Analysis of Magnetic and Non-Magnetic Fingerprint Powders on Varying Substrates

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Abstract: The processing of fingerprints with magnetic and non-magnetic fingerprint powders is common practice among crime scene technicians and latent fingerprint forensic scientists. Numerous studies have been performed on the development of latent prints using chemical processing techniques [1, 2], but not using fingerprint powders. This study involves fingerprint powder processing on different substrates and in different conditions and found that a difference does exist between fingerprint powders.

Introduction

The Scientific Working Group on Friction Ridge Analysis, Study and Technology (SWGFAST) has outlined several topics in need of research. Studying the effectiveness of multiple powders on different surfaces and under varying conditions is one of these. The purpose of this experiment was to determine if there is a difference in adherence and ability to provide ridge detail suitable for comparison between magnetic and non-magnetic powders broken down by both manufacturer and color.

A wide range of substrates was chosen for this experiment in order to encompass the diversity of materials found at crime scenes. Glass was chosen due to its prevalence in breaking and entering cases. Plastic, paper, and metal were chosen because they are products commonly submitted as evidence. Although it is not common practice to process paper with fingerprint powder, at times this method can be beneficial. One such time is when thermal paper is involved, due to the potential of chemical processes to obscure ridge detail and printing [4]. Tile was also selected because of the unique nature of its surface.

The substrates chosen were subjected to two environmental conditions: the normal conditions of the laboratory (with no control over humidity and temperature) were used to mirror the conditions of indoor scenes; the ambient conditions outside* were used to mirror an outdoor scene. Powders from three different companies were used to process the substrates. Magnetic and non-magnetic powders were used in black, gray, white, and dual-print.

Methods

The substrates used in this experiment were: smooth, white tile; light-colored, plastic weigh boats; metal super-glue fuming weigh boats; glass specimen slides; and white printer paper. A total of 288 fingerprints were placed on the surface of each substrate with the exception of the paper. Due to the fact that the paper was only processed with the magnetic fingerprint powders, only 144 fingerprints were used. The fingerprints of two people were used throughout the experiment. Each person placed three consecutive fingerprints on the surface of the substrate using the same finger. This was done three times to produce three replicates of the touch series. In between the replicates, the fingers were rubbed on the individual's face to ensure adequate amounts of oil for processing. After the prints had been placed, they were divided into two groups. One half of the fingerprints were left outside but protected from direct rain and sunlight for one week. The other half were left, undisturbed, inside at 75 degrees F. After one week the fingerprints were processed.

Each fingerprint was divided in half, either physically or through the use of a barrier. One half of the fingerprint was processed with company A's white powder and the other half with company B's. The next fingerprint was processed half with B's and half with C's. The third was processed half with C's and half with A's (Figure 1). (Company key: A - Evident; B - Sirchie; C - Lightning Powder Company). All fingerprints were processed using this technique, which enabled side by side visual comparison.

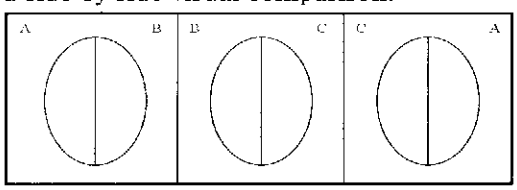

Figure 1: Graphic demonstrating how fingerprints were divided for processing

Due to the large number of brushes that would have been required to prevent contamination, a new technique was implemented to process the fingerprints using non-magnetic powder in order to allow the experiment to remain cost effective. Frying splatter guard was cut into circular pieces and placed in the lids of salt and pepper shakers. This allowed for a thin, even coat of powder to be placed in precise locations. Cotton balls were then used to brush off excess powder. The method outlined in the Manual of Fingerprint Development Techniques was followed for processing with magnetic powders [5].

After processing, the fingerprints were visually evaluated based upon the clarity of ridge detail as well as adherence of the powder. Adherence was ranked as 1, 2, or 3, with 3 being the powder with the most adherence and 1 being the powder with the least adherence. Ridge detail was also ranked as 1, 2, or 3, with 3 being the most visible ridge detail and 1 being the least. If there was no discernable difference between the adherence or the ridge detail, the powders were assigned the same ranking number. If no adherence or ridge detail was observed, a dash line was used. Magnetic white powder was not available from company A, therefore, a double dash was used to indicate no data.

