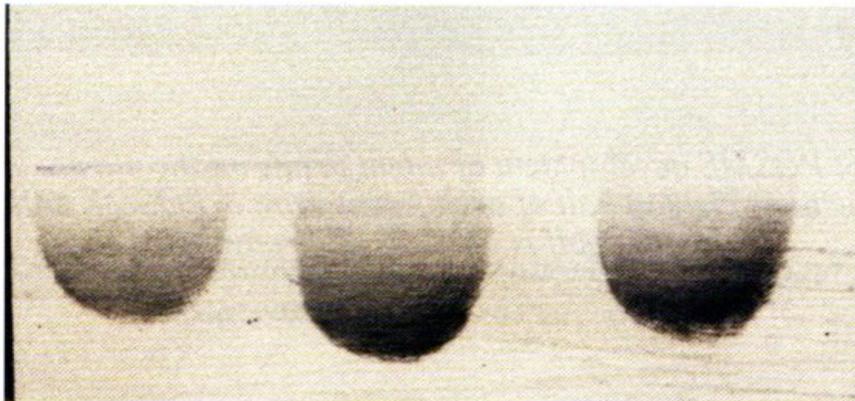


Figure 9

Examples of powder development of the bottom halves of latent prints on the vehicle door (stored inside a garage).

The latent prints on the vehicle door were processed with POSME to evaluate of the quality of the ridge detail in the top half of each latent (POSME only) and the bottom half (POSME after powder). Figure 10 shows examples of latent prints developed with POSME on the vehicle door.

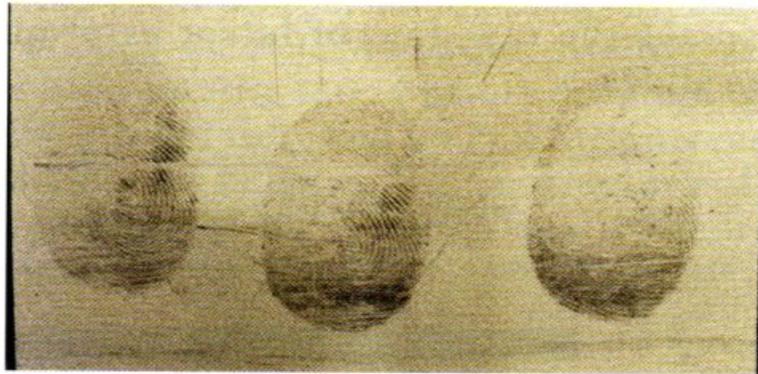


Figure 10

Examples POSME development of latent prints on the vehicle door (stored inside a garage). The top half of each latent print is POSME only, while the bottom half is POSME after powder.

The top halves of the latent prints in Figure 10 represent POSME only. As shown in Table 4, POSME on the top halves resulted in six latent prints scoring 3 or 4, while POSME after powder (bottom halves of latent prints) resulted in ten latent prints scoring 3 or 4.

Powder only	POSME only	Powder & POSME
4/60	6/60	10/60

Table 4

Proportions of latent prints scoring 3 or 4 on vehicle door (stored inside a garage) under each condition.

Discussion

Given that latent prints scoring 3 or 4 presumably represent optimal performance for each processing method, the methods were evaluated by comparing the yield of latent prints achieving a score of 3 or higher. On the glass slides, powder yielded twenty-seven high-quality latent prints (score of 3 or 4) in Sets A and B combined. Compared to powder alone, the yield of high-quality prints increased by 33% with POSME alone (an additional forty latent prints scoring 3 or 4). Compared to powder alone, powder followed by POSME increased the yield

On the vehicle door, powder yielded four high-quality latent prints (score of 3 or 4). POSME alone slightly increased the yield, with six high-quality latent prints developing. Compared to powder alone, powder followed by POSME increased the yield by 5% (an additional 6 latent prints scoring 3 or 4). Figure 13 displays the raw data of latent print quality scores from the vehicle door stored in the garage.

