TECHNICAL NOTE

E. A. Davis,[1] *M.S. and A. H. Lyter III,*[2] *M.S.*

Comparison of Typewritten Carbon Paper Impressions

REFERENCE: Davis, E. A. and Lyter, A. H., III, **"Comparison of Typewritten Carbon Paper Impressions,"** *Journal of Forensic Sciences,* JFSCA, Vol. 27, No. 2, April 1982, pp. 424-427.

ABSTRACT: The carbon copy document is one form of physical evidence that has not received much attention. Although the classical techniques employed to differentiate typewritten documents are often adequate to differentiate carbon copies, the following work suggests an additional technique. Thin-layer chromatography has been used to differentiate many color-containing mixtures, and its usefulness in differentiating carbon paper impressions is discussed.

KEYWORDS: questioned documents, chromatographic analysis, carbon paper

Document examination is an integral part of a forensic science laboratory's assignments. In the case of typewritten carbon copy paper documents several areas of concern are identified by Harris [*1*]. These include determining whether several carbon copies were typed together, identifying fraudulent carbon copies, determining whether a document is a ribbon original or a carbon copy, and examining erasures, alterations, interlineations, or physical markings that may occur on the carbon copies. Analysis of such documents has been primarily physical in nature and has included the examination of type faces, type defects, type alignment, and pressure variations, along with any unique identifying characteristics such as paper fastener markings, folds and creases in the paper, and stains or blemishes.

For several years writing inks have been routinely analyzed in connection with forensic science cases [*2*], with the majority of the examinations focusing on ball-point pen inks. Brunelle et al [*3*] have also described a method for the comparison of typewriter ribbon inks. We found no references in the literature for the chemical comparison of carbon paper impressions. It is proposed that analysis of carbon paper impressions be carried out in a manner similar to those previously reported for ink samples.

Properties of Carbon Paper

Carbon paper is paper covered on one side with a thin, even coating of a mixture of pigmented waxy and oily materials. Originally the general name was given because most of the

Received for publication 26 July 1981; accepted for publication 21 Sept. 1981.

[1]Student at Northeastern University, Boston, MA, and intern at Bureau of Alcohol, Tobacco, and Firearms, U.S. Treasury, Rockville, MD 20850.

[2]Forensic chemist, Bureau of Alcohol, Tobacco, and Firearms, U.S. Treasury, Rockville, MD 20850.

carbon paper made was black and contained carbon as a component [4]. Today other colors of carbon paper exist.

Carbon paper may be divided into two categories, single-use carbons, consisting of one-time and book carbons, and multiple-use carbons, which consist of typewriter carbons and pen/pencil carbons. Variations in the formulations are determined by the intended use of the carbon paper. For instance, pencil carbon waxes are much softer than typewriter waxes and react to a rubbing pressure rather than to the sharp blow of a typewriter [5].[3]

Carbon paper formulations may be applied either as a hot melt wax or in a solvent system. The hot melt wax is manufactured by taking a hot wax-ink mixture and applying it in an even coat to various weights of kraft tissue. Solvent carbon is an innovation that provides increased life and greater legibility as compared to the hot melt application. In this manufacturing process several types of resins, solvents, and inks are combined to form a slurry. An extremely even layer of the slurry is coated on paper or a polymeric film and the excess solvent is driven off. The sponge-like surface acts as a liquid ink reservoir, in contrast to the hot melt type, where the surface is a solid wax. When solvent-type carbon paper is used, the ink surface is gradually replenished by drawing liquid ink from the unused areas of the carbon. In the case of hot melt wax, when the carbon paper is used a piece of the applied coating is transferred to the copy sheet and depleted. Solvent carbons are much cleaner than wax carbons because the coating remains with the paper or film backing [5].

Reagents and Apparatus

The solvents and reagents used were pyridine (American Chemical Society grade), ethyl acetate (Chromar grade) and ethanol (200 proof). Carbon paper samples were obtained from various manufacturers or from local stationery supply stores. The apparatus included chromatographic plates that were precoated silica gel glass plates without fluorescence indicator (E. M. Merck, Darmstadt, West Germany) and a video spectroscanner [6]. Supplies included 10-μL disposable glass pipets, 3.7-mL (1-dram) screw cap disposable glass vials, 50% cotton fiber white bond paper, Whatman chromatographic paper (1M), and wood fiber tissue-weight paper.

