TECHNICAL NOTE

Brian Wilshire,[1] *D.Sc. and Nigel Hurley,*[1] *B.Eng.*

Development of Two-Dimensional Footwear Impressions Using Magnetic Flake Powders

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ABSTRACT: Footwear impressions deposited on various types of surface were developed using magnetic flake powder and several conventional dusting powders. Although comparable results were achieved when glass was the receptor surface, the magnetic flake powder proved superior for revealing footwear impressions on rough or porous surfaces such as linoleum, polythene and paper.

KEYWORDS: forensic science, criminalistics, footwear impressions, magnetic flake powders

Latent footwear impressions found at crime scenes can often be revealed using the powder dusting techniques adopted for the development of latent fingerprints. In general, powders are used only when a damp or wet shoe has tracked across clean non-porous surfaces such as waxed or polished floor tiles. After being walked upon, the texture of the floor surface is altered by the footwear contact so that, following powder dusting, the fine powder particles adhere to the contacted areas to decorate the pattern left by the sole of the shoe. However, when footwear impressions have been made on non-smooth or porous surfaces, it is rare to attempt development either by standard brush application of conventional powders or even by magna-brush application of the magna powders (1) normally recommended for visualization of latent fingerprints deposited on difficult surfaces (2,3).

Several recent studies have shown that for development of latent fingerprints using the magna-brush technique, numerous advantages are gained by replacing conventional magna-powders with fine magnetic flake powders (4–6). Conventional magna-powders are composed of coarse iron particles (up to 50 μm in diameter), mixed with a small amount of fine powder. The coarse iron particles act as a magnetic carrier for the non-magnetic fine powder, but only the fine powder component is capable of adhering to the fingerprint residue. In contrast, with the new magnetic flake powders, there is no need for the coarse iron carrier medium since the flake itself is magnetic, so that all flake picked up with the magna-brush is available for print development.

[1]Professor and Research Student, respectively, Department of Materials Engineering, University of Wales, Swansea, Wales.

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The fine magnetic flake powders have proved especially useful for revealing faint prints on a wide variety of surfaces differing in color and texture. For this reason, this study was designed to assess the effectiveness of the new magnetic flake powders for enhancement of latent footwear impressions.

Experimental Procedures

Although many different magnetic flake powders have been evaluated, pure iron and austenitic stainless steel flake proved particularly effective for development of latent fingerprints deposited on surfaces ranging from glass plates to painted walls, polythene sheets, magazine covers, kitchen worktops (5) and various types of paper (6). For both flake products, the manufacturing operations could be controlled to supply highly-reflective smooth-surfaced flake for bright visualization of latent prints on dark surfaces or poorly reflective uneven-surfaced flake for 'dark' print development on light backgrounds. In all cases, the best results were achieved with flake particles averaging 20 μm in diameter and ~0.5 μm in thickness (5).

In the present investigation, the 'dark' iron powder was applied with a standard magna-brush to two-dimensional footwear impressions produced on several different surfaces, namely, glass, paper, polythene sheets and polished linoleum. All impressions were made using identical procedures, that is, by placing the receptor surface on a smooth dry floor and walking across it in a normal manner. In every case, the same person wearing a new pair of popular training shoes sought to achieve the same downward pressure, duration of contact and contact angle. Initially, marks were made on each type of receptor surface when the footwear was dry, later repeating the procedures for the various surfaces when the soles of the training shoes were dampened with clean water. The wet marks were then allowed to dry completely at room temperature before attempting to develop the resulting impressions.

Sets of nominally identical 'wet' and 'dry' footwear impressions were made for each type of receptor surface. Impressions from each set were then developed using the 'dark' magnetic flake powder, allowing a comparison to be made with the results achieved

(a) with commercial 'dark' magna-powder applied with a standard magna-brush and

(b) with commercial aluminum fingerprint powder applied with clean glass-fiber brushes.

Each trial was conducted in duplicate and, because of the subjective nature of this type of comparison study, the entire experiment

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was repeated several times at weekly intervals. For the initial studies, the new training shoes were stored in a clean dry environment between each experiment, but later trials carried out when the shoes were worn between the experiments did not modify the conclusions drawn.

Experimental Observations

The results achieved in the present investigation can be summarized as follows.

