

TECHNICAL NOTE

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Use of the Scanning Electron Microscope to Examine Fiber Impressions on Typewriter Correction Tape

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ABSTRACT: When a correction ribbon is used to correct a typewritten document, fiber impressions from the paper are impressed upon the ribbon. Previous research used a comparison microscope to match fibers and fiber impressions between a correction ribbon and a document. However, because of inherent features of the correction ribbon system, several difficulties were encountered. Consequently, a scanning electron microscope (SEM) was used to alleviate some of the problems discovered by past research. The SEM, with its greater magnification power, detected both fibers and fiber impressions, creating a basis for association between a questioned document and a correction ribbon. Use of SEM also ameliorated the problems of past research and greatly enhanced points of comparison.

KEYWORDS: questioned documents, typewriter, correction ribbon, scanning electron microscope

Historically, techniques of associating a known typewriter with a questioned document relied upon comparing the unique characteristics of a particular typewriter, typewriter manufacturer, or typewriter ribbon to questioned typewritten text. The unique characteristics most commonly used included font, size, spacing, type style and unique defects such as broken, bent or deformed printing elements.

Since the 1970s, manufacturers have developed and marketed low-cost, durable electronic typewriters with a variety of features to

business and home users. Typewriters were given interchangeable fonts, thermal transfer ribbons, lift-off correction systems and a variety of computer memory features, lessening the chance that the "personality" of a particular machine could be detected. As a result, electronic typewriters became more difficult to associate with a questioned document. These factors now leave the ribbon system as the primary means whereby a typewriter can be associated with questioned, typewritten text.

In 1972, Hahn [1] described a method for associating a questioned document with a known carbon tape ribbon. His technique involved matching the paper fibers of the questioned document with the paper fiber impressions left on the carbon tape ribbon. The basis for this technique is that during the manufacturing process, cellulose fibers are arranged in a random, unique pattern throughout the paper. When typing, the carbon tape ribbon comes between the typing element and the paper. This exerts pressure on the ribbon, transferring a character to paper. The process also impresses fiber patterns from the paper onto the ribbon. With this technique, Hahn was able to make a positive identification using only one character from the questioned document. His method has been used to associate numerous questioned documents with known carbon tape ribbons. However, this method becomes useless when the carbon tape ribbon is removed from the machine. This leaves the correction ribbon as the final link between a document and a typewriter.

Limited research has been conducted regarding correction ribbons and questioned documents. Casey and Purtell [2] discussed the use of correction ribbons to alter typewritten documents. Gerhart [3] found that where the sequence of characters on the correction ribbon and document corresponded, a closer examination of lifted-off characters revealed paper fiber impressions on the ribbon's adhesive surface. These impressions were matched to paper fibers defined by the indented areas on the paper.

Grantham [4] also found that an identification could be made by comparing the paper fibers in areas where letters were erased with characters preserved on the correction ribbon. This research was conducted using a comparison microscope. He also notes an important difference between the comparison of carbon tape ribbons and correction tape ribbons: the images on carbon ribbons and typed characters on paper are positive images. That is, the outline of the character on the ribbon can be superimposed over the character on the paper. With the correction ribbon, however, the process is not quite so easy. He notes:

