Survey of Techniques Used to Visualize Indented Markings

Jerry L. Brown

Questioned Document Examiner, Iowa Division of Criminal Investigation Laboratory, Wallace State Office Building, Des Moines, Iowa 50319-0041

Introduction

This is a review of information and techniques utilized to visualize indented markings on paper. This information is intended only as a survey, providing highlights of the different techniques used to visualize indented marks and text. The main reason for this survey is that since its introduction, the Electrostatic Detection Apparatus (ESDA) is the method of choice for visualizing indented marks. The ESDA is not the panacea for all indented impression problems, but it is easier than whatever is second. Sometimes other methods of inquiry into visualizing indentations may be necessary to come up with needed answers.

This paper is not intended to be "how to" information. If any of these techniques are to be used by the reader, the specific procedure should be researched. Appropriate caution should be practiced when using equipment or chemicals. Many of the chemicals used in these processes are to be considered hazardous materials and appropriate safety precautions should be utilized.

Methods and Materials

Chemical Processes

Chemical processing is used to differentiate thickness in paper; between the compressed areas of impressions and surrounding areas not compressed. In most cases the examiner can photograph these visualized differences using transmitted or reflected light.

Iodine Fumes Iodine fumes are absorbed more readily in compressed areas of the paper, indentations, than in uncompressed areas. Compressed areas appear darker than the remainder of the paper when exposed to iodine fumes. This produces a difference in shading between the undisturbed surface of the paper and the indented markings. Photography of the results must be accomplished promptly as the iodine will dissipate from the document quickly. Caution must be used when using this iodine fuming technique due to the toxic nature of the fumes (Given, 1995, 1997).

Harrison, 1966 and O'Harra and Osterburg, 1949 mention using an aqueous solution of iodine in combination with other chemicals. But before trying this method it is suggested that a test be made on a small portion of the paper. This pretest is to determine if the chemicals in the paper react with the aqueous solution, consequently masking the expected results. Harrison also mentions that there are ways of clearing the paper and then treating it again to help preserve the document from any further changes.

Radioisotope absorption Radioactive sulfur dioxide gas is used in this technique. The document is put into a container with the radioactive sulfur dioxide gas. The radioactive sulfur, like the iodine, is absorbed preferentially in the compressed areas of the paper, indentations, than the non-compressed areas. The document is then placed in direct contact with X-ray film. As the absorbed gas emits radiation it exposes the X-ray film, more-so in the areas of compressed paper and less in the non-compressed areas. The paper remains radioactive for a period of time (Wells, 1971).

Solvent evaporation Benzene is used to differentiate between the compressed and non-compressed areas. Place the document with the indented markings on a glass plate or glass cake dish. A camera should be in place, ready to capture the results of this processing, because the benzene will evaporate quickly. The benzene is used to pour over the document on the glass. A light should be placed under the glass containing the document so that a transmitted light photograph can be taken. It could be helpful if the camera was motorized so that a series of photographs could be taken as the benzene evaporates from the document. Once the setup is complete the light should be turned on, shining up through the document. The idea is that the benzene will evaporate from the compressed (in-

dented) portions of the paper more slowly than from the rest of the paper. The difference in evaporation rates will provide contrast between the compressed and uncompressed areas. Photographs should be taken because the process takes place in a short period of time (Given, 1975, 1977).

Dyes Water soluble dyes can be spread over the surface of the paper using a balloon. The dry chemical dyes will adhere to the balloon surface by static electricity. The dye will be deposited on the surface of the paper using the inflated balloon. This is done by "patting" or "blotting" the surface of the paper using the balloon covered with the dry dye. This method covers the surface with the water soluble dye, leaving the indentations free of the dyestuff. The paper containing the water soluble dye is then passed through a cloud of steam two to three times. Allow the paper to dry in between passes through the steam. The water vapor of the steam develops the dye, turning it the expected color (Fast Green = green color) while leaving the indentations, without dye particles, clear (Given, 1975, 1977).

Scotch Magic Tape™

This method has been reportedly used to visualize the indented markings on material obliterated using markers which do not allow the obliterated material to be visualized with IR techniques. Scotch Magic tape, #811 should be pressed over the obliterated writing. This will create a difference in the way light is reflected from the indentations and the rest of the surface of the paper. The visualized image of the obliterated material may be recorded using a photocopy machine set on a light setting (Oleksow, 1994).

Gelatin Slabs

Thin slabs or strips of gelatin, 1–2 mm thick and the size of a glass microscope slide, are placed over the indentations. These thin slabs of gelatin provide results similar to the Scotch Magic tape above. The gelatin placed over the indentations causes a difference in the refractive index between the undisturbed paper surface and the indented surfaces.

This causes the indentations to become visible. Depending on the gelatin used this method should be done and photographed quickly, to prevent the gelatin melting into the paper (Given, 1975, 1977).