Results

The experiment yielded several potentially useful results. One of these was that the amount of adherence observed on the surfaces of the substrates did not necessarily indicate the clarity of ridge detail that was present. In general, magnetic powder produced the most adherence and the best ridge detail on all the substrates. In the following paragraphs each substrate will be discussed individually.

Tile:

Overall, the fingerprints processed on the tile gave the best results. All the replicates, with the exception of the tile processed with non-magnetic white powder that was in the outside condition, provided clear ridge detail and good adherence (Table 1). In the inside condition, the non-magnetic dual-print powder did not do as well as the magnetic dual-print powder. However, these results were reversed for the outside condition. With regard to the gray powders, the best results were observed in the outside condition with non-magnetic powders. For both black and white powders, magnetic and non-magnetic, there was no significant difference between outside and inside conditions. Figure 2 shows the comparability between two of the non-magnetic black powders.

Figure 2: Fingerprint on tile processed with powder C (left) and A (right)

Plastic:

Essentially no ridge detail was observed on the plastic processed with the non-magnetic powders (Table 2). Adherence was the greatest with magnetic powders in the outside condition. The gray powders showed considerable differences in the adherence of powder (Figure 3). However, they were the only powders that yielded any ridge detail. It appears that the dual-print magnetic powders inside worked the best.

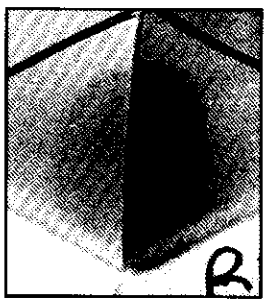

Figure 3: Fingerprint on plastic processed with powder B (left) and C (right)

Glass:

The magnetic black powders gave the only results for the glass exposed to outside conditions (Table 3). Although there was some adherence in the magnetic white powders, it did not give significant ridge detail. The prints kept inside and processed with black magnetic powders and magnetic dual-print powders were comparable. Magnetic white and gray powders were also comparable but did not provide as much ridge detail as the magnetic black and dual-print powders. Figure 4 demonstrates that although ridge detail is comparable, the amount of adherence in powder B obscures contrast. The ridge detail and adherence seen in all of the inside fingerprints processed with non-magnetic powders are similar.

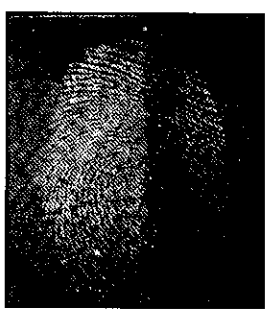

Figure 4: Fingerprint on glass processed with powder B (left) and C (right)

Metal:

The metal super-glue fuming weigh boats exposed to the outside conditions yielded minimal or no ridge detail (Table 4). The metal weigh boats kept inside and processed with magnetic and non-magnetic powders yield-

ed good results with both non-magnetic and magnetic powders; however, the magnetic powder results were slightly better. The magnetic black powder gave good ridge detail in all replicates. Figure 5 emphasizes the difference in adherence between the powders.

Figure 5: Fingerprint on metal processed with powder A (left) and B (right)

Paper:
As anticipated, paper produced limited results (Table 5). Despite this, it appears that the best results were obtained from the magnetic black powders with both inside and outside conditions (Figure 6). The lack of contrast in white and gray powders limited their effectiveness.

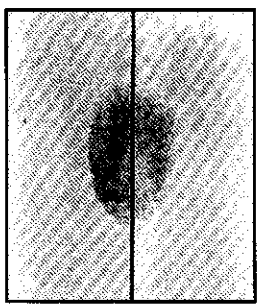

Figure 6: Fingerprint on paper processed with powder A (left) and B (right)

Conclusion

During the course of this study it quickly became apparent that here can be, at times, a vast difference in the clarity of ridge detail obtained from different powders. The results obtained with the magnetic powders were consistently better than the results from the non-magnetic powders. This is especially true for the fingerprints left outside. Although, ultimately, the processing technique determines the results obtained, it is apparent from this study that the powder itself can play a large role as well.

The unique processing technique implemented in this experiment may have compromised some of the results especially with regard to ridge detail. It is the belief of the researchers that this method was adequate for the scope of this study. Further research needs to be completed with additional variables, including temperature, substrate and humidity. It may be beneficial to lift the processed fingerprints prior to analysis to reduce interference from the substrate background. This will provide a wider base of information to assist law enforcement agencies.

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Key for Tables

A - Evident, B - Sirchie, C - Lightning Powder Company

Magnetic white powder was not available from company A, therefore, a double dash was used to indicate no data.

