J Forensic Sci, Oct. 1973, Vol. 18, No. 4

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# Carbonless Paper Systems

In the examination of questioned documents, problems involving the source or authenticity of carbon copies may be encountered. The copy presented may have been prepared through the utilization of individual sheets of carbon paper, or it may have been produced through a carbonless paper system. In some cases it may be significant to determine whether the copy was produced in the conventional manner or with a carbonless system and, if the latter, which particular carbonless system was utilized. For these reasons, a study of the carbonless systems currently in use was undertaken.

All carbonless papers have a transfer system built into the paper eliminating the need for separate sheets of carbon paper. The first patents for a carbonless process were awarded to National Cash Register in 1939. National Cash Register produced the first carbonless product released for public use in 1954 [*1*]. The product was called "No Carbon Required" (NCR) paper. In recent years there has been a rapid increase in the utilization of carbonless paper systems in multiple sets of forms used in Government and industry. Mr. R. S. Schlauch, Chief of Marginally Perforated Contracts of the Government Printing Office in Washington, D.C., stated that in 1970–71, only 10 percent of the Government forms were made with a carbonless paper system. However, Mr. Schlauch feels that in the not too distant future 80 percent of all U.S. Government forms will be printed on carbonless paper.

While many different companies manufacture carbonless paper systems under many different brand names, they all conform to one of the two basic systems: the chemical reaction carbonless paper system and the physical system of carbonless paper.

## Chemical Reaction Carbonless Paper System

The chemical reaction system is the oldest of the carbonless systems. This system was the basis for the first NCR paper introduced by National Cash Register in 1954 [*1*].

The chemical reaction system relies on chemical reaction to generate color. Dyes (such as crystal violet lactone) and certain solvents, used as carriers, are encapsulated in a coating attached to the donor sheet. The capsules are situated between a protective material called stilts. The stilting material prevents the bursting of the capsules by accidental bumping. A coating of clay or resins is affixed to a receptor sheet. The color-producing process takes place when the capsules on the donor sheet are broken by the pressure of the writing instrument and react with the clay or resin coating. The color may take up to a minute to reach full intensity.

The chemical reaction system has two subsections: the chemical transfer system and the chemical self-imaging system.

Received for publication 8 Feb. 1973; accepted for publication 12 March 1973.
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*Chemical Transfer System*

The chemical transfer system requires a minimum of two mating sheets. The coating containing the encapsulated liquid is on the back of the top or donor sheet. The coating of clay or resin is on the face of the second sheet or receptor sheet. The paper is used so that the two coatings are pressed together. The pressure of the writing instrument breaks the capsules allowing the color producing reaction to take place. If additional copies are needed, special sheets coated with the receptive coating on front and the donor coating on back are inserted between the original sheets. Up to eight copies are made in this manner.

Experiments were undertaken with Trans/Rite, which is produced by Mead Corporation. This product is representative of a chemical transfer system of carbonless paper.

No special effects were noticed under ultraviolet light once the chemicals were allowed to react. When the donor sheet, containing the encapsulated liquid was used over normal bond paper, the chemicals alone did not produce an image. However, when the normal bond paper was placed under ultraviolet, the invisible writing fluoresced. When the chemicals were allowed to dry they did not fluoresce under ultraviolet. Remoistening the paper with tap water failed to generate a reaction.

New samples were prepared in the same manner and again dried so that no reaction could be produced. The paper was placed under strong short wave ultraviolet for 1 h. The ultraviolet light developed the chemicals, making the writing visible when removed from the ultraviolet light source and viewed under normal light conditions.

A copy produced by this system was viewed through an infrared image converter. The copy did not remain visible under the viewer.

*Chemical Self-Imaging System*

In the second subsection of the chemical reaction systems of carbonless papers, the need for a mating sheet has been eliminated. The coating, containing both the encapsulated liquid and the reacting powder, is placed on the face of every sheet used with the exception of the first sheet which is normal bond.

This system works on the same principle as the previous one. The pressure of the writing instrument breaks the capsules and allows the reaction to take place. No special sheets are needed to make additional copies.