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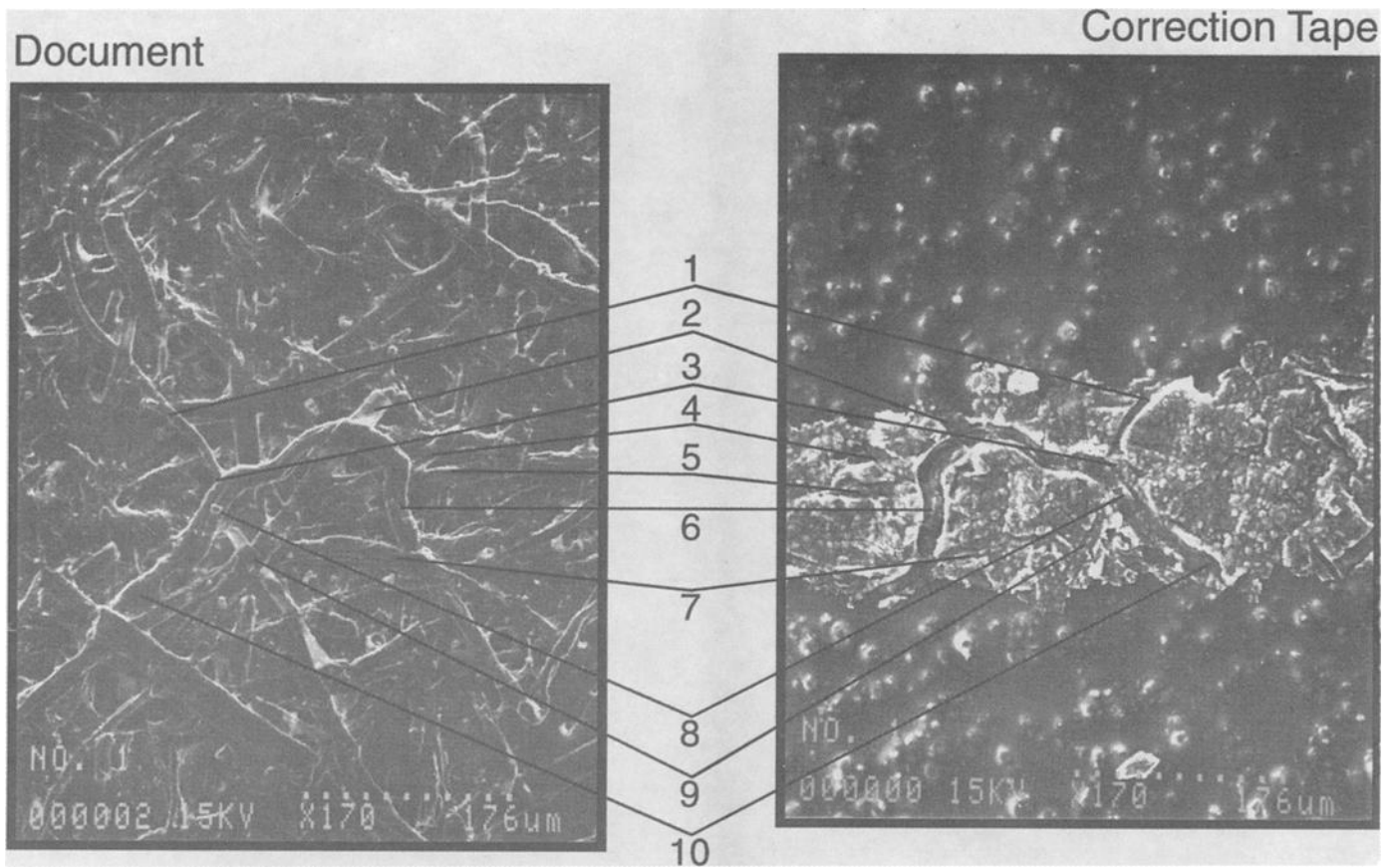


FIG. 1—SEM photomicrographs of document and correction tape used for comparison in Sample 1.

