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Jan A. de Koeijer,[1] M.Sc.; Charles E.H. Berger,[1] Ph.D.; Wendy Glas,[1] B.Sc.; and Henk T. Madhuizen[1]

Gelatine Lifting, a Novel Technique for the Examination of Indented Writing*

ABSTRACT: The limitations of the examination of indented writing impressions using electrostatic detection are often paper related. Paper types such as glossy paper, paper of high basis weight, and lithography or gravure-printed papers often give rise to problems resulting in a decrease in sensitivity or a lack of detection altogether. In this paper, a novel technique for the examination of indented writing is presented, which is in a sense complimentary to the technique of electrostatic detection as it is especially suitable for glossy-coated and printed paper types and can in some instances also deal with paper types of higher basis weight. Indented writing grooves will normally contain more particles than the surrounding nonindented areas due to damage of the surface layer resulting in a build-up of filler powder. The method presented uses black gelatine lifter slabs to lift the paper dust image off the surface of the paper. This image can quite easily be photographed using near-to-coaxial lighting.The gelatine lifting method outperforms oblique lighting for the detection of indented writing and is almost as sensitive as electrostatic detection if compared on the types of paper where both perform well. The main advantage of this new technique is, however, that it is especially suitable for those types of paper where electrostatic detection fails and is therefore a welcome addition to the range of methods available to a forensic document examiner for the examination of indented writing.

KEYWORDS: forensic science, electrostatic detection, ESDA, gelatine lifting, indented writing, glossy paper

Examination of indented writing is one of the most frequently performed activities of a forensic document examiner. In the past, many different approaches have been chosen for the examination of indentations in paper substrates. The methods used include optical, electrostatic, and chemical methods. Most of these techniques are described briefly in the survey by Brown (1). Since its introduction, electrostatic examination of indented writing using an electrostatic detection device (EDD) such as the electrostatic detection apparatus (ESDA) has been the method of choice for most forensic document examiners because of its ease of use and sensitivity. However, the sensitivity of electrostatic detection depends on a number of factors, of which relative humidity (2) and the type of paper to be examined are probably the most important. An in-depth review of some of the variables that an examiner must deal with when using electrostatic examination methods can be found in two articles by Seward (3,4).

This paper will show the problems encountered with electrostatic detection on some different types of paper and will propose an alternative method of examination using black gelatine lifters that is especially suited for some of these paper types. Gelatine slabs are normally used to lift powdered fingerprints from smooth surfaces, but their use for the examination of indented impressions has previously been described in Given (5) and Van den Heuvel (The use(fulness) of gelatine lifters for revealing indented (hand)writing. European conference for Police and Government Handwriting Experts, Nov 13–15, 1996; The Hague), Given used small pieces of transparent gelatine slabs to cause a difference in refractive index between the undisturbed paper surface and the indentations, whereas Van den Heuvel's approach was to use a black gelatine lifter slab to create an image of the indented writing in the form of paper dust lifted off the surface of the document. This paper will elaborate on Van den Heuvel's method, explain its mechanism in more detail, and compare its results with those of the ESDA and oblique lighting methods.

[1]Chemistry Department, Document group, Netherlands Forensic Institute, P.O. Box 24044, 2490 AA The Hague, The Netherlands.

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Materials and Methods

Preparation of Samples

Indented writing test samples were partially created using a specially fabricated device, similar to the "Gradient" ruler described by Purdy (6). The ruler was devised to give a gradual difference in writing depth of 0.04 mm over a length of 156 mm. Besides lines with a fixed variation in depth, some hand-written text and lines of varying writing pressure were added to the test samples. All test samples were made by writing on a stack consisting of (from top to bottom) a standard photocopy paper, three pages of the paper to be examined (see Table 1), and one page of cardboard (250 g) laying on a hard, smooth surface. The test samples were afterwards cut in half to produce two almost similar sample sets for the duplicate testing. Figure 1 shows a diagram of a test sample.

The following types of paper were examined:

(1) laser printer/copier paper;
(2) coated inkjet paper;
(3) inkjet photo paper;
(4) A4 Writing pad paper;
(5) printed cardboard cover sheets of writing pads;
(6) glossy calendered paper;
(7) cheap print paper;
(8) glossy quality print paper; and
(9) airmail paper.