Experiments were performed on 3M Type 100 carbonless paper. This product is representative of the chemical self-imaging carbonless papers now on the market.

No reaction could be observed under ultraviolet light on either the copy or the reverse of the top sheet of normal bond paper. Apparently once the chemicals react, they do not respond to ultraviolet light.

When a copy produced by this system was subjected to infrared viewing, it was noticed that the reaction was identical to the copy produced by the chemical transfer system. The image did not remain visible under infrared viewing.

To distinguish between copies made by the two chemical systems a simple test can be made. Using a fingernail or other object which does not produce a visible mark, make a small line on the face of the copy to be examined. If the copy was produced by the chemical transfer system, no visible reaction will appear. However, if the copy was produced with the chemical self-imaging system, the pressure will break the capsules and a visible mark will appear.

**Physical System of Carbonless Paper**

The physical system is based on the same principles as ordinary carbon paper, which uses the physical transfer of a wax ink coating to the copy. In the physical system of

carbonless papers, the coating of solvent-carried dyes is attached to the papers being used. This process eliminates the need of additional sheets being involved. The coating is of a wax nature and does not appear to rub off under normal use.

The first carbonless paper based on the physical system was released by Frye Manufacturing Company under the brand name of "Impact" in 1964 [2]. This product was basically a physical transfer process which is the first of two subsections in this area to be discussed.

*Physical Transfer System*

The physical transfer system of carbonless paper relies on two mating sheets. The donor coating is a solvent carried dye. The coating is applied to the back of all sheets to be used except the last sheet.

The receptor coating is a waxy coating that is applied to the front of all sheets used except the first sheet.

The pressure of the writing instrument displaces a portion of the coating which is accepted by the receptor coating. The image produced is extremely clear and readable.

In testing this system of carbonless paper, "Mimix" produced by St. Regis Paper Co. was used. This product is representative of a physical transfer system used in carbonless paper as manufactured today.

No reaction was visible under ultraviolet light. However, under infrared viewing the image produced in the copy remained visible.

If the donor sheet is used with normal bond paper without the receptor coating, the images produced are visible but broken and highly unsatisfactory.

*Physical Self-Imaging System*

The physical self-imaging system of carbonless paper is the newest in the field of carbonless papers. In the physical self-imaging system of carbonless paper, the complete coating is placed on the back of all sheets used with the exception of the last sheet. The need for the receptor coating has been deleted.

The first product utilizing this process was "Hi-Mark" produced by Frye Manufacturing Co. (Des Moines, Iowa). Samples were sent out for evaluation in the Spring of 1969. The product was first released to the public on March 22, 1971.

No reaction under ultraviolet light was observed. A copy made was viewed under infrared and the images remained visible.

A microscope is useful in distinguishing copies made with the physical transfer carbonless system from those made with the physical self-imaging carbonless system. The front surface, or receptor surface, of the copy made with the physical transfer system is coated with a wax-like substance. If scraped slightly, fibers will break loose and leave impressions in the coating.

When the front surface of the copy made with the self-imaging system is scraped the fibers will break away as in the normal bond paper.

**Discussion**

Determining the difference between copies made by carbonless paper and those made by regular carbon paper is somewhat simple. Whereas copies made by a chemical system do not remain visible under infrared, copies made with a physical system, which include regular carbon paper, do remain visible. Images made with carbon paper, even if the carbon paper is new, feather out onto the paper fibers that cross the area of the image.

This is due to the carbon paper being forced down into the image. This is quite evident under magnification.

Copies made with a physical self-imaging carbonless system are quite clear and even edged. This is produced because only the solvent-carried dye coating is pressed into the image. While copies made with the physical transfer carbonless system follow the same rule they also have the additional aspect of being on a coated receptive sheet.

## Summary

A survey of the carbonless paper systems and their identifying characteristics has been presented in an effort to meet some of the problems that have been encountered by document examiners. Their use cannot help but grow as multiple form production converts more and more to carbonless paper.

## References

[1] "Mead Carbonless," Mead Corporation, 2nd ed., 1971.
[2] Richard Stewart, personal correspondence, Frye Manufacturing Co., Des Moines, Iowa.

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