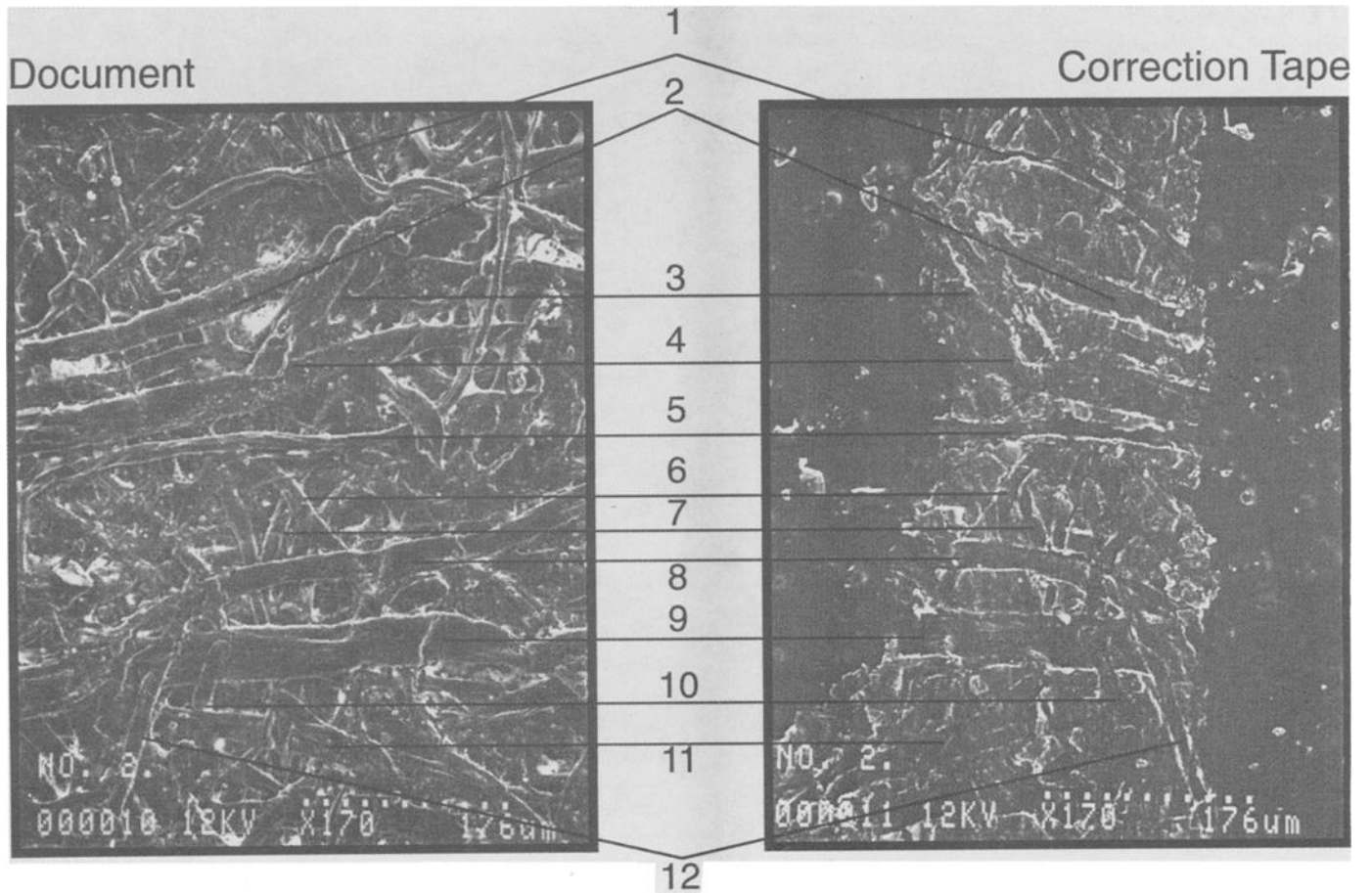


FIG. 2—SEM photomicrographs of document and correction tape used for comparison in Sample 2.