Four pages of each paper class were examined with the exception of the airmail paper, of which only one sample was used. Table 1 shows the total sample set.

TABLE 1—*Paper used in the examination (sample numbers are built up out of the paper type and a serial number).*

Sample #	Paper type	Paper brand	Name	BW(g/m^2)
1.1	Laser/copier	MoDo van Gelder	Balans	80
1.2	Laser/copier	HP	Laserjet	90
1.3	Laser/copier	Fastprint	Gold	80
1.4	Laser/copier	Veneka	Laser	80
2.1	Coated inkjet	Xerox	Premium TCF	90
2.2	Coated inkjet	DCP	1821	100
2.3	Coated inkjet	Fastprint	Office star	90
2.4	Coated inkjet	Rey	Success	100
3.1	Inkjet photo	IBM	Digital photo inkjet	180
3.2	Inkjet photo	IBM	Gloss coated inkjet	130
3.3	Inkjet photo	Datacopy	Photo gloss	160
3.4	Inkjet photo	Kodak	Premium Picture	220
4.1	Writing pad	Kantic	Squared writing paper	80
4.2	Writing pad	ASPA	Lined writing paper	80
4.3	Writing pad	No brand known	Lined writing paper	80
4.4	Writing pad	V&D Selection	Lined writing paper	80
5.1	Printed cardboard	Kantic	Cover of writing pad	180
5.2	Printed cardboard	ASPA	Cover of writing pad	180
5.3	Printed cardboard	No brand known	Cover of writing pad	180
5.4	Printed cardboard	V&D Selection	Cover of writing pad	200
6.1	Calendered	Hello	Gloss finish	90
6.2	Calendered	Hello	Gloss	100
6.3	Calendered	Mondial	Gloss	90
6.4	Calendered	Silverblade	H.V. M.C. gloss finish	90
7.1	Cheap Print	Cover sheet of magazine	Rotogravure print	90
7.2	Cheap Print	Page of LC/GC Europe	Offset litho print	60
7.3	Cheap Print	Page of Adobe Magazine	Offset litho print	90
7.4	Cheap Print	Page of Focus Magazine	Offset litho print	100
8.1	Glossy print	Cover of LC/GC Europe	Offset litho print	140
8.2	Glossy print	Cover of Adobe Magazine	Offset litho print	150
8.3	Glossy print	Cover of Focus Magazine	Offset litho print	250
8.4	Glossy print	Cover of Money Magazine	Offset litho print	150
9.1	Air mail	Elco	Atlantic klipper A5	22.4

BW, basis weight.

Materials

Black gelatine lifter slabs with a polyester backing, size 13×9 cm, were used (BVDA, Haarlem, the Netherlands). The slabs were applied to the paper samples using a rubber fingerprint roller. Images from the gelatine lifters as well as from oblique lighting were captured with a Kodak DCS 660 high-resolution digital camera (Kodak, Vianen, The Netherlands). Electrostatic detection was performed with the ESDA from Foster and Freeman using cascade development with beads and toner.

Methods

From the 35 paper types, 14 samples were selected and tests were prepared in duplicate as shown in Fig. 1. One of the test sets was examined first with the ESDA, followed by gelatine lifting, and the other set was examined in the reverse order. This was to establish in which way these two techniques influence each other's results. Following the interpretation of the results of this first test, samples from the 35 paper types were examined in the following order: electrostatic detection, gelatine lifters, and oblique lighting. All examinations were performed in duplicate on two separate halves from the same test sample by two different examiners. The second examination was performed $2\frac{1}{2}$ years after the first. During the time in between, the samples were kept reasonably immobile in closed envelopes in the ESDA room.

