



Home Office

Scientific Development Branch

Fingerprint and Footwear Forensics Newsletter: Special Edition

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THE POWDERS PROCESS, STUDY 3: Evaluation of Fingerprint Powders on Textured Surfaces and U-PVC

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EXECUTIVE SUMMARY

In recent newsletters HOSDB has given guidance to scene examiners for powdering smooth surfaces. This included advice on best practice for use of aluminium powder and information regarding the effectiveness of powders on smooth surfaces commonly encountered at scenes of crime. This newsletter gives advice for the powdering of surfaces which generally yield fewer marks, such as textured surfaces and u-PVC. The objective is:

- *To ascertain if there is a significant difference in the performance of a range of fingerprint powders on textured surfaces or u-PVC.*

It must be remembered that some of the textured surfaces studied in this trial would give better results, in terms of marks developed, if chemically treated in a fingerprint development laboratory following guidelines given in the Manual of Fingerprint Development Techniques (MoFDT) and update newsletters. However, for volume crime, powdering is often the only option as it is cheap, easy to apply and effective on many surfaces.

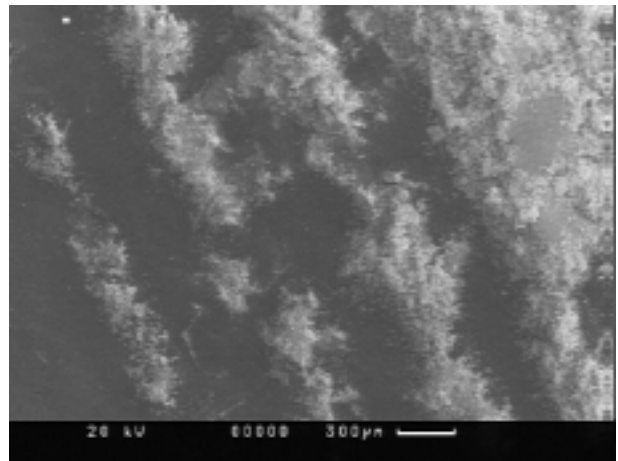


Figure 1: Scanning Electron Microscope (SEM) image of fingerprint ridges powdered with magneta flake showing some infill and texture contours

The trial results show that there is a large difference in the effectiveness of the powders tested on textured surfaces. In all cases magnetic powders developed considerably more marks than the non-magnetic ones. In particular, the two part magnetic powders were most effective. Based upon the results in this trial the following recommendations are made:

- *Aluminium powder or black granular powder should not be used on textured surfaces.*
- *Where appropriate, a black or jet black magnetic powder should be used on textured surfaces.*

- *Black or jet black magnetic powders should be used on u-PVC window and door frames.*
- *For serious crime, scene examiners should consult their force fingerprint development laboratory staff as chemical processing may be more effective on textured surfaces.*

INTRODUCTION

This report is the third in a series of newsletters and gives guidance to scene examiners for selecting powders to use on textured or other surfaces generally considered difficult to powder. When powdered, the surface texture of many of these surfaces may be developed in addition to, or instead of, the mark. This is illustrated in Figure 1 where ridges are developed but their shape has been distorted due to the underlying texture.

The previous two newsletters have given guidance on the application of aluminium powder and the effectiveness of powders on smooth surfaces. They are Home Office publications:

- Study 1: Evaluation of Fingerprint Brushes for Use with Aluminium Powder (Publication No. 54/04 - August 2004)
- Study 2: Evaluation of Fingerprint Powders on Smooth Surfaces (Publication No. 08/06 - February 2006)

These newsletters were sent to forces but can also be found on the Home Office website (www.hosdb.homeoffice.gov.uk). They will be referred to throughout this document.

This will be the final newsletter detailing trial results. However, we intend to publish a document that summarises the recommendations from all newsletters and gives simple guidance about powdering techniques.

OBJECTIVE

The previous newsletter in this series (Publication No. 08/06) reported some of the findings from a survey of scene examiners on powdering practices in the UK. The survey

indicated that many textured surfaces are not powdered due to the poor success rate anticipated. For the textured surfaces that are powdered, there appears to be little consistency in the products used by scene examiners. This variation in powder use has been confirmed at practitioner workshops and meetings held at HOSDB throughout the course of this study. Therefore, the objective is:

- *To ascertain if there is a significant difference in the performance of a range of fingerprint powders on textured surfaces or u-PVC.*

POWDERS AND THEIR APPLICATION

The same powders and application methods as described in the last newsletter (Publication No. 08/06) were used in this study. They are:

- Aluminium flake and glass fibre brush
- Magneta flake and magnetic applicator
- Black granular and squirrel mop brush
- Black magnetic and magnetic applicator

Flake powders, in particular aluminium, are traditionally used on smooth surfaces only. However, the survey results indicate that, in some cases, scene examiners are using aluminium powder on all surfaces that they treat, including ones with some degree of roughness. It was therefore included in the trial.