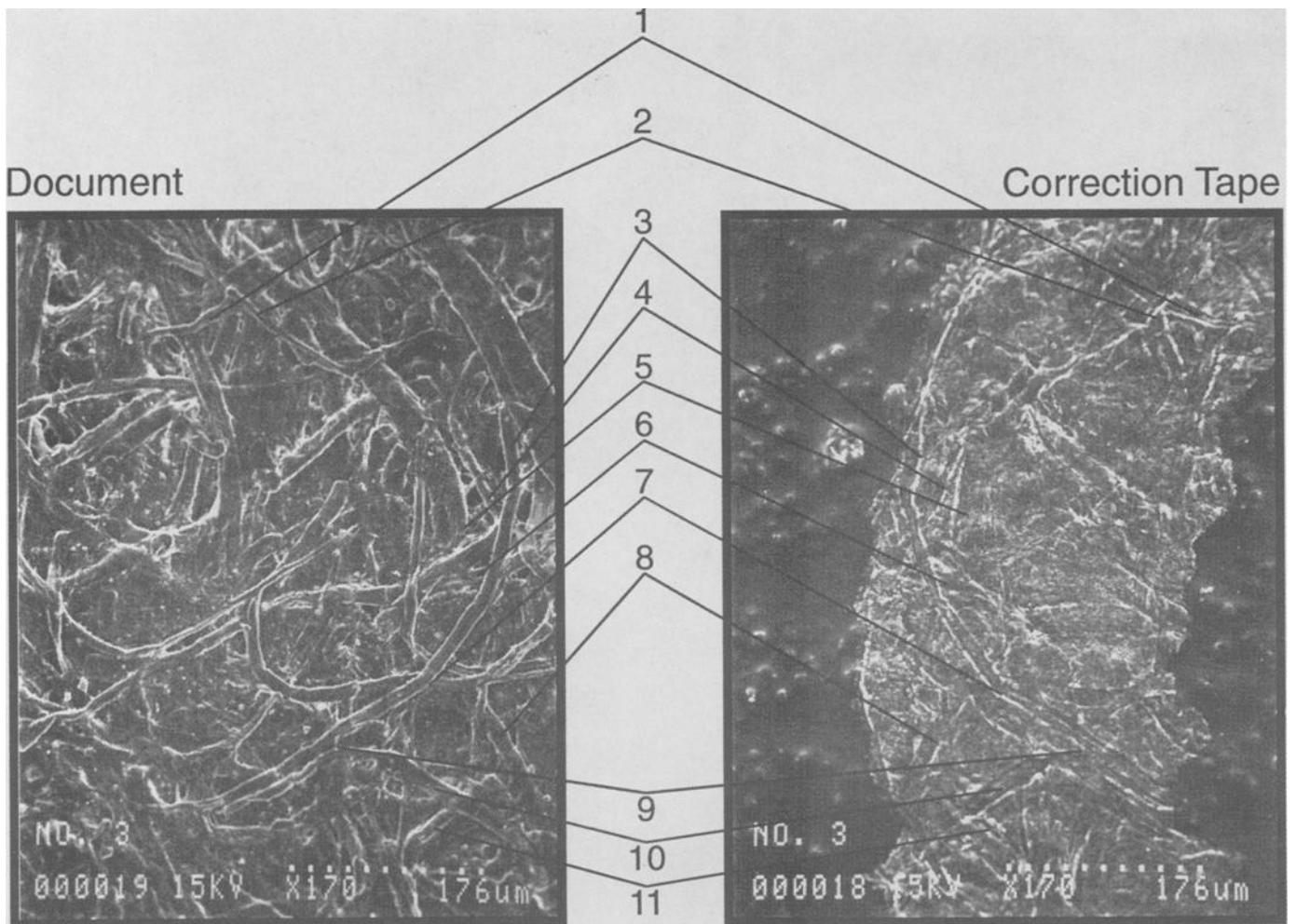


FIG. 3—SEM photomicrographs of document and correction tape used for comparison in Sample 3.

With the correction ribbon, the mind must engage in a few twists and flips. The function of the correction ribbon is to remove . . . the character from the paper. Due to the filtering effect of the adhesive and the ribbon, the character . . . is mounted on the adhesive and cannot be examined from the front view as a positive image. . . . [T]he foregoing circumstances make it very difficult in a microscopic environment to locate precisely the critical area of the fibers, and, once fixed, to remain visually and mentally focused.

In using a comparison microscope, Grantham also noted the following:

Unfortunately, not all fibers on the paper create an impression on the ribbon. Paper may seem smooth to the unaided eye, but under 30 \times magnification an uneven topography becomes apparent. Recognizable fibers sometimes dwell in the valleys rather than on the ridges and do not make sufficient contact with the ribbon to leave an impression. Less recognizable fibers can interfere with more interesting fibers. And in some cases, a prominent fiber observed on the surface of the paper leaves only a partial impression on the ribbon, or none at all.

Grantham additionally found that the control of lighting, in terms of intensity, direction and station can be tedious.

In hoping to better control conditions and eliminate some of

the problems Grantham encountered with the comparison microscope, we turned to the scanning electron microscope (SEM). Because the SEM has greater magnification and clarity than a comparison microscope, we expected it to increase depth of field, enhance contrast, and show numerous, highly detailed points of comparison. To our knowledge, this method of analysis has never been tested.

Equipment and Method of Analysis

Our approach to this research attempted to recreate the office conditions in a typical military working environment. Two typewriters, common in the Air Force, were selected: a Panasonic typewriter, Model KX-E3000, in use since 1990, equipped with a Panasonic Electric Typewriter Ribbon, Correctable Ribbon Model SKX-E20; and an IBM Wheelwriter 10, Series III, in use since 1982, equipped with an IBM Selectric System/2000 "Wheelwriter" 3 & 5 Lift-off tape.

