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PAPER

CRIMINALISTICS

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An Investigation into the Use of a Portable Cyanoacrylate Fuming System (SUPERfume®) and Aluminum Powder for the Development of Latent Fingermarks*

ABSTRACT: Few techniques offer "*in situ*" methods of friction ridge skin mark development. "*In situ*" development reduces mark transportation, degradation, and often cost. The effectiveness of cyanoacrylate fuming using the SUPERfume® and dusting with aluminum powder for latent fingermark development on several nonporous surfaces, stored in various temperature environments for time periods up to 52 weeks, was investigated. Five thousand and four hundred latent fingermarks were deposited under controlled conditions and graded. The results suggested that cyanoacrylate fuming (SUPERfume®, Foster and Freeman, U.K.) was more effective at developing latent fingermarks on textured and smooth plastic surfaces and for marks stored in temperatures of 37°C, whereas aluminum powder was more effective on glass, enameled metal paint, and varnished wood, and for storage temperatures below 20°C. There were no significant benefits to using either technique for marks older than 24 h, but it was possible to develop fingermarks following 52 weeks of storage using both techniques.

KEYWORDS: forensic science, fingerprints, latent fingermarks, cyanoacrylate fuming, SUPERfume®, aluminum powder

There are a variety of techniques that can be used for the development of latent friction ridge skin marks (1). Most of these can only be used in a laboratory because of the requirement for specialist equipment and health and safety implications. One exception is powder dusting, which is an established technique for the development of friction ridge skin marks on nonporous surfaces at scenes of crime (2). Its extensive usage is attributed to its cheap and time-efficient approach, which can be carried out at the scene of the crime, with no significant health and safety risks. Aluminum powder is one of the most popular powders used by scenes of crime officers (3). It is a flake powder that is manufactured by passing aluminum grit through a ball mill. Stearic acid is then added to aid the milling process and to promote adhesion to the residue in the print (4). Research has demonstrated that it is most effective if applied with a glass fiber brush (3).

Cyanoacrylate fuming as a method of latent fingermark development was first reported by several agencies, including the Criminal Identification Division of the Japanese National Police agency (5) and Northampton Police in the U.K., who shared their findings with the Home Office (6). Cyanoacrylate contains alkyl 2-cyanoacrylate monomers, which polymerize readily in the presence of suitable nucleophilic initiators (A^-), such as the hydroxide ions present in moisture found on most surfaces, and also alcohols, amines, and carboxyl ions (7). It is known that some components of latent friction ridge skin residue can act as suitable nucleophilic initiators (8).

There have been a number of attempts to devise "*in situ*" cyanoacrylate fuming methods (9). Foster and Freeman Ltd. have introduced a portable cyanoacrylate fuming system, which can be used at the scene of the crime, known as the SUPERfume® (10). Latent friction ridge skin marks are prone to destruction during transportation and degradation over time; therefore, it is advantageous that friction ridge skin marks are developed at the scene of the crime rather than at the laboratory. The Home Office Scientific Development Branch (HOSDB) carried out an investigation into the effectiveness of the SUPERfume® compared with laboratory fuming and powder dusting for the development of latent fingermarks following storage up to 4 weeks. It was reported that the SUPERfume® was able to successfully develop latent friction ridge skin marks, particularly on textured surfaces. In other instances, powder and/or laboratory cyanoacrylate fuming in a specially designed cabinet was reported to be more effective (11).

The aim of this research was to compare the effectiveness of a portable cyanoacrylate fuming device (SUPERfume®) with aluminum powder for the development of latent fingermarks. The objectives of the study included an investigation into the effectiveness of each technique at developing latent fingermarks on various nonporous surfaces, which were subjected to various temperature storage environments for up to 52 weeks of storage.

Methods

Overview of the Research

Latent fingermarks from six participants were deposited onto five clean nonporous surfaces. The surfaces containing the latent fingermarks were then stored in one of five temperature-controlled environments for one of nine storage time periods. Half of the samples

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were then treated using cyanoacrylate fuming (SUPERfume®), and the remaining half were dusted with aluminum powder.