EXPERIMENTAL

The experimental method, as described in Publication No. 08/06 for depositing, developing and assessing the quality of fingerprints, was used throughout this trial. In summary, a range of fingerprint donors deposited 'un-groomed' marks in a depletion series. Marks were left to age for either one day or one week prior to developing with the selected powder. The powdered marks were graded in terms of the quantity of clear ridge detail visible on the surface.

Laboratory Control Methods

Most of the powdering was carried out in a Bassaire SPL 4 RFM powdering cabinet with a flow rate across the sash in excess of 0.3ms^{-1} . Wooden furniture was powderd in the fingerprint laboratory wearing FFP3 disposable respirators.

Test Surfaces

A range of surfaces commonly found at scenes of crime, but generally considered difficult to powder (as indicated in the scene examiners survey), were included in the trial and are listed in Table 1. The table groups the surfaces into similar types. Images of the surfaces can be found in Appendix 1.

Surface Category	Surface Comments
u-PVC	White, smooth and shiny with striation marks. Several years old but not exposed to outdoor conditions.
	White, smooth and shiny but contains some grain. Several years old but not exposed to outdoor conditions.
	New, bright white, very smooth, glossy finish.
Laminate Furniture (not wood)	White, slightly textured, laminate coated chipboard typically used for shelving and cupboards.
	Imitation wood self adhesive strips designed to adhere to furniture to give a wood grained finish
	Imitation beech effect laminate furniture with a wood grain texture typically used in office furniture
Kitchen Worktops	Old, patterned, 1980's style, melamine worktop with uniform texture.
	Modern, patterned, melamine worktop with uniform texture.
	Modern, melamine worktop with heavy texture.
Furniture (wood)	Old wardrobe doors, varnished, quite smooth with some cracks.
	Old sideboard, stained/varnished, wood grain texture and cracks. Surface quite different on the top, front and side.

Table 1: Details of the surfaces used in the trial

Test surfaces were purchased from a range of suppliers, such as DIY stores, second hand shops etc, over several years. Most were cut into approximately A4 size panels for storage

purposes with the exception of the real wood furniture which was treated as a whole item.

The effectiveness of a powder will be dependent upon the cleanliness of a surface. A trial on dirty surfaces, while possibly more realistic, would be extremely difficult to set up and quality control. Obtaining a range of dirty surfaces large enough and consistent enough to compare the four powders would be very difficult. Therefore, the u-PVC surfaces, kitchen worktops and laminate furniture were cleaned with laboratory detergent followed by thorough rinsing. The surfaces were subsequently wiped with ethanol. The wooden furniture was polished with furniture polish and then left for one week prior to the trial. It was not cleaned in the same manner as the other surfaces as detergents and ethanol are likely to alter the surface coating on the wood.

Trial Size

Table 2 shows the number of fingerprints developed with powder in this trial. As with Studies 1 and 2, a considerable amount of data has been generated in order to reduce the possibility of spurious results caused by the large number of variables associated with fingerprint work. In addition, each experiment was repeated at least once.

Type of Surface	Number of graded marks
u-PVC	2400
Laminate furniture	2900
Kitchen worktops	2740
Wood furniture	1520
Total	9560

Table 2: Total number of fingerprints developed in this trial

RESULTS AND DISCUSSION

The results for each type of surface are shown in Figures 2-6. They are presented in a similar way to the results in the last newsletter for smooth surfaces: bar graphs show the percentage of marks developed with greater than a third ridge detail for each powder and age.

Unplasticised Poly (Vinyl Chloride)

Unplasticised poly(vinyl chloride), u-PVC, window and door frames are now commonly powdered at crime scenes. Chemically, the substrate can vary considerably as it is modified with a variety of antioxidants, fillers, pigments etc to increase the life-time and reduce the cost of the product. U-PVC window and door frames are normally quite smooth and would not be expected to pose any difficulty to a scene examiner. However, they are generally considered more problematic for developing marks than other smooth surfaces and tend to give higher background development, thus obscuring weak marks.