Casting Methods

These methods rely on filling the indentations with some solid or flexible matrix. The casts of the indentations can be processed, photographed or otherwise examined to determine the indented text.

Mikrosil Process the questioned document with the indented markings using the typical ESDA method up to the point of using the corona. Place the Mikrosil over the imaging film to make a casting of the surface indentations of the plastic film. To enhance this method it is best to place the Mikrosil on the imaging film and place a thin coating on a glass plate. Press the glass plate onto the top of the Mikrosil on the imaging film. This will press the Mikrosil into the indentations in the paper and imaging film (Carlsson, 1991; McKesson, 1994).

Silicone rubber A technique used by Thorpe in Canada involved placing Silicone rubber on the indentations. The result would be a cast with raised impressions. The cast can be dusted with latent print powder to bring out the detail. He suggested using this to compare typewriter fonts and ribbons, check protector parts, adding machine fonts, rubber stamps and indented writings (Thorpe, Feb. 1971, Oct. 1971).

Vinylite replica (thermoplastics) Longhetti and Kirk reported using a sheet of Vinylite plastic and an ordinary heat lamp. They would take the questioned document with the indented markings and place it on a resilient backing. The Vinylite was placed on top of the document and the heat lamp was used to warm and soften the plastic. Once the paper obtained a wet appearance, the process was done and the heat lamp removed. The plastic was allowed to cool. One way of visualizing the indentations is to rub the surface of the replica with a finely powdered rouge. The powder tended to adhere to the lower portions of the replica and rub off the raised portions (the indentations), thus, the contrast between the portions where the rouge adhered and where it rubbed off allowed the examiner to visualize the indented material. The paper indicates this method can be used numerous times on the same document (Longhefti and Kirk, 1950; Kirk, 1974; Cain).

Fluorescent Powder

This technique involves spreading a fluorescent powder (Lycopodium) over the surface of the paper using a balloon. This method is similar to the process using the water soluble dyes (discussed previously). Powder adheres to balloon surface by static electricity. Fluorescent powder is deposited on the

surface of the paper using the inflated balloon. This is done by "patting" or "blotting" the surface of the paper with the balloon which is covered with fluorescent powder. This method covers the surface of the document with the fluorescent powder, leaving the indentations free of the powder. Using an UV light, the examiner can view or photograph the paper. The indented images will show little or no fluorescence. The paper should be examined with UV light before using this method since some papers may "naturally" fluoresce. Chemicals added during the paper making process may interfere with the fluorescent properties of the powder. Important Safety NOTE- Lycopodium powders can be flammable (Given, 1975, 1977).

Fluorescent Liquid

Besides fluorescent powders, fluorescent liquids (invisible inks), can be used to visualize indented text areas. This method is particularly useful for impressions such as notary seals. Applications such as using the fluorescent liquid on the backside of a paper with raised impressions may also be useful. Polyvinyl alcohol and carboxymethylcellulose are dissolved in water. Added to this solution is a water soluble fluorescent powder and glycerin. The glycerin keeps the ink from drying too rapidly. A small amount of this solution is placed on a glass plate and rolled out with a finger print roller. The roller, with the fluorescent ink, is then passed over the impression(s). This should be done under ultraviolet illumination so that as the impressions develop, the examiner can stop when adequate results are noted. It may be necessary to reprocess under developed portions of the impression(s). A photograph of the results may be made (Gayet, 1953).

Dry Markers/Waxy Crayon/Oil Base Artist Crayon

Dry markers can be used to rub over the ESDA imaging film after processing on the ESDA. Spread a blue (or a color of your choice) over the surface of the imaging film on the ESDA (processed up to point of using corona). Using another marker of contrasting color, which is almost dry, again go over the surface of the text area. The color of the first marker should remain in the indentations. The resulting images of the impressions may or may not be covered with the clear contact paper. Covering the imaging film will make the imaging film easier to handle (Oleksow, 1994).

Pencil rubbing (shading) This is possibly the oldest method of visualizing indented markings. It is possible to use a broad piece of pencil lead or other similar broad marking device to rub over the surface of paper. This will leave the indentations free of discoloration. The clear impressions should contrast with the shaded, uncompressed surface (Lewis, 1981; Eveft, 1993).

Ronchi Ruling Plate

To carry out this examination a glass plate called a Ronchi ruling plate with etched, closely spaced fine black lines, is placed on top of the document the suspected indented markings. By rotating the glass while in contact with the paper, a point may be reached at where the indentations in the paper can be viewed through the glass plate. When using the Ronchi ruling plate one may also change the angle of the light as the paper is examined. This may enhance in the observed results (Lewis, 1981; Eveft, 1973).