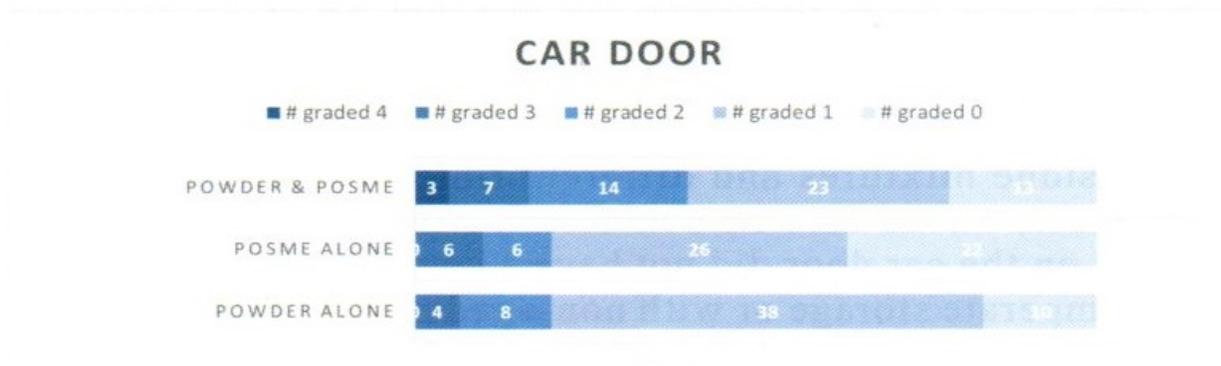


Figure 13

Raw data of quality scores of the latent prints on the vehicle door by processing technique.

As shown in Figure 14, application of POSME solution after black powder resulted in the development of more latent prints scoring 3 or 4 under each aging condition on all surfaces in this performance study.

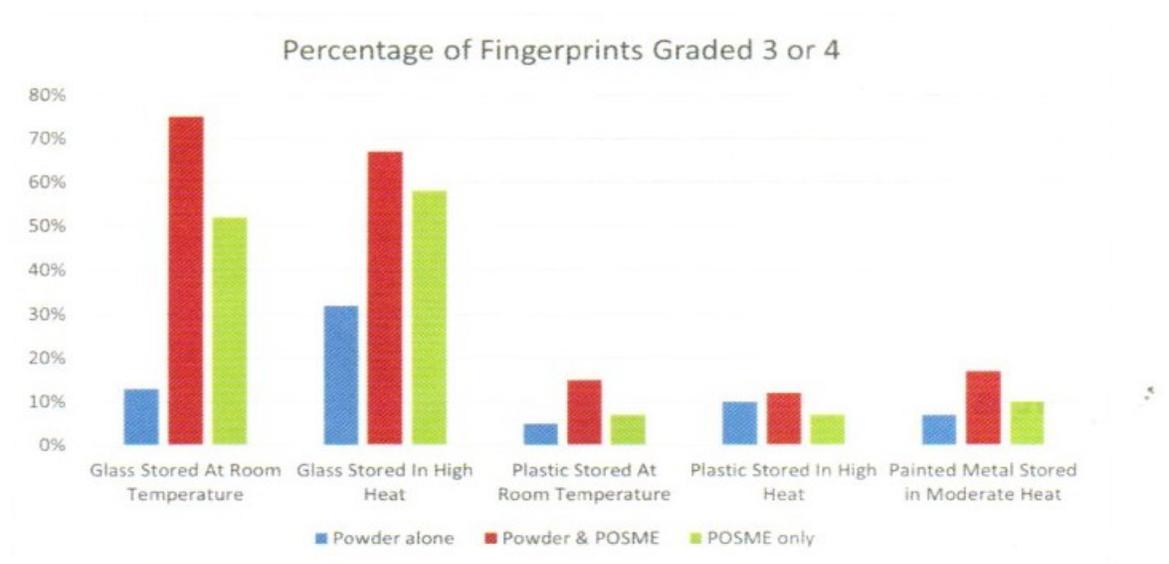


Figure 14

Percentage of latent prints graded 3 or 4 on Set A (glass and plastic stored inside), Set B (glass and plastic stored outside), and vehicle door (stored in garage).

by 48% (an additional fifty-eight latent prints scoring 3 or 4). Figure 11 displays the raw data of latent print quality scores from the glass slides.