Within the six participants, there were two individuals who appeared to deposit latent fingermarks that were rich in residue. Two of the participants appeared to donate fingermarks that were considered to be "average"; here, the marks were complete in terms of ridge detail, without excessive or insufficient quantities of residue being present. Two of the participants appeared to transfer a smaller quantity of friction ridge skin residue, and some of their fingermarks were incomplete in terms of ridge detail. In any one condition (i.e., surface, storage temperature, or storage time), three participants (one from each category) were asked to deposit latent fingermarks. Each participant deposited 10 consecutive latent fingermarks onto the relevant surface. Prior to the deposition, the participants were asked to refrain from washing their hands for at least 1 hour and to rub their hands together to distribute the latent residue between their friction ridges. An inked fingerprint was also deposited onto white office paper immediately following the collection of the latent fingermarks as part of the grading methodology (12). All fingermarks and fingerprints were deposited using a fingerprint sampler, which was a device designed to facilitate the deposition of fingermarks at a consistent force of three Newtons, while maintaining a consistent angle and duration of friction skin to surface contact (12). From each depletion series, depositions one, two, five, and 10 were retained for storage to provide latent fingermarks that ranged in their mass (13). The remaining fingermarks were destroyed. Latent fingermarks on each surface type were stored in cardboard boxes measuring 320 × 230 × 40 mm (latent mark side up). Prior to usage, the sides of the boxes were removed to allow air circulation and consistent storage environments (the boxes were stacked on top of one another). Details of the variables used within the investigation can be seen in Table 1.

TABLE 1—*A summary of the variables used within the research project.*

	Total Number of Fingermarks
1 depletion series	10 fingermarks
3 participants	30 fingermarks
5 surfaces—glass, enameled metal paint, smooth plastic, textured plastic, varnished wood	150 fingermarks
5 storage temperatures— −10°C (±3°C), 0°C (±3°C), +10°C (±2°C), +20°C (±2°C), +37°C (±2°C)	750 fingermarks
9 storage times—24 h, 72 h, 1, 2, 4, 8, 12, 24 and 52 weeks	6750 fingerprints
2 development techniques—aluminum powder, cyanoacrylate fuming (SUPERfume®)	13,500 fingermarks
Depositions one, two, five, and 10 were graded	5400 fingermarks

The Development of Latent Fingermarks Using the Portable Cyanoacrylate Fuming System (SUPERfume®)—Construction of the Fuming Room

A fuming room measuring 8 m^3 was assembled inside the research laboratory. Wooden beams measuring approximately 2 m in length and 60 × 60 mm in width and depth were attached horizontally to the internal walls at a height of 2 m, to form the roof structure. Additional wooden beams measuring 2 m were attached at a 90° angle to the roof beam's edge and supported to the floor. Plasterboard covers were affixed to the side beams to form a partition wall. Heavy duty clear polythene sheeting was affixed to the wooden beams using heavy duty staples, to form the walls of the cube. The polythene was secured to the floor using duct tape. The samples were positioned on a platform measuring approximately 1 m^2, which was approximately 1 m in height from the floor of the fuming room. Control latent fingermark samples were placed at each of the four corners of the slide platform. After each fuming cycle, the control latent fingermarks were examined to check for consistency in their development. The SUPERfume® equipment was arranged into the room, and the procedure was carried out according to the manufacturer's guidelines (10). Following development, all samples were treated with Basic Yellow 40, according to guidelines published by the U.K. Home Office (1).

The Development of Latent Fingermarks Using Aluminum Powder

A synthetic glass fiber zephyr brush was carefully loaded with aluminum powder and brushed over the surface of the slide. This procedure was continued, following the direction of ridge flow until the fingermark was fully developed. A piece of scotch tape was transferred to the surface of the slide to preserve any latent fingermarks. Air bubbles or creases within the tape were avoided.

The Assessment of Latent Fingermark Quality

The quality of the developed fingermarks was assessed using a grading system developed through primary research with fingerprint experts and research personnel (12). The four criteria examined in each mark included the quantity of the fingermark available for analysis, which was achieved by comparing the latent fingermark with the inked fingerprints deposited under controlled conditions using the fingerprint sampler, as described in the Overview of the Research. The quantity of the latent mark occupied by usable ridge detail was also assessed, as was the continuity of the ridges and the degree of contrast between the ridges and the furrows. Each criterion was graded out of five to give a total score out of 20. According to this system, the higher the total grade, the higher the quality of the fingermark. A previous study had demonstrated consistency in the assessment of the friction ridge skin marks using this system (12). The fingermarks were graded in no particular order, without prior information as to the age or storage temperature to avoid bias in the data.

Statistical Analysis

A comparison between the two development techniques combining all factors of surface type, storage temperature, and time was investigated first using a matched pairs *t*-test.

The data sets containing the fingermark grades for each of the relevant factors of surface, temperature, and time were then examined in turn to investigate the existence of statistically significant difference between the two development techniques. For example, for each of the five surfaces a comparison between cyanoacrylate fuming (SUPERfume®) and aluminum powder was made using matched pairs *t*-tests. The effect of both development techniques individually on each of the factors was determined using repeated measures ANOVA tests. Bonferroni multiple comparison testing was used to locate the differences within the data sets. Mean values were used to interpret any statistically significant differences found, and their reliability was investigated using confidence intervals. The effect size was calculated in each instance using guidelines proposed by Cohen (14).