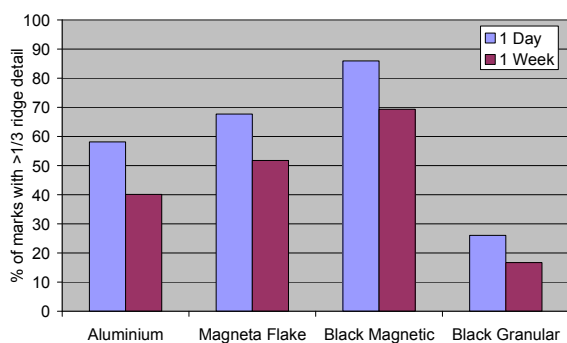


Figure 2: Effectiveness of fingerprint powders on u-PVC

Figure 2 shows the combined results for the three u-PVC surfaces. It can be seen that this type of surface behaves quite differently from other smooth surfaces (glass, ceramic, painted metal) reported in the previous newsletter and summarised in Appendix 2. In that case, there was very little difference between the powders (all were very effective). However, these results clearly show that the black magnetic powder is far superior to the other powders. The two flake powders perform

reasonably well, but black granular powder was very poor across all three u-PVC surfaces.

The quality and number of marks reduce by approximately 20% after the marks were aged for one week. It was noticeable that weaker marks (one week old and/or towards the bottom of a depletion series) were often inverted where the powder adheres to the background but not the fingerprint ridges (see Figure 3).

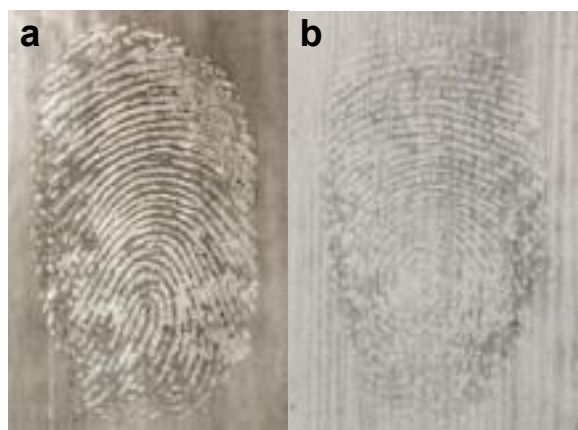


Figure 3: Reverse mark development on u-PVC with (a) black magnetic powder and (b) magneta flake

Furniture (Laminate)

The surface of laminate furniture can vary considerably. Some may have the appearance of wood such as modern office furniture, but close up the texture can still be quite different. Some may have a wood grain effect whilst other may have a uniform texture (from smooth to rough) and colour (quite often white).

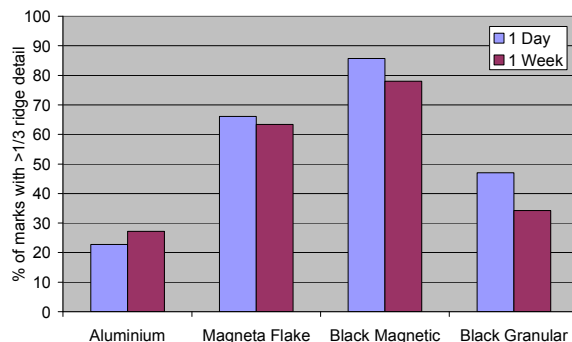


Figure 4: Effectiveness of fingerprint powders on laminate furniture

The three surfaces selected for this category were quite different in terms of colour and texture (as described in Table 1). However, the relative effectiveness of the powders on the individual surfaces was very similar. The combined results are shown in Figure 4. As with u-PVC, the most effective powder was black magnetic with ~ 80% of marks being developed with greater than one third clear ridge detail. Magneta flake also performs well. The two non-magnetic powders performed poorly – predominantly due to the powders developing surface texture rather than ridge detail. Ridge detail was only developed on heavier marks at the top of a depletion series. On average, there was a small drop off in effectiveness with time.

Matt Kitchen Worktops

Kitchen melamine work surfaces generally have either a shiny, smooth finish or a textured, matt finish. The shiny ones should be powdered according to the guidelines issued in the last study. The matt ones are the most textured surfaces trialled in this study. Many scene examiners would not powder such surfaces as the powder tends to develop the texture rather than the mark. However, where resources are limited (eg volume crime) powders may be the only process that can be used as the surfaces are normally non-removable.