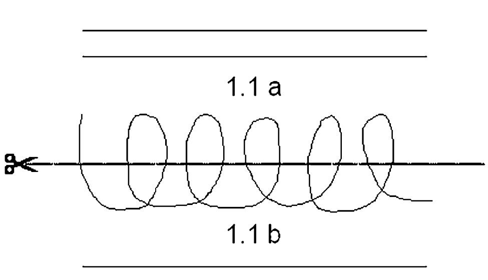


FIG. 1—*Diagram of a test sample with, on the top and bottom, a pair of indentations with a controlled depth profile and in between the sample numbers and a handwritten figure. The test sample was cut in half to produce two sample sets.*

Electrostatic detection was performed under closely monitored ambient conditions with a relative humidity between 50% and 65%. The samples were charged with the corona for about 20 sec, sweeping in random directions over the entire surface of the samples. The charged samples were allowed to rest for a period of 5–10 min before development with the cascading beads.

Gelatine lifting was performed by applying the gelatine slabs to the test samples laying on a smooth glass surface. The slabs were applied from one end and slowly lowered to cover the sample. After this, a rubber fingerprint roller was applied to the reverse side of the slab with light pressure to ensure good surface contact between the slab and the paper and remove any trapped air. The gelatine slabs were peeled off the samples slowly by starting at one corner and pulling in one smooth motion. Directly after removing the slabs (S), the lifted image was photographed with the digital camera (C) using near-coaxial lighting created by two projectors (L) in combination with two mirrors (M); see Fig. 2.

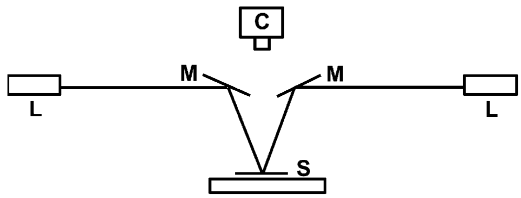


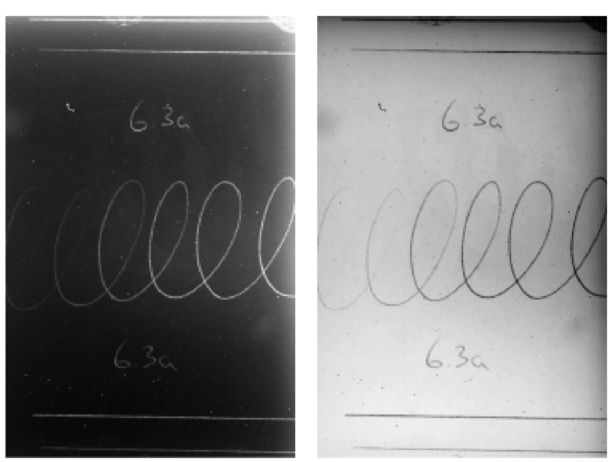
FIG. 2—*Setup for photographing the dust-images on the gelatine slabs.*

Most images of gelatine lifts displayed in this paper are negatives of the original images; see Fig. 3.

Oblique lighting images were photographed with a digital camera using halogen light from a Volpi light rod.

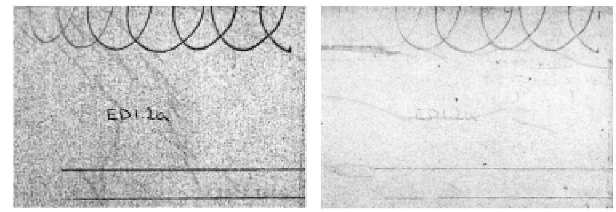
Results

Raster electron microscopy (REM) examinations of indentations before and after gelatine lifting have shown that before gelatine lifting, a high concentration of paper dust particles from the paper filler is found in the indentation groove; see Fig. 4. After gelatine lifting, the concentration of filler particles in the indentation groove is not much different from that outside of the groove.



A (#6.3) B (#6.3)

FIG. 3—*(a) An original image of a gelatine lift from paper #6.3, and (b) the negative image of (a).*



a (#1.2) b (#1.2)

FIG. 5—*Image quality of electrostatic lifts taken (a) before and (b) after gelatine lifting.*

Effect of Gelatine Lifting on Electrostatic Detection Results

Electrostatic detection following gelatine lifting showed a substantial overall deterioration in the results obtained. An example of this deterioration is shown in Fig. 5.