For the results pertaining to storage temperature linear regression, R^2 values were used to aid interpretation. All statistical testing was carried out using SPSS version 16 (IBM SPSS, IBM Corporation, Somers, NY).

Results

Comparison Between Marks Developed Using Aluminum Powder and Cyanoacrylate Fuming (SUPERfume®)

When all surface types, storage temperatures, and storage time periods were considered aluminum powder produced fingermarks of a higher quality compared with cyanoacrylate fuming (SUPERfume®), with a mean grade of 9.03 compared with 7.99. The results of the matched pairs *t*-test provided evidence to suggest that this difference was significant (*t*: 7.821, *N*: 2700, p: 0). The eta-squared value was 0.14, which suggested that the magnitude of the difference between the means was large.

Effect of Surface Type on Latent Fingermark Grade

Latent fingermarks developed using aluminum powder had a higher mean grade than cyanoacrylate-fumed (SUPERfume®) marks on glass, enameled metal paint, and varnished wood surfaces. Latent marks developed using cyanoacrylate fuming (SUPERfume®) had a higher mean grade on textured plastic and smooth plastic surfaces. These results are shown in Fig. 1.

This was taking into account all temperature storage conditions and time periods. The error bars displayed on Fig. 1 illustrate the 95% confidence intervals for the mean values. The confidence intervals were considered to be small, suggesting that the mean values were reliable. The results of the matched pairs *t*-tests suggested that the differences were statistically significant ($p \leq 0.05$). The eta-squared results suggested that the magnitude of the difference was large for glass and enameled metal paint, medium for textured plastic, and then reduced in the order of varnished wood and smooth plastic. These results are shown in Table 2.

The results of the repeated measures ANOVA suggested that significant differences were present within the data for both development techniques ($p \leq 0.05$). The multiple comparison tests for each development technique indicated that statistically significant differences in latent fingermark grades existed between each of the surfaces ($p \leq 0.05$). The magnitude of these differences according to the eta squared values was very large.

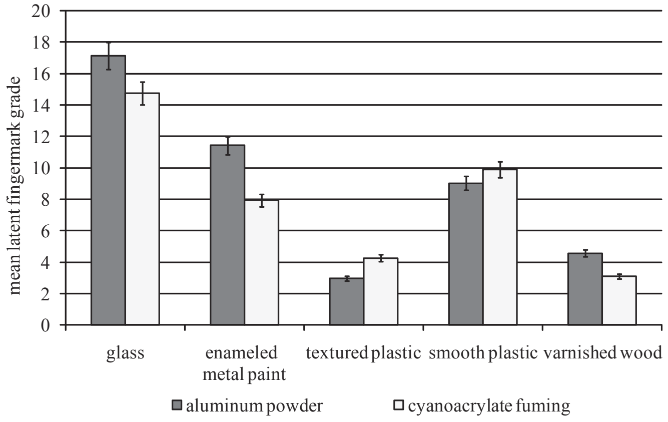

FIG. 1—*Difference in mean latent fingermark grade between marks developed using aluminum powder and cyanoacrylate fuming (SUPERfume®) for each surfaces type.*

Effect of Storage Temperature on Latent Fingermark Grade

For both development techniques, as the temperature of the storage environment decreased, the mean latent fingermark grade increased. This is shown in Figs. 2 and 3.

At 37°C, cyanoacrylate fuming (SUPERfume®) provided fingermarks with a higher mean grade than aluminum powder for all surface types and storage times. The error bars displayed on Figs. 2 and 3 illustrate the 95% confidence intervals for the mean values. The relatively small confidence intervals suggested that the mean values were reliable. At storage temperatures lower than 20°C, aluminum powder produced fingermarks with a higher mean grade than those developed using cyanoacrylate fuming (SUPERfume®). The results of the matched pairs *t*-tests suggested that the differences between the development techniques were significant ($p \leq 0.05$). According to the eta-squared results, the effects of temperature on fingermark grade ranged from small to very large. There was no statistically significant difference in latent fingermark grade between the two development techniques at 20°C ($p \geq 0.05$). These results are shown in Table 4.

The ascending slope of the trend line was far steeper for aluminum powder, and there was also a stronger correlation between the data points and the trend line ($R^2 = 0.94$) compared with cyanoacrylate fuming (SUPERfume®) ($R^2 = 0.35$). The stronger correlation was likely to be due to the value for 0°C, which was higher than for any other temperature.