We created our own questioned documents on government letterhead and bond paper. Two corrections for examination were made on each type of paper. Specific areas to be examined were cut from the test paper and ribbon. These portions of paper and segments of ribbon were then mounted on a glass slide with metal conductive tape. Each sample was lightly sputter coated with gold using the EmScope SC500 Sputter Coater. Samples were examined with the Hitachi S-570 Scanning Electron Microscope, using 12 kilovolts accelerating potential at a magnification of 170 \times .

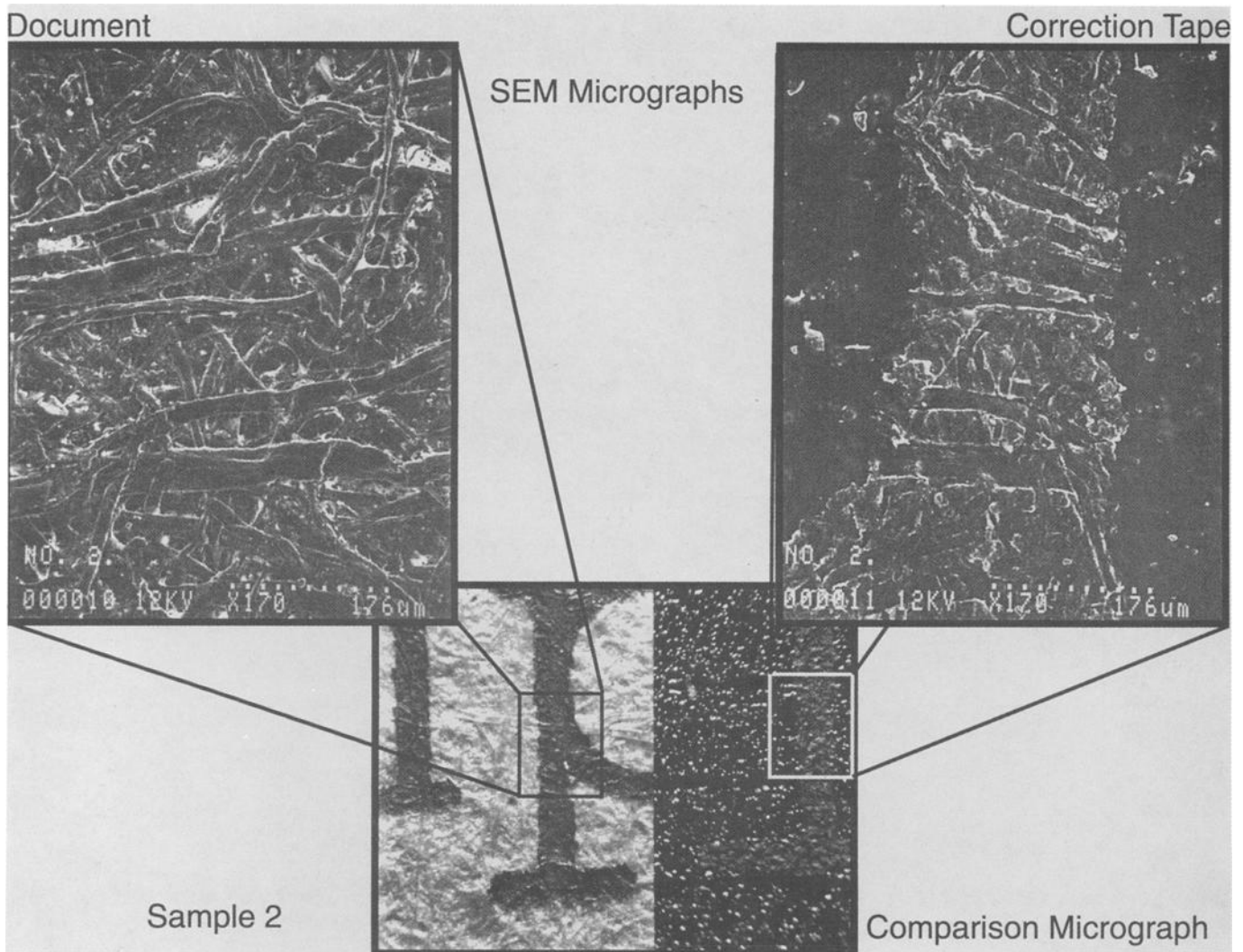


FIG. 4—SEM photomicrographs and comparison photomicrographs of areas of comparison in Sample 2.