1. For footwear impressions on glass, all powders were effective in developing both 'wet' and 'dry' marks (Fig. 1*a* and *b*).
2. For impressions on polythene sheets, the aluminum powder proved ineffective. The magna-powder enhanced the dry marks (Fig. 2*a*), but was not as effective for wet marks. In contrast, the dark magnetic flake clearly revealed both the wet and dry impressions (Fig. 2*b*).
3. On linoleum, nothing was revealed with the aluminum powder, with very little detail brought up with the magna-powder (Fig. 3*a*). The magnetic flake powder proved very effective for dry marks (Fig. 3*b*), but less so for wet marks. Interestingly, for the wet marks, the magnetic flake powder developed a negative image, i.e., the powder particles adhered to regions not contacted by the sole of the training shoe rather than regions of contact.
4. For dry and wet footwear impressions on paper, reasonable enhancement was achieved with the magna-powder (Fig. 4*a*), but the greatest detail was revealed with the magnetic iron flake powder (Fig. 4*b*). Once again, no features were clearly identifiable on dusting with the aluminum flake powder.

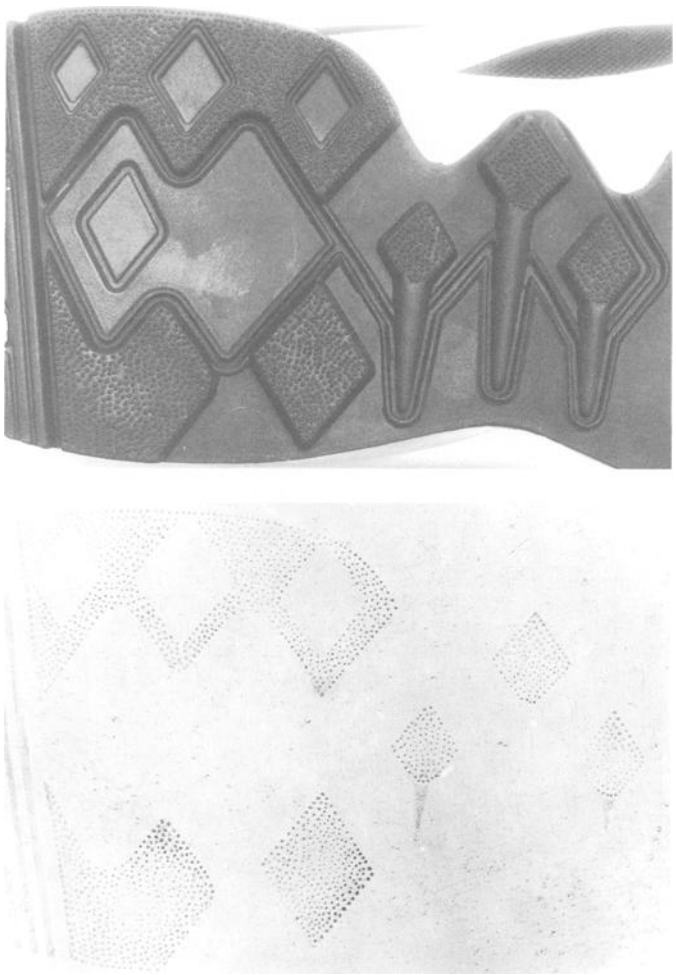

FIG. 1—(a) *Photograph of the training shoe sole and* (b) *a dry impression on glass developed with commercial aluminum powder, with the developed mark lifted onto a transparent acetate sheet before being photographed.*