The results of the repeated measures ANOVA suggested that significant differences were present within the data for both development techniques ($p \leq 0.05$), as shown in Table 3. For marks developed using aluminum powder, there were significant differences in latent fingermark grade between all storage temperatures, as indicated by the repeated measures ANOVA multiple comparison tests ($p \leq 0.05$), except 0°C and −10°C ($p \geq 0.05$), which were the temperatures that also yielded the highest mean grades. For marks developed using cyanoacrylate fuming (SUPERfume®), there were statistically significant differences between marks stored at 0°C compared with all other storage temperature environments ($p \leq 0.05$), but there were no statistically significant differences between the mean grades from latent fingermarks stored in the other temperature environments ($p \geq 0.05$). The magnitude of these differences according to the eta squared values was very large.

Effect of Storage Time on Latent Fingermark Grade

The trend lines in Figs. 4 and 5 demonstrate that, over time, there was a steady decline in the mean latent fingermark grades for

TABLE 2—*The results of the paired t-tests and effect size for surface type.*

Surface Type	*t*	*N*	*p* (2DP)	Eta-Squared (2DP)	Effect Size
Glass	10.054	540	0	0.16	Large
Enameled metal paint	9.231	540	0	0.14	Large
Textured plastic	−6.137	540	0	0.07	Medium
Smooth plastic	−3.082	540	0	0.02	Small
Varnished wood	4.852	540	0	0.04	Small

T, *t*-test statistic; *N*, number of samples; DP, decimal places; Eta squared, effect size statistic (14).

TABLE 3—*The results of the repeated measures ANOVA tests and effect size for surface type, storage temperature, and storage time.*

	F		*p* (2DP)		Eta squared (2DP)	
Variable	Aluminum powder	Cyanoacrylate fuming	Aluminum powder	Cyanoacrylate fuming	Aluminum powder	Cyanoacrylate fuming
Surface type	585.102	407.593	0	0	0.52	0.43
Storage temperature	105.962	23.834	0	0	0.16	0.04
Storage time	56.128	22.627	0	0	0.15	0.07

F = ANOVA test statistic; *N* = 540 for each surface type and storage temperature, 300 for each storage time.

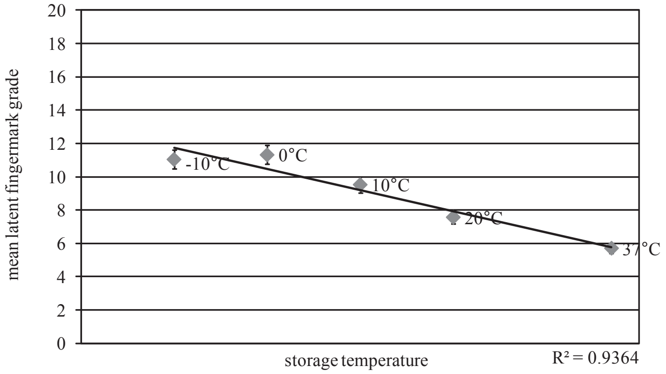

FIG. 2—*Effect of storage temperature on mean latent fingermark grade for marks developed using aluminum powder.*

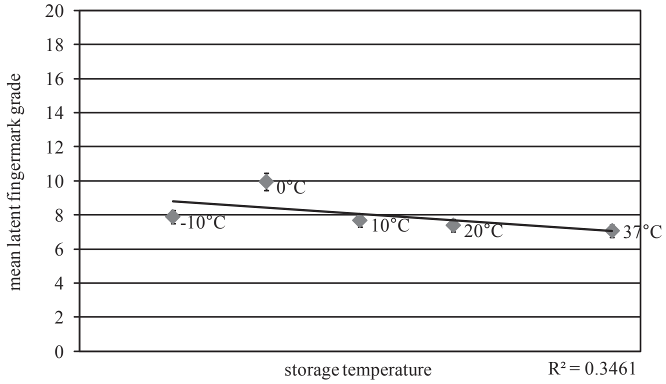

FIG. 3—*Effect of storage temperature on mean latent fingermark grade for marks developed using cyanoacrylate fuming (SUPERfume®).*

TABLE 4—*The results of the paired t-tests and effect size for storage temperature.*

Storage Temperatures	*t*	*N*	*p* (2DP)	Eta Squared (2DP)	Effect Size
37°C	−5.831	540	0.00	0.06	Medium
20°C	0.631	540	0.53	0.00	Small
10°C	6.562	540	0.00	0.07	Medium
0°C	4.361	540	0.00	0.03	Small
−10°C	9.704	540	0.00	0.15	Large