Adherence: Ranking of 1, 2, 3, with 3 being the powder with the most adherence and 1 being the powder with the least adherence. If there was no discernable difference between the adherence or the ridge detail, the powders were assigned the same ranking number.

Ridge detail: Ranking of 1, 2, 3, with 3 being the most visible ridge detail and 1 being the least. If no adherence or ridge detail was observed, a dash line was used.

Table 1
Results on Tile

	Inside				Outside			
	Magnetic		Non-Magnetic		Magnetic		Non-Magnetic	
	Adherence	Ridge Detail	Adherence	Ridge Detail	Adherence	Ridge Detail	Adherence	Ridge Detail
Black								
A	2	2	3	2	2	2	3	1
B	3	3	2	3	3	3	1	2
C	1	1	3	2	1	1	1	3
White								
A	--	--	3	1	--	--	2	-
B	3	1	1	3	3	1	1	-
C	1	3	3	1	1	3	3	-
Gray								
A	1	2	2	1	1	2	3	3
B	2	2	1	2	1	2	1	1
C	3	1	3	2	3	1	3	3
Dual-Print								
A	3	2	3	2	3	1	3	2
B	3	2	2	1	3	2	3	2
C	3	2	1	3	2	3	2	2

Table 2
Results on Plastic

	Inside				Outside			
	Magnetic		Non-Magnetic		Magnetic		Non-Magnetic	
	Adherence	Ridge Detail	Adherence	Ridge Detail	Adherence	Ridge Detail	Adherence	Ridge Detail
Black								
A	2	1	3	1	3	-	3	-
B	2	1	3	1	3	-	2	-
C	2	1	2	2	3	-	2	-
White								
A	--	--	1	-	--	--	2	-
B	1	-	1	-	1	-	1	-
C	3	-	2	-	3	-	3	-
Gray								
A	2	1	2	-	2	1	2	1
B	1	1	1	-	1	1	1	-
C	3	-	2	-	3	1	2	1
Dual-Print								
A	2	1	1	-	3	-	2	-
B	2	1	1	-	3	-	2	-
C	3	1	1	-	3	-	2	-

Table 3
Results on Glass

	Inside				Outside			
	Magnetic		Non-Magnetic		Magnetic		Non-Magnetic	
	Adherence	Ridge Detail	Adherence	Ridge Detail	Adherence	Ridge Detail	Adherence	Ridge Detail
Black								
A	3	3	1	1	2	2	-	-
B	3	3	2	1	2	2	-	-
C	3	3	3	3	2	2	-	-
White								
A	--	--	3	1	--	--	-	-
B	3	2	1	1	3	1	-	-
C	1	3	2	3	2	-	-	-
Gray								
A	2	3	3	1	-	-	-	-
B	3	3	1	3	-	-	-	-
C	1	1	2	1	-	-	-	-
Dual-Print								
A	3	3	2	1	-	-	-	-
B	3	3	3	3	-	-	-	-
C	3	3	3	3	-	-	-	-

Table 4
Results on Metal

	Inside				Outside			
	Magnetic		Non-Magnetic		Magnetic		Non-Magnetic	
	Adherence	Ridge Detail	Adherence	Ridge Detail	Adherence	Ridge Detail	Adherence	Ridge Detail
Black								
A	2	3	2	2	1	-	-	-
B	2	3	2	2	2	1	-	-
C	2	3	2	2	3	-	-	-
White								
A	--	--	2	2	--	--	-	-
B	3	2	2	2	3	1	-	-
C	2	3	3	2	2	1	-	-
Gray								
A	3	3	2	2	2	1	-	-
B	2	2	2	2	1	-	-	-
C	2	2	2	2	2	1	-	-
Dual-Print								
A	2	2	2	2	2	1	-	-
B	1	2	2	2	2	1	-	-
C	2	2	2	2	2	-	-	-

Table 5
Results on Paper

	Inside Magnetic		Outside Magnetic	
	Adherence	Ridge Detail	Adherence	Ridge Detaill
Black				
A	3	2	2	3
B	3	2	3	3
C	1	1	1	1
White				
A	-	-	-	-
B	-	-	-	-
C	-	-	-	-
Gray				
A	1	-	-	-
B	1	-	-	-
C	3	2	-	-
Dual-Print				
A	3	2	2	2
B	3	2	2	2
C	2	-	3	2

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