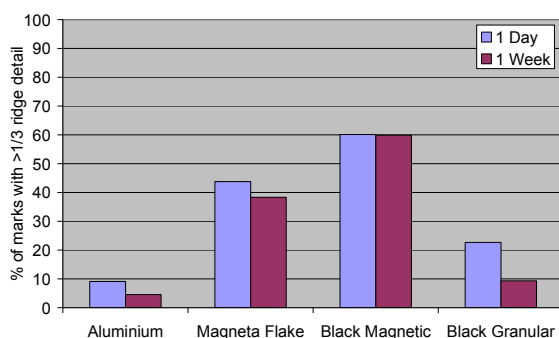


Figure 5: Effectiveness of fingerprint powders on kitchen worktops

Figure 5 shows the results and it can be seen that no powder performed as well on this type of surface compared to other surfaces studied so far. However, the black magnetic powder

performs reasonably well, developing 60% of the marks with greater than one third ridge detail. Aluminium and black granular powder again performed very poorly due to the development of texture rather than ridge detail.

Another problem encountered with this type of surface was the reduced ability to sweep out or clean up over-developed marks. For aluminium powder this was not a problem as the marks are built up gradually and should not be over-powdered. For the other three, any attempt at clearing out the mark actually just forced the powder deeper into the troughs within the surface texture.

Ridge detail developed with black magnetic powder, as with the laminate furniture, showed the least distortion due to surface texture. This is the main reason that it scores so highly on such surfaces.

Furniture (Wood)

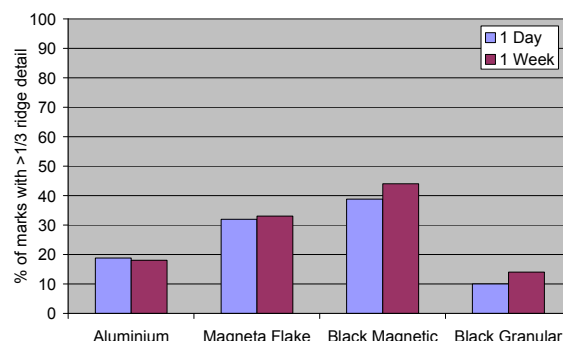


Figure 6: Effectiveness of fingerprint powders wooden furniture

The wood used in this study was of varying condition but generally old and worn. Figure 6 shows an average for all of the wooden furniture results. Results did vary considerably depending upon the condition of the wood tested. However, black magnetic was always the most effective powder irrespective of condition. With increasing smoothness of the surface, the performance of all the powders improves until they demonstrate equivalent behaviour, as described in Study 2.

Overview of Powder Effectiveness on Smooth and Textured Surfaces

The trial results from the previous newsletter for smooth surfaces and this newsletter for textured surfaces are combined to show the relative effectiveness across all surfaces (Figure 7). Cross-comparison of results from different studies must be viewed with caution as they can be misleading. Variations in performance on a surface will occur depending upon the time of day or year in which the trial was conducted. These variations could considerably alter the chemical composition of the mark and thus the effectiveness of the range of powders. However, for this work it is still a useful way to make a broad comparison of results across all surfaces.

The ordering of the surfaces along the x-axis correlates to the decreasing performance of aluminium powder. It can be seen that this roughly correlates to the increase in surface texture with glass being the smoothest and the

melamine kitchen surfaces being the roughest and most difficult to powder. Aluminium powder goes from being the most effective powder on glass, to the worst on heavily textured surfaces. Black granular powder follows a similar trend although it is generally less effective than aluminium powder apart from some heavily textured surfaces.

The two magnetic powders are more effective on textured surfaces than either aluminium or black granular. This is likely to be the result of the application method. The fibres of a brush, when coming in contact with a textured surface, tend to apply the powder to the crests of the texture, thus developing the texture pattern in addition to or instead of the mark. An extreme example of this is shown in Figure 8, where ridges can just be seen at the top of the mark, but the majority of the powder has developed only the texture pattern.