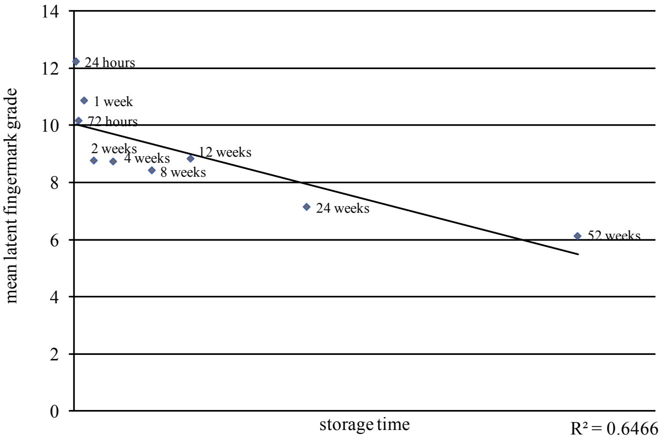

FIG. 4—*Effect of storage time on mean latent fingermark grade for marks developed using aluminum powder.*

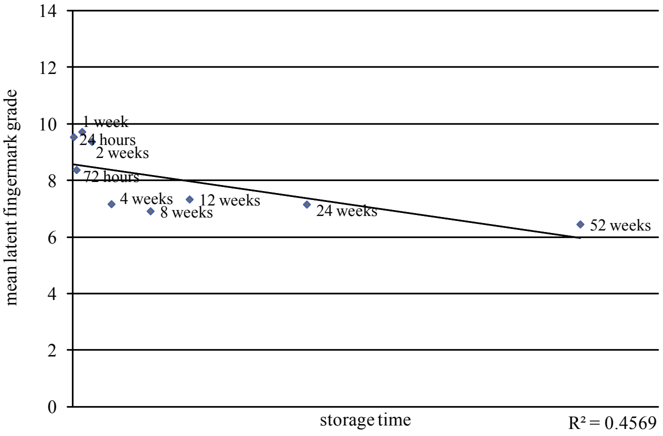

FIG. 5—*Effect of storage time on mean latent fingermark grade for marks developed using cyanoacrylate fuming (SUPERfume®).*

fingermarks developed using both aluminum powder and cyanoacrylate fuming (SUPERfume®).

For seven of the nine time periods used for the investigation, latent fingermarks developed using aluminum powder provided higher mean latent fingermark grades compared with latent fingermarks developed using cyanoacrylate fuming (SUPERfume®). These results are taking into account all surface types and storage temperatures. The error bars displayed on Fig. 6 illustrate the 95% confidence intervals for the mean values. They provide evidence that the mean values were reliable.

The results of the matched pairs *t*-tests indicated that there were significant differences in mean latent fingermark grade between the two development techniques at each time period except 2, 24, and 52 weeks ($p \le 0.05$). The eta-squared results suggested that the magnitude of the differences was large for 24 h, but was generally small for all of the other time periods. These results are shown in Table 5.

The results of the repeated measures ANOVA suggested that significant differences were present within the data for both

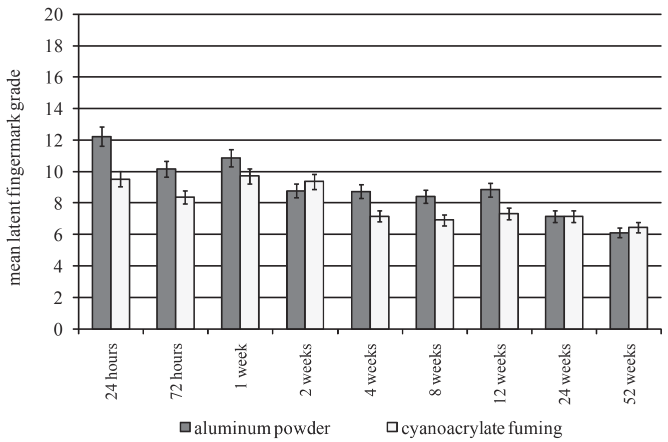

FIG. 6—*Differences in mean latent fingermark grade between marks developed using aluminum powder and cyanoacrylate fuming (SUPERfume®) over time.*

TABLE 5—*The results of the paired t-tests and effect size for storage time.*

Storage Time	*t*	*N*	*p* (2DP)	Eta Squared (2DP)	Effect Size
24 h	6.609	300	0	0.13	Large
72 h	4.086	300	0	0.05	Small
1 week	2.954	300	0	0.03	Small
2 weeks	−1.672	300	0.1	0	Small
4 weeks	3.831	300	0	0.05	Small
8 weeks	3.34	300	0	0.04	Small
12 weeks	4.356	300	0	0.06	Medium
24 weeks	−0.009	300	0.99	0	Small
52 weeks	−0.864	300	0.39	0	Small

development techniques ($p \le 0.05$). The magnitude of these differences according to the eta squared values was very large. These results are shown in Table 3.