Experimental Procedure

Samples of 19 black and 5 blue carbon papers from 13 carbon paper manufacturers were examined by infrared (IR) reflectance, IR luminescence, and thin-layer chromatography (TLC). Carbon paper impressions were made by typing an *M* onto a sandwich of two pieces of 50% cotton fiber bond paper with a carbon paper sheet in the middle. These were analyzed for IR reflectance and IR luminescence by using a video spectroscanner [6]. The impressions were removed from the paper by using a scalpel and were transferred to glass vials. The ink was extracted from each impression with 10 μL of pyridine and was then spotted onto the precoated silica gel chromatographic plates with disposable glass pipets, developed, dried, and compared visually under white light. The TLC parameters were a mobile phase of ethyl acetate/ethanol/water (70:35:30), a developing time of 10 min, and air drying at room temperature. Carbon paper impressions (once again of the *M*) were also applied to Whatman chromatographic paper and to tissue paper and were analyzed by the above procedure to determine the effect of the three paper types. Paper blanks containing no carbon paper impressions were analyzed simultaneously.

With the 50% cotton fiber bond paper in the typewriter, carbon paper impressions of the *M* were then made in random areas on each of five individual sheets of the same type of car-

[3]Personal communication from W. C. Krueger, research fellow, Institute of Paper Chemistry, Appleton, WI.

TABLE 1—*Infrared reflectance and luminescence properties of five blue carbon paper impressions.*

Sample	Reflectance	Luminescence
Blue No. 1	opaque	no
Blue No. 2	transparent	yes
Blue No. 3	transparent	yes
Blue No. 4	transparent	yes
Blue No. 5	opaque	yes

bon paper. This procedure was used to analyze random samples from different areas of each sheet as well as areas from each of the five sheets to determine intrasheet and intrabatch differences. Paper blanks were also considered.

Again with the 50% cotton fiber bond paper, carbon paper impressions of an *M*, the number *1*, a lowercase *i*, a semicolon (;), and a period (.) were obtained. The samples studied were one *M*, and one and two of each of the other impressions obtained. This was done to determine the minimum sample size.

Results

The analysis of all 19 black carbon paper impressions by video spectroscanner showed that all of the impressions were opaque under transmitted light and did not luminesce with a blue-green filter. The impressions made by the five blue carbon papers had varying luminescence properties, which are summarized in Table 1.

The TLC procedure differentiated among the inks extracted from the impressions on bond paper of all 19 black and 5 blue carbon papers. The examination of the effect of paper type on the carbon impression indicated no discernible differences among the samples.

The analysis of five sheets from a single batch yielded chromatograms that were qualitatively similar for different areas of the same sheet as well as for the five different sheets, which indicates batch uniformity.

The ink extracted from one *M* was more than enough to permit analysis and easy comparison between samples. The ink extracted from one and two samples of the numeral *1* and a lowercase *i* were also sufficient to allow differentiation among the samples; however, the ink extracted from fewer than two semicolons was not sufficient for comparison.

Summary

The results of this study show that TLC techniques previously used to examine writing and typewriter ribbon inks can be successfully applied to distinguishing the ink in carbon paper impressions. The luminescence properties of colored carbon paper impressions may be used as an additional means of distinguishing certain of these impressions.

Acknowledgments

The authors thank Mr. Richard Brunelle, chief of the Forensic Science Branch at the Bureau of Alcohol, Tobacco, and Firearms, and Northeastern University in Boston, MA, for the internship of Ms. Davis, during which this work was completed; and Dr. A. A. Cantu of the Forensic Science Branch at the Bureau of Alcohol, Tobacco, and Firearms for many beneficial discussions.

References

[1] Harris, J. L., *Journal of Criminal Law, Criminology, and Police Science*, Vol. 50, No. 2, July-Aug. 1959, pp. 211-212.
[2] Brunelle, R. L. and Pro, M. J., *Journal of the Association of Official Analytical Chemists*, Vol. 55, No. 4, July 1972, pp. 823-826.
[3] Brunelle, R. L., Negri, J. F., Cantu, A. A., and Lyter, A. H. III, *Journal of Forensic Sciences*, Vol. 22, No. 4, Oct. 1977, pp. 807-814.
[4] Waters, C. E., "Typewriter Ribbons and Carbon Paper," Circular C431, National Bureau of Standards, Washington, DC, June 1941, p. 20.
[5] Product information, Carter Ink Co., Waltham, MA.
[6] Richards, G. B., "The Application of Electronic Video Techniques to Infrared and Ultraviolet Examinations," presented at the 28th Annual Meeting of the American Academy of Forensic Sciences, Washington, DC, 16-20 Feb. 1976.

Address requests for reprints or additional information to
Albert H. Lyter, III
Federal Forensic Associates
917 Merridale Blvd.
Mt. Airy, MD 21771