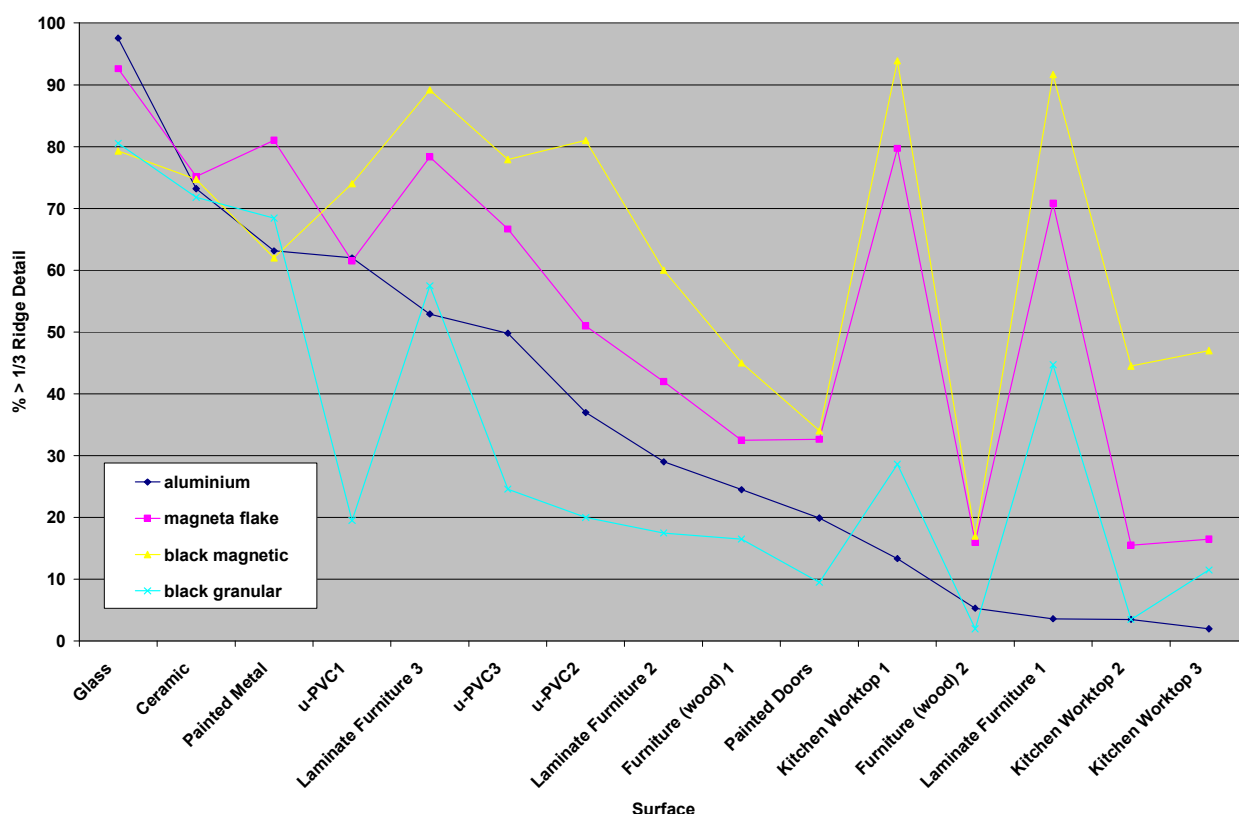


Figure 7: Effectiveness of commonly used fingerprint powders over the range of smooth and rough surfaces



Figure 8: Aluminium powdered mark on a heavily textured surface.

Figure 9 shows a comparison of the two flake powders on a textured painted door. The marks are deposited from the same finger within a few seconds of each others so that they are chemically and physically as similar as possible. Both aluminium and magneta flake have similar size flakes and stearic acid coatings (more details can be found in Study 2). Both marks are good, however the detail in (a) is slightly obscured in some areas by the surface texture. This difference is more pronounced in Figure 10 which compares the two granular powders. The powder applied with a brush (a) shows very little ridge detail and a lot of surface texture, whilst the magnetic powder develops a perfect mark. It is difficult to believe that these marks are actually developed on the same surface as there is little indication of texture with the magnetic powder.

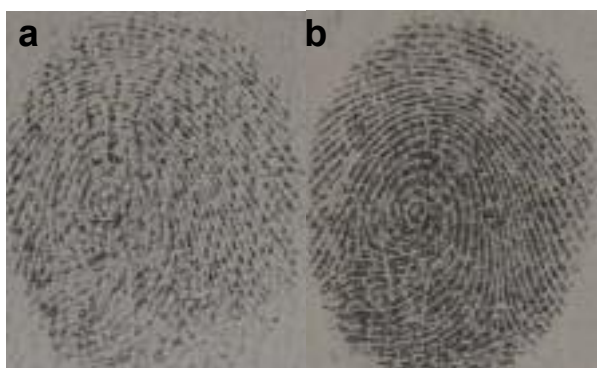


Figure 9: (a) aluminium powder and (b) magneta flake on a textured painted door.

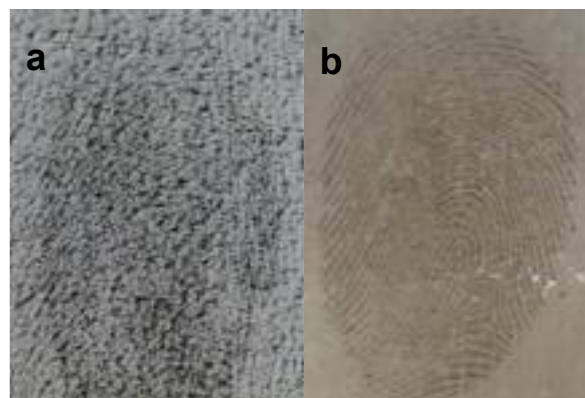


Figure 10: (a) black granular and (b) black magnetic on a textured painted door.