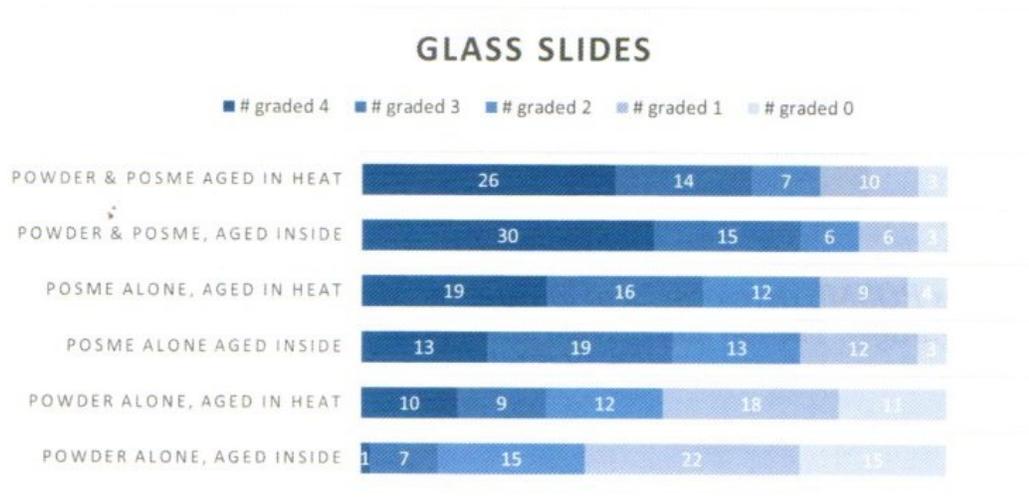


Figure 11

Raw data of quality scores of the latent prints on the glass slides by processing technique and aging method.

On the plastic bags, powder yielded nine high-quality latent prints (score of 3 or 4) in Sets A and B combined. POSME alone had no significant impact on the yield, with eight high-quality latent prints developing. Compared to powder alone, powder followed by POSME increased the yield by 6% (an additional seven latent prints scoring 3 or 4). Figure 12 displays the raw data of latent print quality scores from the glass slides.

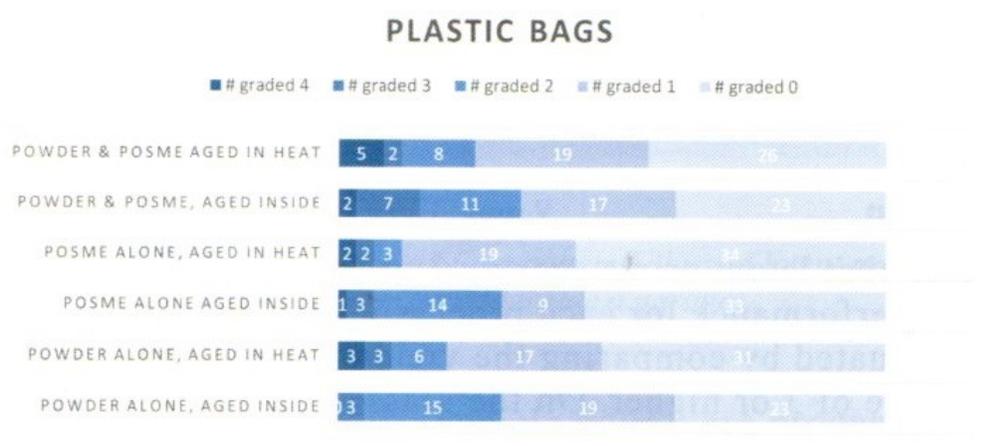


Figure 12

Raw data of quality scores of the latent prints on the plastic bags by processing technique and aging method.

Conclusions

The data from this limited replication of UCIO's study supported the conclusion of the original researchers that the POSME solution enhances visualization of aged prints, especially when applied sequentially after powder application on non-porous surfaces. The constraints of this study can provide no speculations on the other surfaces included in the original study. As indicated in the original UCIO publication, further research evaluating the effectiveness of POSME on other surfaces such as skin or contaminated surfaces would be beneficial. Additionally, further research regarding different latent print residue mixtures and different times on surface (ageing parameters) would also be beneficial. Additionally, the use of POSME on the car door did not have a control comparison with room temperate storage or with non-aged prints on that surface. These, in addition to testing during cold periods, would be recommendations for further research on its use with vehicles.

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