An overview of the quality of the electrostatic lifts taken before and after gelatine lifting is given in Table 2.

Effect of Electrostatic Detection on Gelatine Lifting Results

Gelatine lifting following electrostatic detection showed no significant deterioration in results. In some instances, the results even improved owing to a decrease in the background dust image. An example of this is shown in Fig. 6.

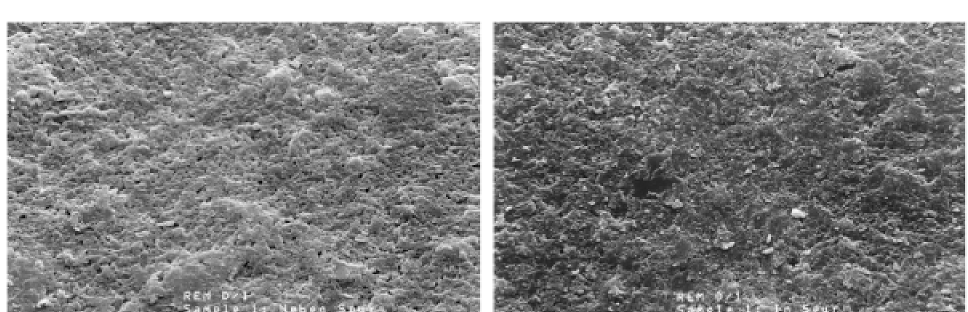
An overview of the quality of the gelatine lifts taken before and after electrostatic detection is given in Table 3.

From the above experiments, it was concluded that gelatine lifting should in principle be performed after electrostatic detection as there is a significant deterioration in the ESDA lift after gelatine lifting but no unambiguous sign of deterioration of the gelatine lifting results after ESDA examination.

Comparison of the Results from Gelatine Lifting with Electrostatic Detection and Oblique Lighting

The results obtained using the techniques mentioned on the 35 paper samples are listed in Table 4. The same sample was used for each of the detection methods.

The results from Table 4 are summarized in Table 5 showing the preferred method for the different paper classes. These results show that gelatine lifting gives good results over a broad spectrum of paper types, often competing with electrostatic detection in the noncoated paper types and outperforming the other methods in most of the coated paper samples including printed paper. It must be mentioned, however, that the adhesive force of the gelatine



a (next to indentation groove) b (in indentation groove)

FIG. 4—*Raster electron microscopy (REM) image of paper surface (a) next to the indentation groove showing small loose particles and (b) inside the indentation groove showing many loose particles.*

TABLE 2—*Quality of electrostatic lifts (EL) before and after gelatine lifting (GL).*

	First set of samples		Second set of samples	
Sample #	EL before GL	EL after GL	EL before GL	EL after GL
1.1	++	+ −	++	+ −
1.2	++	+	++	+
1.3	++	+ −	+	+
1.4	+	+	++	+ −
2.1	+	+ −	−	−
2.2	+++	+ −	+ −	−
2.3	++	+	++	+
2.4	++	+ −	++	−
3.4	−	−	−	−
4.1	+++	++	+++	+
4.2	+++	+	++	+
4.3	+++	++	+++	++
4.4	+++	++	+++	++
6.3	−	−	−	−

The shaded cells represent the best results obtained for a certain brand of paper. The second set of samples was measured after $2\frac{1}{2}$ years.

Scoring: −, (almost) no visible information; + −, poor legibility; +, reasonable legibility; ++, good legibility; +++, sharp definition/excellent legibility.

TABLE 3—*Quality of gelatine lifts (GL) before and after electrostatic detection (ED).*

	First set of samples		Second set of samples	
Sample #	GL before ED	GL after ED	GL before ED	GL after ED
1.1	+	++	+	+
1.2	++	++	+	++
1.3	++	++	++	++
1.4	+	++	+	+
2.1	+	+ −	+	+
2.2	++	++	+	++
2.3	++	++	+	+
2.4	++	++	+	++
3.4	+++	+++	+ −	−
4.1	+	++	+	++
4.2	++	++	+	++
4.3	++	+++	++	++
4.4	++	++	+	+ −
6.3	+++	+++	+	++

The shaded cells represent the best results obtained per set, per brand of paper. The second set of samples was measured after $2\frac{1}{2}$ years.