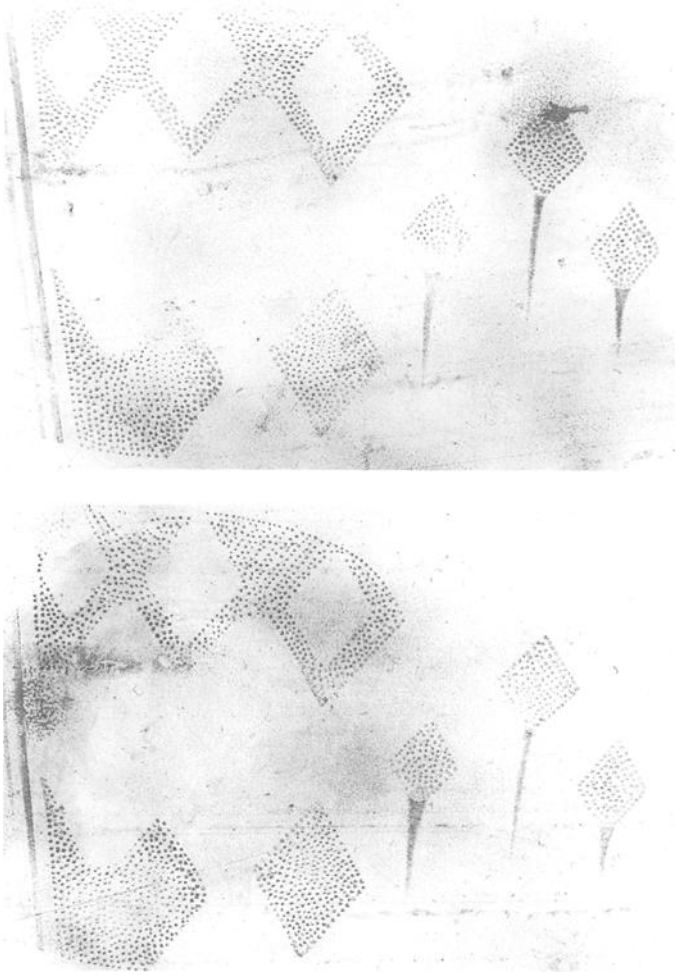

FIG. 2—*Dry impressions on polythene sheets developed with* (a) *magna-powder and* (b) *dark magnetic flake.*

As reported in earlier trials describing the development of latent fingerprints (5,6), most of the magnetic flake particles can be retrieved from the furrows between the fingerprint ridges simply by moving a rare-earth magnet over the developed print without touching the surface on which the latent fingerprint was deposited. This procedure does not remove the flake particles adhering strongly to the fingerprint residue, resulting in improved print by reducing the 'background.' This effect was also observed in this study, with the detailed features of the footwear impressions developed with the magnetic flake powder being more clearly defined after moving a rare-earth magnet about a centimeter above the receptor surface. As a result, the footwear impressions developed with the magnetic flake powder were characterized by background and smudging levels much lower than with the other powders investigated.

FIG. 3—*Dry impressions on a linoleum floor developed with* (a) *magna-powder and* (b) *dark magnetic flake.*

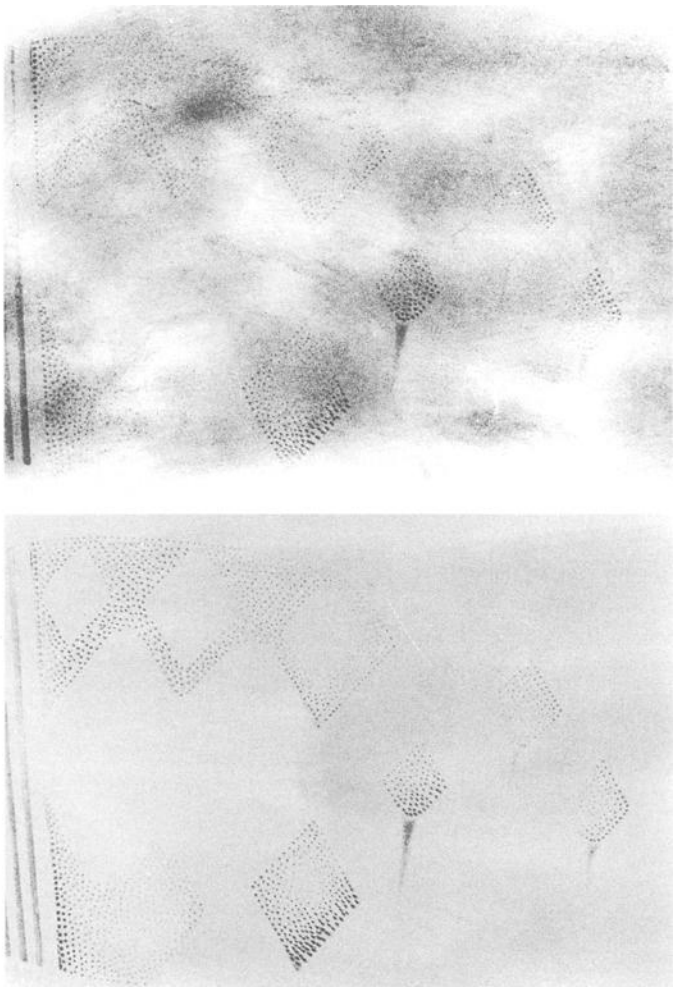

FIG. 4—*Dry impressions on sheets of matte paper developed with* (a) *magna-powder and* (b) *dark magnetic flake.*

Conclusions

Although several different dusting powders effectively revealed the detailed characteristics of wet and dry impressions left by a training shoe on glass plates, superior results with far lower background levels were achieved when magnetic flake powder was applied with a magna-brush to develop latent footwear impressions deposited on linoleum, polythene, and paper.

Acknowledgments

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Address requests for reprints or additional information to
Brian Wilshire
Department of Materials Engineering
University of Wales, Swansea
Swansea, West Glamorgan SA2 8PP
Wales