Photography

Side lighting (grazing incident or oblique lighting) Along with the pencil rubbings, this is probably one of the first used effective techniques for viewing indented latent images. Side lighting of a document is used by directing a focused or narrow beam of light across the questioned document to create shadows, consequently, the indentations can be visualized. Sometimes taking more than one photograph at different exposures will aid in deciphering the indented markings (Scott, 1969; Osborn, 1929). Small areas may be photographed using this procedure. Larger areas of the document may be photographed if the document is "painted" with side lighting. This technique can be done in a completely darkened room. The shutter on the camera is left open and the light is moved around the document to create shadows in different areas of the document, highlighting all the document. It may be necessary to do some "dodging" or "burning-in" of the image when printing the photograph. Sometimes, when original writing was produced with heavy strokes or typewriting it may be possible to determine the original material by examining the backside of the paper using side lighting (Given, 1975, 1977). (O'Hara and Osterburg, 1949).

Sometimes the paper fibers have been disturbed so that the raised paper fibers will cast interfering shadows over the impressions. This makes photography using side lighting difficult. In these cases

Dennstedt and Voigtlander recommend that the paper should be moistened and exposed to the air to dry. No pressure should be applied to the paper while wet. By repeating this process several times the paper fibers will tend to lay back down so the side lighting photography may be used successfully (Mitchell, 1935).

Axial lighting Axial lighting photography of some types of indented markings is useful, especially on rough, textured surfaces (Ex.: textured surfaces of Bible book covers). This examination is performed by using a camera setup in the normal viewing manner in a darkened room. A piece of glass is placed between the camera lens and the surface of the document containing the possible indentations. The glass, about 4 × 4 inches, is held in place at a 45° angle. A focused beam of light is directed at the angled glass, with the light parallel to the surface of the document but above the surface. When the light beam hits the angled glass, part of the light goes through the glass and a portion is reflected down toward the surface of the document. The light that is reflected from the glass to the surface of the document is reflected back from the surface of the indentations, straight up into the lens of the camera. The resulting image on the film appears as if the light were coming from the camera, and then reflected from the document straight up into the lens. This will often give results on textured or rough surface documents that cannot be visualized any other way. You can place your eye where the camera lens would be to see whether or not you will observe significant results. You can also make slight adjustments to the glass and/or light source to see if positioning these in different ways might provide better results. This method also works on the majority of the reflective, high gloss papers (Caywood, 1973).

Radiology

Some success has been noted using soft X-rays. By exposing indentations to soft X-rays, as one would a water mark, the indentations may be recorded on photographic film (Polaroid TM). In combination with the soft X-rays, Given mentions using a mixture of 200 mesh lead dust and benzene to "produce barely readable results". He passed the mixture across the document with the document at an angle of approximately 45°. When the benzene evaporates the lead dust was found to have settled in greater quantities in the indentations than on the surface of the document. By exposing the paper with the lead dust on it to soft X-rays, he was barely able to visualize the indentations (Given, 1975, 1977). Given references similar work done by Graham and Gray.

Infrared Retroreflection

This method uses tiny beads that act as thousands of little Infrared reflectors. The beads reflect incident light back in the direction from which it comes. The beads can be spread across the surface of the document, hopefully settling or collecting in the indentations. The beads on the surface of the document are collected using a tacky-surfaced roller or paper. The beads in the indentations are then viewed using an infrared device such as a metascope (Given, 1975).

Scanning Electron Microscope (SEM)

There are some methods of visualizing indented markings using a Scanning Electron Microscope and/or SEM coating preparations (Ex.: Carbon coating). Using the SEM or coating preparations is not practical for most indented marking examinations. This is because only small areas can be examined with SEM and the specialized, expensive equipment needed (Given, 1975).

Holography

In 1983 Evett, reported on using a process called Double Exposure Hologram I Interferometry to examine papers for indented markings. This method is used for recording small disturbances in the paper. This method would expose a photographic plate twice, with minute changes in the contours of the document between photographs. When viewed as a hologram using coherent light (laser), the two superimposed images would have interference fringes in the regions where the paper had been disturbed by indentations.

Electrostatic Detection Apparatus (ESDA) Indentation Materializer Electrostatic Document Device or Electrostatic Vacuum Box

This technique is widely used by document examiners today. A document containing suspected indented marks is placed upon a vacuum bed, the vacuum pump is turned on, an imaging film is used to cover the document and an electrically charged corona is passed over the document and film. A toner is cascaded, developed with a powder cloud, or brushed over the surface of the imaging film. Any resulting visualized images may be preserved

by using a clear fixing, contact film. This system works best with slight or weak indentations (ESDA Operating Instruction Manual, Foster and Freeman, Ltd., Carney, 1992).

Results

Methods used to visualize indented marks have been listed. This listing of methods should not be considered all inclusive. There are no doubt other methods that have been used with success. These methods should be looked at as springboards into additional research by combining some of the methods or modifying some methods which could yield even better analyses.

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