Scoring: −, (almost) no visible information; + −, poor legibility; +, reasonable legibility; ++, good legibility; +++, sharp definition/excellent legibility.

lifter destroyed the coating on the printing side of two of the four examined photographic quality inkjet papers.

Some examples of the differences in image quality obtained by the different methods are given in Figs. 7–9.

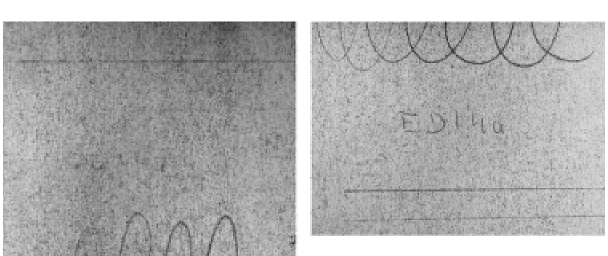
On two samples of coated inkjet paper of photographic quality, problems arose due to the fact that the gelatine lifter's adhesive force caused a partial removal of the coating. Figure 10 shows the resulting image from the front side of the paper with the removed coating and from the noncoated backside of the paper.

To test the sensitivity of the gelatine lifting method, the second and third underlying pages of a number of different samples were tested. An example of the results is shown in Fig. 11.

Discussion

The technique of gelatine lifting is based on the adhesion of paper filler particles pulverized under the writing pressure to a slightly adhesive gelatine foil. REM research has shown that the concentration of paper filler particles in the writing groove is substantially larger than in the surrounding area. The contrast between the black gelatine foil and the white filler particles lifted by the foil provides us with an image of the indented writing on the document.

Gelatine lifting has been shown to be an all-round method of visualizing indented writing. The gelatine lifting process can be



a (#1.4) b (#1.4)

FIG. 6—*Image quality of gelatine lifts taken from paper # 1.4, (a) before and (b) after electrostatic detection.*

TABLE 4—*Comparison of results from electrostatic detection (ED) on the front side, gelatine lifting (GL) of both sides, and oblique lighting (OL) on the front side of the document.*

	First set of samples				Second set of samples			
Sample #	ED	GL front	GL back	OL	ED	GL front	GL back	OL
1.1	++	+	+	+ −	+	+	+ −	+ −
1.2	+++	++	+	+ −	++	++	+	+ −
1.3	+++	++	+	+ −	−	−	+	−
1.4	+	+	+	+ −	+	++	+	−
2.1	+	+	+ −	+ −	+	+	+ −	−
2.2	++	++	+	+ −	++	++	+	−
2.3	++	+	+ −	+ −	++	+	+	−
2.4	++	+	+ −	−	+	+	+ −	−
3.1	+ −	−*	++	+++	−	−*	+	++
3.2	−	−*	++	+++	−	−*	++	++
3.3	−	+ −	+	+++	−	+	+ −	++
3.4	−	+++	−	−	−	+ −	−	−
4.1	+++	++	+ −	+ −	+++	+	+ −	−
4.2	+++	++	+ −	+ −	+++	++	+ −	+ −
4.3	+++	++	+	+	+++	++	+ −	+
4.4	+++	++	+	+ −	+++	++	+ −	+ −
5.1	+ −	+++	+	+ −	−	++	+ −	
5.2	+ −	+++	+	+ −	−	++	+ −	−
5.3	+	++	+ −	+ −	−	++	+ −	−
5.4	−	+ −	+	−	−	−	+ −	−
6.1	+ −	++	+	+ −	−	+	−	−
6.2	−	+	+	+	−	+ −	−	−
6.3	+ −	+++	+	+ −	−	++	−	+ −
6.4	+ −	+++	++	+ −	−	++	+ −	−
7.1	−	++	+++	+ −	−	++	++	−
7.2	+	+++	+++	−	+ −	++	++	−
7.3	+	+++	++	+ −	−	++	+	−
7.4	+	+++	++	+ −	+ −	+	++	+ −
8.1	−	+	+	−	−	−	+ −	+ −
8.2	+ −	++	++	+ −	−	+	+	−
8.3	−	+	++	+ −	−	+ −	+	+ −
8.4	+	+ −	+	+ −	−	+ −	+ −	+
9.1	+++	+++	++	+	++	++	++	+

*The adhesive force of the gelatine lifter destroyed the paper coating.