Magneta flake, although very effective, could be difficult to apply especially when developing fresh, heavy marks as they often overdevelop. This is demonstrated in the top right-hand corner of Figure 1 on the front page where the ridges merge together due to unavoidable over powdering. This excess powder can be difficult to remove. The first step is to try to remove it with the magnetic applicator which is successful to some degree. If this does not work, the mark can be cleaned out with a soft brush such as a squirrel mop. This works effectively on smooth surfaces, but on textured surfaces the powder gets pushed into the troughs of the surfaces texture. We did not notice similar problems with black magnetic powder.

Magnetic Powders – Additional Work

There are many magnetic powders available from forensic suppliers. In addition to the single part flake powders such as magneta flake there is a whole host of multi-component magnetic powders, one of which is the black magnetic powder tested in this trial. They are generally labelled as 'jet black', 'black', 'grey', 'white' and 'bichromatic' magnetic powders. It was the intention of this piece of work to determine if they all perform similarly in terms of finding marks on textured surfaces.

A small trial was conducted to compare twelve magnetic powders from CSI Equipment Ltd, Tetra Scene of Crime and

WA Products^{*}. Five donors were used with ten marks per depletion and marks were aged for one day only. In total 600 marks were developed.

In addition to the effectiveness study, the physical properties of the powder were investigated using SEM imaging and the elemental components of each powder were determined using energy dispersive spectroscopy (EDS).

Chemically and physically the 'black' and 'jet black' magnetic powders were all very similar irrespective of supplier. This was reflected in their ability to detect marks: they all performed similarly and developed considerably more marks than the other magnetic powders. The remaining magnetic powders varied considerably in terms of composition and performance but were not as effective as the dark powders. In particular the grey magnetic powders were extremely ineffective.

Some of the differences between magnetic powders are the result of the ease of application. All of the powdering carried out in this newsletter was on horizontal surfaces in a powdering cabinet. Magnetic powders are more difficult to apply on vertical surfaces and care must be taken to ensure that the applicator is not scraped across the surface as this could destroy a mark.

Figure 11 shows the brush head created when a magnetic applicator is loaded with black magnetic powder. The head is uniform and returns to that shape after coming in contact with a surface. This powder is easy to apply and was the least messy of the magnetic powders on vertical surfaces.

Figure 12 shows the head created when magneta flake is used. The type of 'brush' created is very different from the one obtained with black magnetic powder. The powder is more prone to dropping off when used – especially on vertical surfaces. Although this is a very effective powder, its application can be messy.

^{*} The trial methodology described in Option 3 of the Appendix in Publication No. 08/06 was followed.

Figure 13 shows the brush head created with a grey magnetic powder after coming in contact with a surface: the powder forms a flat pad and does not return to the original uniform shape. This makes it extremely difficult to apply the powder without scratching the surface with the applicator.



Figure 11: Magnetic applicator loaded with black magnetic powder



Figure 12: Magnetic applicator loaded with magneta flake



Figure 13: Magnetic applicator loaded with magnetic grey powder

CHEMICAL ENHANCEMENT

Powdering is one of the simplest and most effective ways of enhancing latent marks at crime scenes. However, chemical enhancement, such as the superglue process, can be extremely effective, especially on surfaces that are difficult to powder such as carrier bags or textured surfaces.

The results of this study suggest that powders can be used effectively on some textured surfaces, but in practice it may be necessary to decide if a surface should be powdered at the scene or taken back to a fingerprint development laboratory for treatment with superglue.

HOSDB has given some advice following earlier studies. Home Office Publication No. 30/03: 'Superglue Treatment of Crime Scenes' indicated that on smooth, non-porous surfaces, powdering was more effective than superglue. This was supported by further short studies, one of which is reported in Publication No. 20/05: newsletter article – 'Superglue or Powders on Cars?' There is little evidence regarding the relative effectiveness of the two techniques on textured or rough surfaces, although we believe superglue is likely to be the more effective process.

Currently, HOSDB is in the process of evaluating new powder suspensions for use on a range of non-porous surfaces. At this time it is unclear whether powder suspensions are more effective than powders. However, when used sequentially after powders additional marks are developed. This has been reported in the October 2005 Newsletter (Publication No. 47/05). Further updates will be reported in future newsletters.

