TECHNICAL NOTE

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Paper Match Comparisons by Submersion

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ABSTRACT: Comparisons of torn paper matches are difficult, time-consuming microscopic examinations. A technique is described where adjacent match bodies are submerged in an ethanol/water solution resulting in a significant increase in the number of observable points of identification.

KEYWORDS: questioned documents, papers, matches, inclusions, submersion

The various aspects of comparing a torn match with a matchbook have been described in detail in the literature [*1,2*]. These are difficult comparisons requiring a time-consuming microscopic examination. The comparison of inclusions (foreign matter such as dirt, debris, and other contaminants included in the matchboard at the time of manufacture) along the cut edge of two adjacent match bodies is the easiest and most significant feature to look for in the comparison of paper matches. Inclusions are fairly common and, when present in sufficient size and contrast to be adequately photographed, provide an impressive demonstration of common origin.

As a result of submerging two adjacent match bodies in a liquid that has a refractive index similar to that of cellulose, the cellulose fibers along the cut edges of the matches become transparent. This increases clarity and unmasks small cut inclusions and other details previously obscured by surface fibers. Consequently, there is a significant increase in the number of points of identification.

Materials and Methods

The apparatus used for submerging the matches is of adequate size to accommodate a match booklet. This permits comparison of a loose burned match with the adjacent match remaining in the booklet. The apparatus appearing in Fig. 1 measures 2 by 2 by 2½ in. (51 by 51 by 63.5 mm) in height. Either glass or Plexiglas® is suitable as a construction material, joined with epoxy glue. The sides of the match holder are made with two pieces of 1/16-in. (1.6-mm) thick Plexiglas, 1 in. (25.4 mm) wide by 1¾ in. (44 mm) tall. Attached to each of

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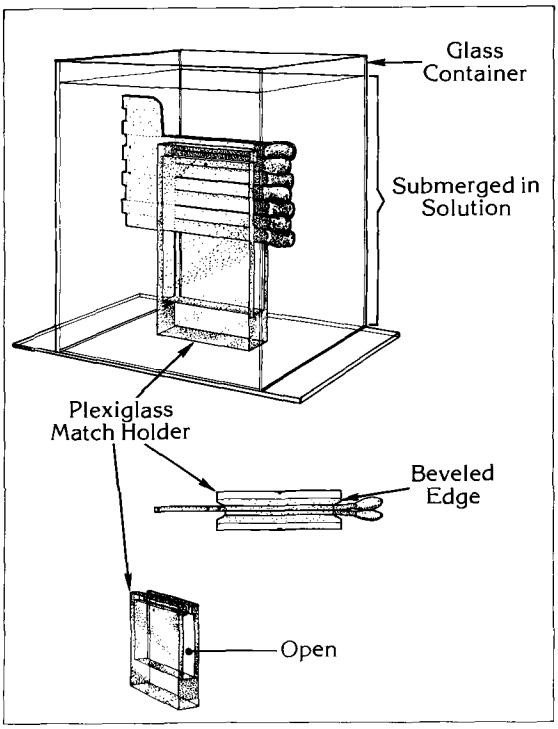

FIG. 1—*Glass container and Plexiglas match holder for submersion of match booklet.*

the inside walls at the top are two narrow strips of 1/16-in. (1.6-mm) Plexiglas with beveled edges. A 3/8-in. (9.5-mm) spacer attached to the bottom of the side walls leaves a 1/16-in. (1.6-mm) gap between the beveled strips. The match holder has two small indentations on the outside walls for ease of removal from solution with forceps.

Before the examination of inclusions by submersion, the matches are compared regarding size, coloration, wax dip line, and cut and torn edges. The match bodies suspected of originally occupying adjacent positions in the matchbook are positioned in the match holder. The beveled inside upper edge allows for easy insertion and spring tension holds the matches in place. The matches are submerged in a suitable liquid and viewed through a stereoscopic microscope equipped with a camera.

Numerous liquids with a refractive index near that of cellulose (about 1.53) are effective including xylene (1.49), ethanol (1.36), water (1.38), as well as various halocarbons, ethylene glycols, and hydrocarbons. After consideration of various factors such as toxicity, volatility, and the destructive effect on matches, the preferred liquid was found to be an 80% ethanol/water solution. This solution does not dissolve the match head and leaves most of the wax dip line intact, providing contact time in the liquid is not excessive. Some purple dye coatings are slightly soluble in this solution. Prolonged submersion should be avoided since ultraviolet (UV) fluorescence properties of some matches may be altered.

Observable detail is greatly enhanced as a result of submersion. Only one corresponding inclusion can be observed in the match bodies appearing in Fig. 2. While submerged in ethanol/water, however, the entire edge of the inclusion can be seen as well as numerous additional smaller inclusions shown in Fig. 3. Inclusion details can be additionally enhanced by increased magnification as shown in Fig. 4.