For marks developed using aluminum powder, the results of the repeated measures ANOVA multiple comparison tests suggested that the differences between all time periods up to 2 weeks were statistically significant ($p \le 0.05$). There were no statistically significant differences for marks developed between 2 weeks until 12 weeks, when the grades reduced continuously until the end of the research study period. Fingermarks developed at 24 and 52 weeks were statistically significantly different to all other time periods. For cyanoacrylate-fumed marks, the trend was quite different. There were no statistically significant differences located in the repeated measures ANOVA multiple comparison tests for latent fingermark grade between any of the time periods up to 4 weeks ($p \ge 0.05$). At 4 weeks of storage, there were no statistically significant differences between these grades and the later time periods of 8, 12, 24, and 52 weeks ($p \ge 0.05$), but there were significant differences between these later time periods and time periods earlier than 4 weeks ($p \le 0.05$).

Discussion

Aluminum powder might have produced latent fingermarks with a statistically significantly higher mean grade overall because of the relative consistency in the performance of the technique compared with the cyanoacrylate fuming method (SUPERfume®). It was difficult to control the internal conditions of the SUPERfume® room; for example, it was anticipated that there would have been fluctuations in temperature and relative humidity during the treatment cycle, and even small variations in ambient temperature can have a significant effect on the relative humidity of the environment (11). Also, it was not possible to monitor development during the treatment cycle and therefore avoid factors that might be detrimental to the fingermarks, such as overdevelopment.

The results of this investigation have demonstrated that latent fingermarks deposited onto different nonporous surfaces responded very differently to aluminum powder and cyanoacrylate fuming (SUPERfume®). The differences in the performance of the techniques with respect to surface type were interpreted according to the similarities and differences of the surface properties. For example, the surfaces could be broadly divided into smooth and textured surfaces, and generally, smoother surfaces retained latent fingermark ridge detail more effectively than textured surfaces. The reduction in mean latent fingermark grade for enameled metal paint and smooth plastic that were both smooth surfaces compared with glass could be because of a reduced adhesive force (15), increasing their fragility which would make them prone to destruction prior to or during development, particularly with powder dusting (16). Cyanoacrylate fuming (SUPERfume®) was considered to be a less destructive technique because there was no comparable contact between the cyanoacrylate fumes and the latent ridges, which was used to explain the increased mean grade for smooth plastic. The enameled metal paint substrate was affected by the Basic Yellow 40 dye because the paint absorbed the dye, affecting the clarity of the latent mark as the fluorescence was not limited to the latent ridges. In some instances, it also caused the paint to peel away, causing destruction of the mark. These problems were not encountered with the aluminum powder, which explained its effectiveness in this instance.

When latent residue is deposited onto a surface, the droplets of the residue merge together to form the ridge structure (17). On textured surfaces, the residue may have resided in the grooves of the surface and prevented the merging of the residue, unlike on smooth surfaces, causing the ridges to become discontinuous. Aluminum powder produced a general powder layer over the textured surface. It was possible to visualize the surface area of the mark, but there was no ridge detail presents, suggesting that the ridges were laid unevenly, and the usual selective contact between the powder flakes and the latent ridges was poor. With cyanoacrylate fuming (SUPERfume®), the polymer formed on the ridges producing complete marks, some of which had discernable ridge detail, which supported previous research (11). This is likely to have been influenced by different compositions of latent residue, i.e., residue contaminated with the oily components of sebaceous secretions is known to produce ridges that are more continuous in nature (17). It was therefore hypothesized that those fingermarks containing oily sebaceous residue were more able to withstand small differences in the surface topography than fingermarks of predominantly eccrine origin. The varnished wood was not as textured as the plastic, which might explain its slightly higher score. However, there was often background interference where the wood had absorbed the basic yellow dye. The surface might be dusted with powders to avoid this problem.

The destruction of the enameled metal paint substrate by the Basic Yellow 40 dye, and the absorptive nature of the varnished wood could suggest that the relatively poorer quality latent fingermarks developed using cyanoacrylate fuming technique (SUPERfume®) were attributable to the dye and not to the development technique itself. It is possible that an alternative solvent may not have had such a destructive effect.