CONCLUSIONS

A clear trend has emerged in this trial with the two part magnetic powders outperforming aluminium, black granular and magnetite flake across all surfaces tested. In particular, the black or jet-black powders were more effective than the lighter magnetic powder.

RECOMMENDATIONS

Based upon the results in this trial the following recommendations are made:

- *Aluminium powder or black granular powder should not be used on textured surfaces.*
- *Where appropriate, a black or jet black magnetic powder should be used on textured surfaces.*
- *Black or jet black magnetic powders should be used on u-PVC window and door frames.*
- *For serious crime, scene examiners should consult their force fingerprint development laboratory staff as chemical processing may be more effective on textured surfaces.*

APPENDIX 1: Images of surfaces used in the trial. The inserts are images taken with a $\times 5$ macro lens



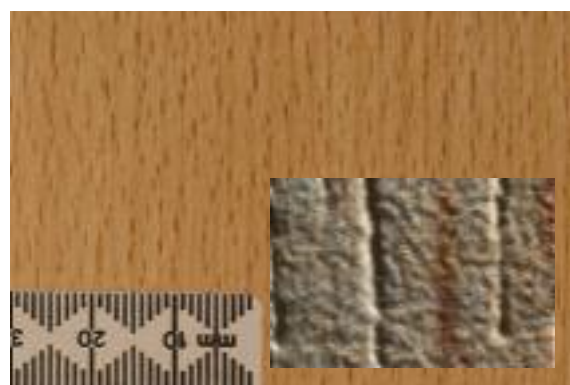
u-PVC1