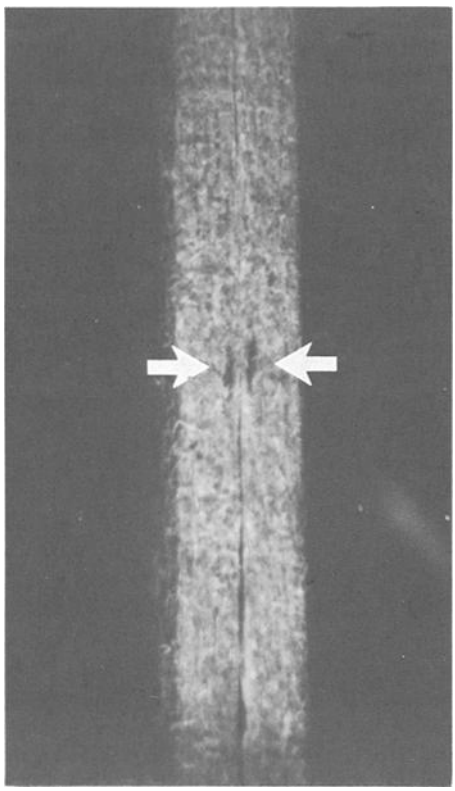

FIG. 2—*Adjacent match bodies before submersion. Arrows indicate one matching characteristic (×15).*

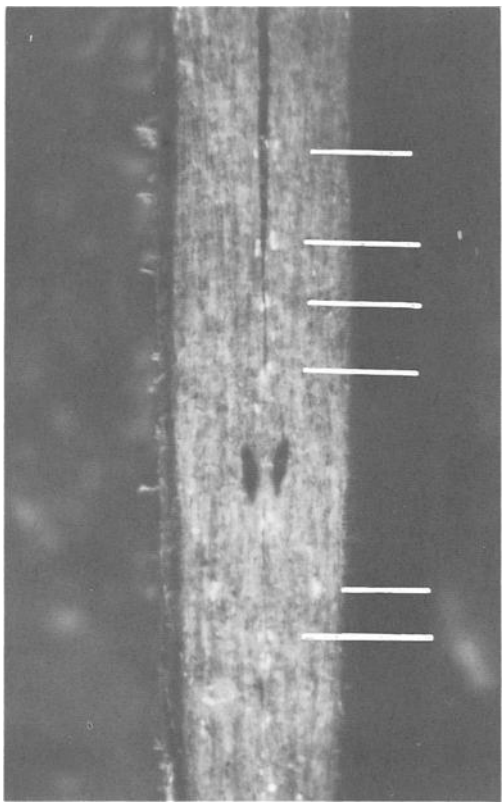

FIG. 3—*Adjacent match bodies from Fig. 2 photographed while submerged in an ethanol/water solution. Note additional matching characteristics indicated by arrows and the clear view of the shape of the large inclusions (× 15).*

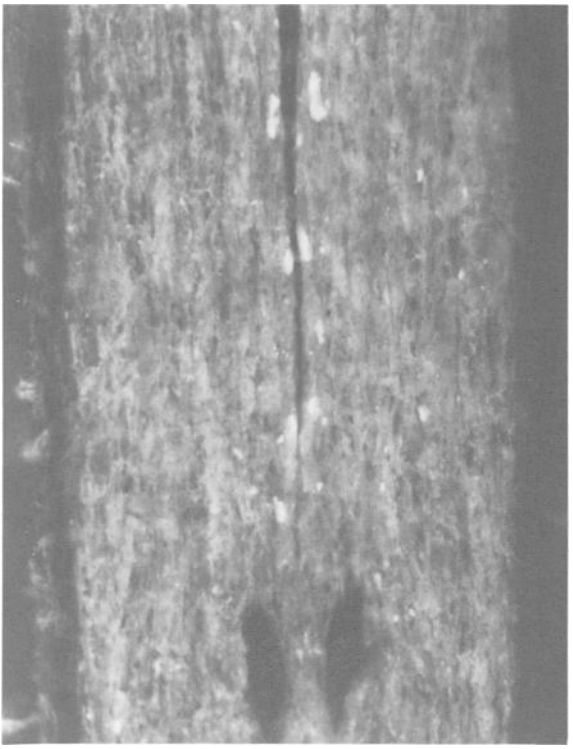

FIG. 4—*Enlargement of a portion of the submerged matches from Fig. 3 showing additional enhancement of small inclusions (×37).*

Results

The cut edges of two adjacent matches in some 40 match booklets have been examined to date using the submersion technique, and in virtually every case a sufficient number of individual characteristics were present to permit identification. The technique of submerging two adjacent match bodies in a liquid such as 80% ethanol/water solution causes the cellulose fibers along the cut edges to become transparent. The inclusions, which are not transparent, become more readily observable. Additionally, a more detailed comparison can be made of the thickness and irregularities along the cut edge of the surface coatings of the matchboard. This increase in the number of observable points of comparison significantly aids in the positive identification of torn burned matches.

References

[*1*] Funk, H. J., "Comparison of Paper Matches," *Journal of Forensic Sciences*, Vol. 13, No. 1, Jan. 1968, pp. 137-143.

[*2*] Dixon, K. C., "Positive Identification of Torn Burned Matches With Emphasis on Crosscut and Torn Fiber Comparisons," *Journal of Forensic Sciences*, Vol. 28, No. 2, April 1983, pp. 351-359.

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