The SUPERfume® equipment was designed to treat all surfaces simultaneously; however, on the basis of these results, it would seem that the technique might offer an advantage to latent fingermark development in situations where the majority of surfaces are textured plastic or smooth plastic, given the destructive potential of the dusting technique. In instances where a mixture of surfaces are present, particularly glass, enameled metal paint, or varnished wood, it would seem that the aluminum powder dusting technique would be more effective. Where there was a complete range of surface types present, it is advised to consider each surface independently if possible or to dust such surfaces prior to cyanoacrylate fuming at the scene.

The results relating to storage temperature were generally consistent with previous research, which concluded that higher temperatures accelerate the rate of dehydration (18,19), chemical reactions, and bacterial activity (16). During dehydration, the ridges start to narrow and the residue loses it stickiness (20). Higher temperatures might have caused some of the residue to migrate, altering the latent ridge structure. If the ridges had started to narrow, they might have appeared to be discontinuous and lost contrast. Ridge continuity and contrast formed part of the criteria used to assess the quality of the latent marks (12), which would explain the generally lower mean grades in the warmest storage temperature. In terms of aluminum powder dusting, dehydrated marks contained few residues for the powder to adhere to, explaining their poorer grades. Dehydration affected the cyanoacrylate fuming to a lesser extent because following evaporation of the volatile components of latent residue, many reactive nucleophiles are likely to remain in the mark (21). Cooler temperatures would have significantly slowed the rate of dehydration and preserved the latent residue, thus improving the effectiveness of the development techniques. This explains the statistically significant difference at 37°C, and the reduced effect of storage temperature with respect to latent fingermark development as the storage temperature was reduced.

The storage temperature of the environment did not affect the latent fingermarks developed using cyanoacrylate fuming to the same extent as aluminum powder dusting. This was attributed to the sensitivity of the cyanoacrylate fuming (SUPERfume®) method to dehydrated marks (21). Also, the fingermarks developed using cyanoacrylate fuming were first exposed to high levels of relative humidity (80%), a strategy routinely used and recommended by the Home Office (1) to improve the clarity of the subsequently developed friction ridge skin marks (22) and to accelerate polymerization (23).

The results of this investigation suggested that a storage temperature of −10°C did not produce latent fingermarks of a statistically significantly higher quality than 0°C. Interestingly, there was some evidence to suggest that the storage temperature of −10°C was detrimental to latent fingermark quality. One interpretation of this was that any water vapor within the storage environment may have resided on the substrates and then condensed when they were transferred into a warmer environment (fuming room), causing further polymerization of the cyanoacrylate ester and/or adhesion of the aluminum powder and reducing the clarity of the fingermark. Alternatively, expansion of the residue upon freezing might have caused the latent ridges to merge, thus reducing the quality of any ridge detail and contrast upon development. Control of the humidity levels was not possible and was not measured. This was considered to be an important finding for future research studies and/or storage prior to development.

FIG. 7—*Latent fingermarks deposited onto glass surfaces following 52 weeks of storage at 20°C and developed using cyanoacrylate fuming (SUPERfume®) (left) and developed using aluminum powder dusting (right).*

A reduction in mean latent fingermark grade was attributed to degradation within the latent mark (20). Latent friction ridge residue that originates from eccrine gland secretions are known to last for significantly shorter time periods than those composed of sebaceous secretions (22). It was reported that the average lifetime of eccrine sweat marks when kept indoors on glass, metal, and plastic ranged between 7.5 and 12.2 days (18), which would support the initial and rapid deterioration reported here. After 2 weeks, it was likely that less volatile oily sebaceous secretions increased the longevity of the fingermarks, which did not change significantly for up to 52 weeks of storage. In the same study, sebaceous fingermarks were on average found to survive up to 73.2 days on glass (18), supporting the idea that sebaceous residue resides on surfaces for longer time periods. Latent residue of eccrine origin exposed to cyanoacrylate vapor produces polymer fibers that are very different in morphology to polymer fibers produced from sebaceous residue (8). This difference to the visual appearance of the mark could explain the reduction in latent mark quality.

Where time is a consideration, the results of this study would suggest that there is no significant benefit to using either technique unless the crime scene has been located within 24 h, in which instance aluminum powder would be recommended. These results have demonstrated that it is still possible to develop usable fingermarks following 52 weeks of storage, using aluminum powder and cyanoacrylate fuming (SUPERfume®) on all surfaces. Figure 7 provides examples of marks developed on glass surfaces, following 52 weeks of storage at 20°C.