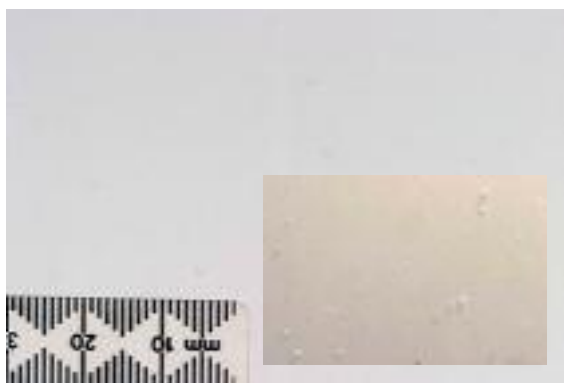
Furniture 2 - wood effect



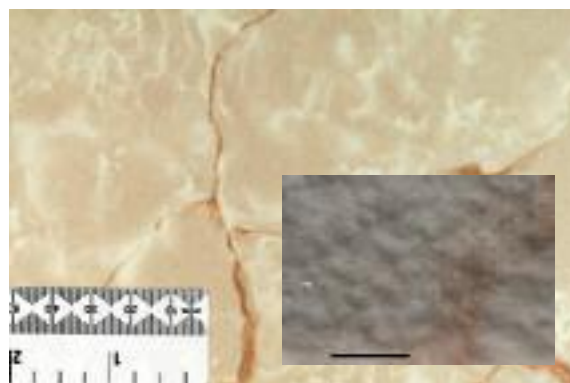
u-PVC2



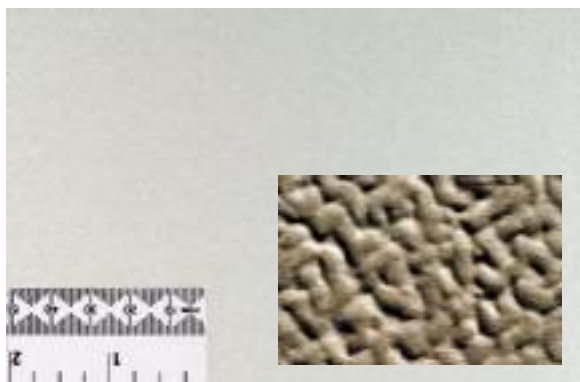
Furniture 3 - fake wood



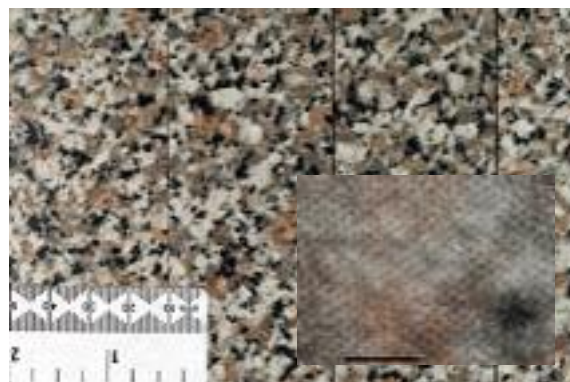
u-PVC3



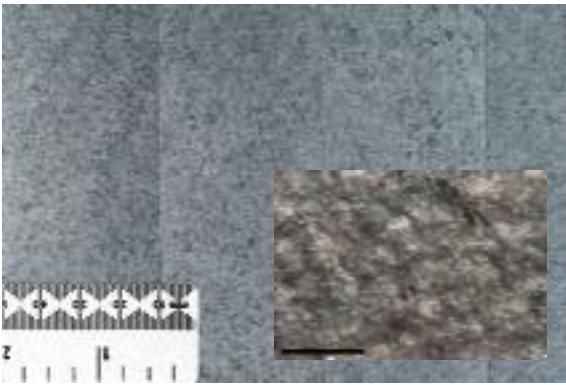
Kitchen Surface 1



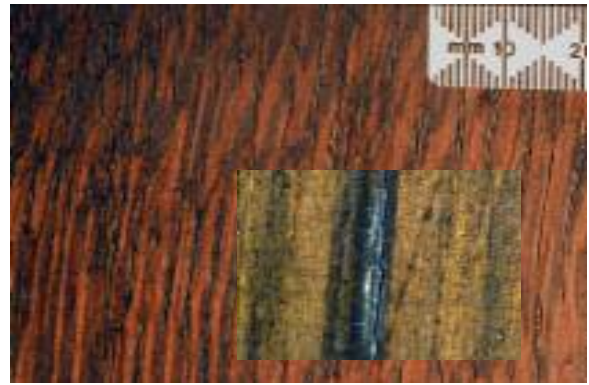
Furniture 1 - white textured



Kitchen Surface 2



Kitchen Surface 3

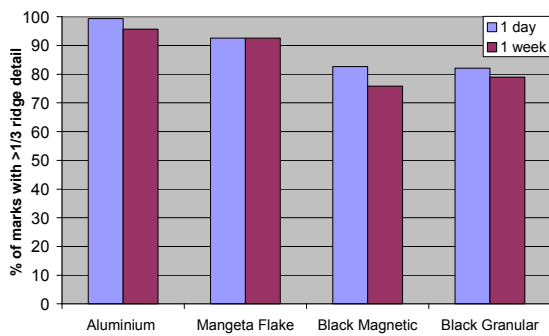


Real Wood 2 – Sideboard

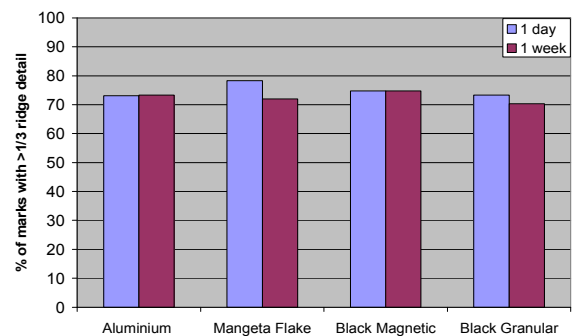


Real Wood 1 – Wardrobe door

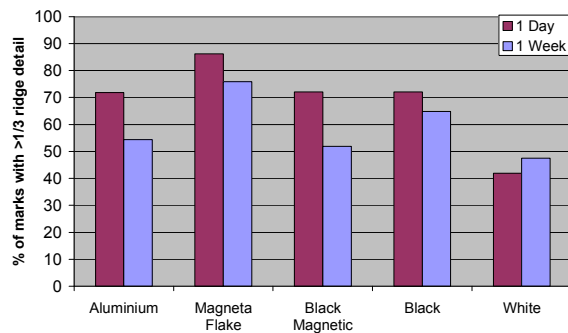
APPENDIX 2: Summary of results from Study 2 - refer to newsletter (publication no. 08/06) for full details



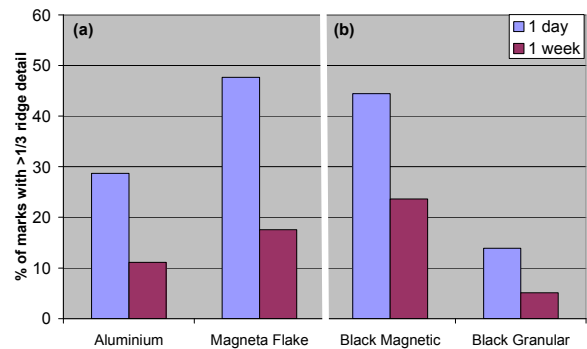
Effectiveness of fingerprint powders on glass



Effectiveness of fingerprint powders on ceramic



Effectiveness of fingerprint powders on painted metal



Effectiveness of fingerprint powders on gloss painted wood

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