The shaded cells represent the best results obtained per set per brand of paper. The second set of samples was examined after $2\frac{1}{2}$ years.

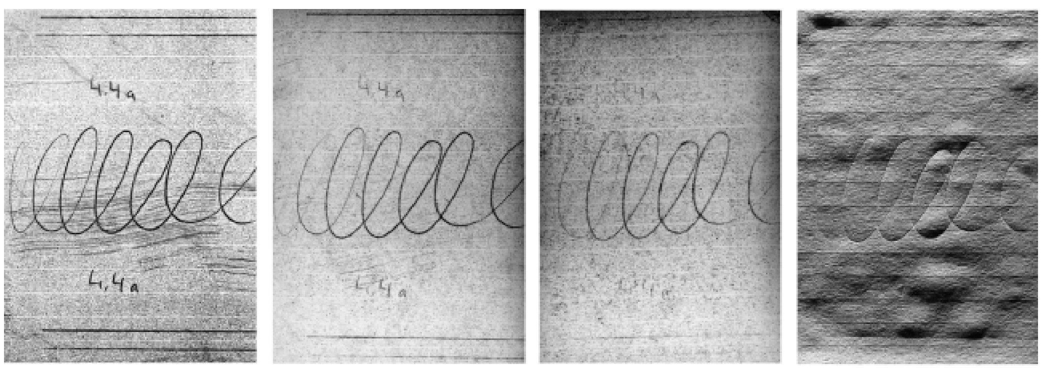
Scoring: −, (almost) no visible information; + −, poor legibility; +, reasonable legibility; ++, good legibility; +++, sharp definition/excellent legibility.

TABLE 5—*Preferred method for different paper classes.*

Type of paper	Best results obtained with method
Laser printer/copier paper	Electrostatic detection and gelatine lifting
Coated inkjet paper	Electrostatic detection and gelatine lifting
Inkjet photo paper	Oblique lighting and gelatine lifting
A4 Writing pad paper	Electrostatic detection
Cover sheets of writing pads	Gelatine lifting
Glossy calandered paper	Gelatine lifting
Cheap print paper	Gelatine lifting
Glossy quality print paper	Gelatine lifting
Airmail paper	Electrostatic detection and gelatine lifting

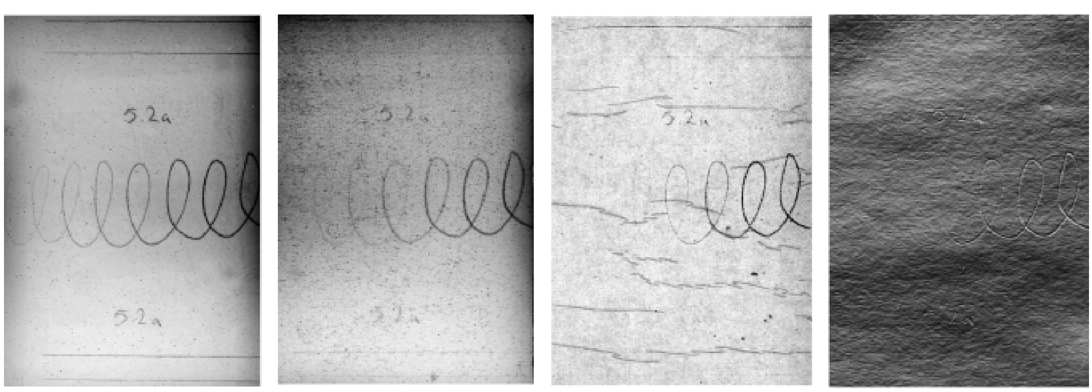
successfully used with a greater variety of paper types than the electrostatic process. Electrostatic detection is, however, still the preferred method for the most common types of writing, printing, and copying paper. But in cases where other types of paper are submitted, such as printed paper from magazines, glossy paper, paper of high basis weight (250 g/m^2 or more), etc., gelatine lifting is the favored method, producing results that are often better than those produced by electrostatic detection.