The idea that cyanoacrylate fuming (SUPERfume®) was less affected by increasing time periods of storage was attributed to the relative sensitivity of chemical development techniques, compared with physical methods of development.

This investigation has built upon previous research into this area and provided a comprehensive guide into the effectiveness of a very old and established technique and a relatively new and innovative product against a range of common factors known to influence the enhancement of latent friction ridge skin marks. The results of this investigation aim to help practitioners to make an informed choice when selecting treatments for "*in situ*" latent fingermark development.

References

1. The Home Office Scientific Development Branch (HOSDB). The manual of fingerprint development techniques. Sandridge, Hertfordshire, U.K.: Home Office Scientific Development Branch, 1998.
2. Sodhi GS, Kaur J. Powder method for detecting latent fingerprints: a review. Forensic Sci Int 2001;120(3):172–6.

3. Bandey H. The powders process, study 1: evaluation of fingerprint brushes for use with aluminium powder. Sandridge, Hertfordshire, U.K.: The Home Office Scientific Development Branch (HOSDB), 2004, Publication Number: 54(04).
4. James JD, Pounds A, Wilshire B. Flake metal powders for revealing latent fingerprints. J Forensic Sci 1991;36(5):1368–75.
5. Lee HC, Gaensslen RE. Cyanoacrylate fuming: theory and practice. Ident News 1984;34:8–14.
6. Wood LW. The discovery of superglue fuming. Fingerprint Whorld 1991;16(64):117–8.
7. Edwards HGM, Day JS. Fourier transform Raman spectroscopic studies of the curing of cyanoacrylate glue. J Raman Spectrosc 2004;35(7):555–60.
8. Wargacki SP, Lewis L, Dadmun MD. Understanding the chemistry of the development of latent fingerprints by superglue fuming. J Forensic Sci 2007;52(5):1057–62.
9. Geller B, Springer E, Almog J. Field devices for cyanoacrylate fuming: a comparative analysis. J Forensic Ident 1998;48(4):443–51.
10. Mason Vactron. SUPERfume portable superglue fuming system, instruction manual and user guide. Evesham, Worcestershire, U.K.: Mason Vactron, 2003.
11. Bandey H, Kent T. Superglue treatment of crime scenes, a trial of the effectiveness of the Mason Vactron SUPERfume® process. Sandridge, Hertfordshire, U.K.: Police Scientific Development Branch, 2003;Publication Number: 30.
12. Fieldhouse SJ. Consistency and reproducibility in the deposition and evaluation of latent fingermarks, contributing to an investigation into the effectiveness of a portable cyanoacrylate fuming system and aluminium powder for latent fingermark development (Ph.D. thesis). Stoke on Trent, U.K.: Staffordshire University, 2009.
13. Czekanski P, Fasola M, Allison J. A mechanistic model for the superglue fuming of latent fingerprints. J Forensic Sci 2006;51(6):1323–8.
14. Cohen JW. Statistical power analysis for the behavioural sciences, 2nd edn. Hillsdale, NJ: Lawrence Erlbaum Associates, 1988.
15. Bobev K. Fingerprints and factors affecting their condition. J Forensic Ident 1995;45(2):176–83.
16. James JD, Pounds A, Wilshire B. Obliteration of latent fingerprints. J Forensic Sci 1991;36(5):1376–86.
17. Thomas GL. The physics of fingerprints and their detection. J Phys E 1978;11:722–31.
18. Holyst B. Kriminalistische abschätzung des spurenalters bei fingerpapillarlinien. Archiv für Kriminologie 1987;179:94–103. In: Champod C, Lennard C, Margot P, Stoilovic M, editors. Fingerprints and other ridge skin impressions. Boca Raton, FL: CRC Press, 2004;188–90.
19. Ricci C, Phiriyavityopas P, Curum N, Chan KL, Jickells S, Kazarian SG. Chemical imaging of latent fingerprint residues. Appl Spectrosc 2007;61(5):514–22.
20. Baniuk K. Determination of the age of fingerprints. Forensic Sci Int 1990;46:133–7.
21. Wargacki SP, Lewis LA, Dadmun MD. Enhancing the quality of aged latent fingerprints by superglue fuming: loss and replenishment of initiator. J Forensic Sci 2008;53(5):1138–44.
22. Lewis LA, Smithwick RW, Devault GL, Bolinger B, Lewis SA. Processes involved in the development of latent fingerprints using the cyanoacrylate fuming method. J Forensic Sci 2001;46(2):241–6.
23. Mankidy PJ, Rajagopalan R, Foley HC. Facile catalytic growth of cyanoacrylate nanofibres. Chem Commun 2006;10:1139–41.

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