Each of our four samples was examined in the following manner.

Using the SEM, fiber impressions were located on the portion of the ribbon that corresponded to the questioned area of correction on the document. These impressions were then photographed using the Polaroid camera affixed to the SEM. Next, the questioned area of correction on the document was located and photographed. These photographs were then used for comparison. As stated earlier, the photo of the ribbon surface is a *negative* image of the photo of the paper surface. However, use of the SEM photographs, without the additional distractions and difficulties presented by the comparison microscope, greatly simplifies the examination process. Attached are three SEM samples, with points of comparison labeled as such.

The samples were then examined using the American Optical Corporation UFM-2 Forensic Comparison Microscope (Model K2031A) equipped with 1.2 \times , 2 \times and 4 \times objectives and a fiber optic illuminator. Using the 4 \times objective, the samples were examined for the same points of comparison found under the SEM. The resulting examination yielded questionable results. A few fiber impressions could be located but we could not state, with any degree of certainty, that the comparison was a match. These impressions were then photographed with a Polaroid camera affixed to the comparison microscope using Polaroid PN-55 Film. Despite camera and lighting adjustments, the resulting photographs

were darker rendering adequate comparison of the fiber impressions off the photographs impossible. Sample 2 photographed best under the comparison microscope. The Sample 2 photographs taken with the SEM and the comparison microscope are attached, showing the corresponding areas of examination.

Discussion

While the use of a SEM may seem costly, we found that the cost per sample was approximately \$100.00. It took approximately three hours to prepare, locate, and photograph each set of fibers and fiber impressions. The skills of a competent SEM technician were essential to our quick and successful results.

This method may best be used in situations where fiber impressions are not easily identifiable with the comparison microscope. Also, when few fiber impressions can be accurately discerned in lower resolution, this method will enhance what fibers there are, increasing the chances that a match can be made.

We noted few problems with this form of analysis. While this method is somewhat destructive in that the ribbon and paper will never be able to be restored to their original condition, the sputter coated ribbon and paper stay intact for repeated examination, if necessary.

At first we feared that the ribbon may be susceptible to destruc-

tion due to conditions encountered within the SEM. However, no such problem occurred. Additionally, the adhesive on the correction ribbon did not melt or stick to the equipment.

We found that the comparison process became easier when the ribbon was examined for fiber impressions, first. This allowed identification and photography of a particular fiber feature. This fiber formation then acted as a land mark when searching the corrected area on the questioned document. It was also helpful to refer to the micrograph of the fiber impression while searching for the fiber on the document.

Photography of our samples was a simple process, due to the preconfigured Polaroid camera attached to the SEM; no additional lighting or filters were necessary. Our camera provided a negative, in addition to the photograph. We found that the negative of the fiber impression photo (which is a *positive* image) could be overlaid on the photograph of the fiber from the questioned document. This greatly eased identification of points of comparison. We were able to identify between 9 and 12 points of comparison for each sample.

To portray this data in a format meeting courtroom presentation standards, we scanned the micrographs of the tapes and documents into a Macintosh IICI with a Hewlett-Packard ScanJet Plus (256 levels of gray, 300 dots per inch [dpi] resolution). We then enhanced and sharpened the scans with Aldus Digital Darkroom. The scans were placed into an Aldus Pagemaker document, where we compared and labeled them. The comparisons were then printed on a Linotronic Printer 60 at 600 dpi resolution. However, acceptable results can be obtained by using a laserprinter that has a resolution of 300 dpi.

Summary

Previous research with comparison microscopes laid a foundation for the association of a typewriter correction ribbon to a

questioned document. However, the research encountered difficulties, due to inherent properties of the typewriter correction ribbon system. The use of a SEM to detect fibers on documents and fiber impressions on correction ribbons provides a basis for a positive identification, with less difficulty and greatly enhanced points of comparison.

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