Gelatine lifting has a substantial negative effect on the results of electrostatic detection if the gelatine lifting is performed first. On the other hand, electrostatic detection before gelatine lifting does

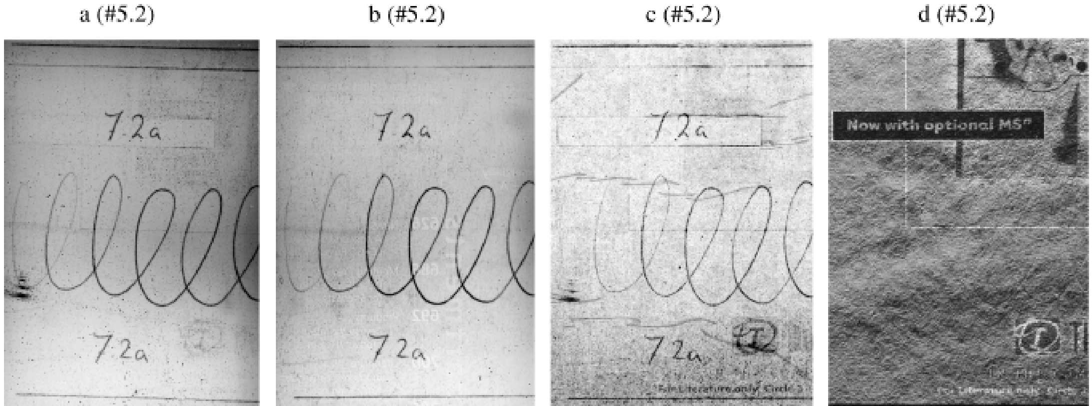


a (#4.4) b (#4.4) c (#4.4) d (#4.4)

FIG. 7—*Comparison of results on paper #4.4 where (a) electrostatic detection gives superior results to gelatine lifting of the (b) front and (c) backside and (d) oblique lighting.*

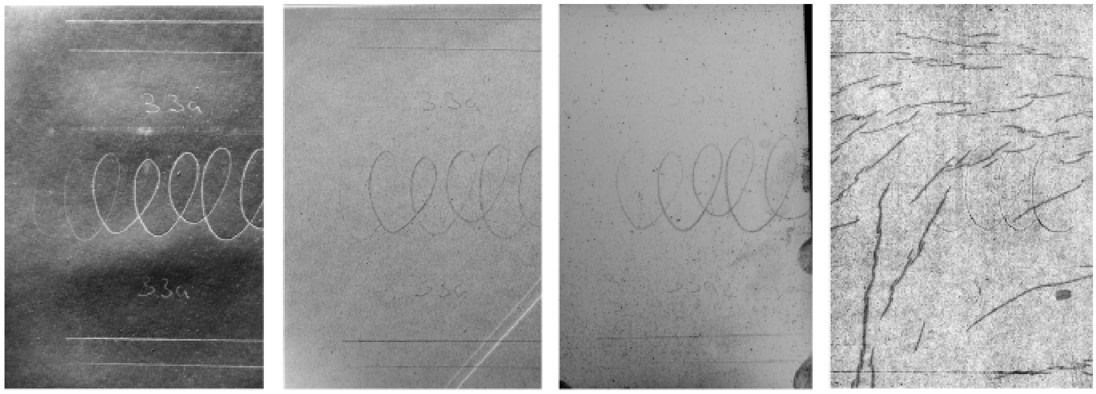


a (#5.2) b (#5.2) c (#5.2) d (#5.2)



a (#7.2) b (#7.2) c (#7.2) d (#7.2)

FIG. 8—*Comparison of results on paper # 5.2 and 7.2 where gelatine lifting of the (a) front side and/or (b) backside gives superior results to (c) electrostatic detection and (d) oblique lighting.*



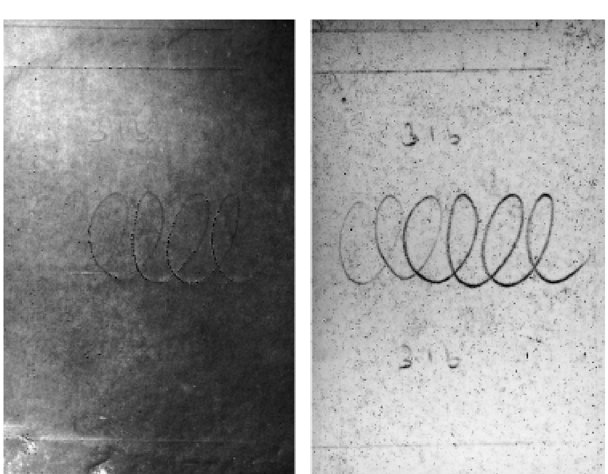
a (#3.3) b (#3.3) c (#3.3) d (#3.3)

FIG. 9—*Comparison of results on paper #3.3 where (a) oblique lighting gives superior results to gelatine lifting of the (b) front and (c) backside and (d) electrostatic detection.*

not seem to have any significant negative influence on the results of the latter. Sometimes, the results even improve when gelatine lifting is preceded by electrostatic detection. This is probably owing to a partial removal of the background surface dust by the electrostatic forces generated during electrostatic detection. It must therefore be emphasized that an electrostatic examination of the document must always be performed before an examination by gelatine lifting. Owing to this semidestructive nature of the gelatine lifting technique, permission from the client may also be necessary to perform this type of examination.

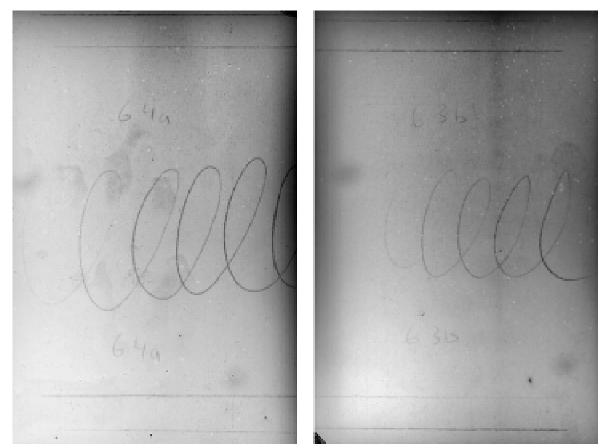
The sensitivity of gelatine lifting depends mainly on the type of paper (coated or noncoated) and the pressure applied to the writing instrument. In some cases, indented writing impressions could be developed on certain types of paper situated three or four sheets below the sheet bearing original writing. The sensitivity shown thus far is often comparable with—and for specific types of paper better than—electrostatic detection and definitely exceeds that of oblique lighting in almost all papers examined.

Care must be taken with some types of coated papers, especially photographic inkjet paper, because the adhesive force of the gelatine lifter may damage the coating. All other types of paper examined, however, showed no signs of any damage to the paper surface.



a (#3.1) b (#3.1)

FIG. 10—*(a) Damage to the paper surface of photographic quality inkjet paper #3.1 due to the adhesive force of the gelatine lifter. (b) The noncoated backside of the document gives a normal image by gelatine lifting.*



a (#6.4) b (#6.3)

FIG. 11—*Indented impressions obtained by gelatine lifting from the (a) second and (b) third underlying page of paper #6.4 and #6.3, respectively.*

Results of tests on the influence of the application of gelatine lifters to paper on the quality of DFO and ninhydrin development of fingerprints indicate that if the gelatine lifter is kept on the document for only a short period of time (just the time necessary to apply it and lift it off again), almost no detectable damage is inflicted on the latent prints on the document. Longer periods of contact result in background fluorescence and/or coloration influencing the contrast of the weaker fingerprint details.

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Additional information and reprint requests:
Jan A. de Koeijer, M.Sc.
Chemistry Department
Netherlands Forensic Institute
Document group
P.O. Box 24044
2490 AA The Hague
The Netherlands
E-mail: j.de.koeijer@nfi.minjus.nl