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A New Approach to Unraveling Tangled Adhesive Tape for Potential Detection of Latent Prints and Recovery of Trace Evidence

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ABSTRACT: Occasionally, crumpled adhesive tape strips are encountered in criminal cases involving rape, murder, kidnapping and explosives (bombing). Such tape is usually submitted to a crime laboratory for the detection of latent prints, to establish a physical match with other strips or roles of tape, or to be examined for associative evidence, such as hair, fibers, or paint, which may be adhering to the tape surfaces. To achieve these objectives, it is often necessary to unravel the tape without affecting the potential latent prints which may be present on the adhesive or nonadhesive surfaces. This paper describes a new technique, using a solvent consisting of a blend of aliphatic and halogenated hydrocarbons, to unravel tangled tape which, unlike existing freezing or heating methods, minimizes disturbance of latent prints. This procedure was used on various types of commercially available adhesive tapes bearing latent prints, which were subsequently detected by crystal violet, cyanoacrylate fuming, and fluorescent dye stain development procedures. This simple technique proved to be very convenient and successful in unraveling various types of adhesive tapes for the detection of latent prints and possible recovery of trace evidence.

KEYWORDS: forensic science, criminalistics, adhesive tapes, fingerprints, untangling of adhesive tape, latent print detection, crystal violet, cyanoacrylate fuming, trace evidence materials

Commercially produced adhesive tapes are used in various criminal activities, including binding victims' hands and feet, taping victims' mouths, constructing explosive devices, and preparing collage or cut-out threat notes. Often, a suspect unintentionally deposits latent prints on the adhesive or nonadhesive surfaces of tape material. Pieces of adhesive tapes are usually recovered in crumpled condition and submitted to forensic science laboratory examinations for the following purposes:

1. To develop latent prints that may be present on both the adhesive and nonadhesive tape surfaces and to compare any developed latent prints with the inked/record prints of the suspect or suspects.

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2. To establish a physical match between the ends of questioned strips of tape and the ends of known rolls of tape (recovered from a suspect).
3. To determine if the tape ends were cut with a sharp, serrated, or blunt instrument and if they are consistent with having been cut with an instrument found at a crime scene or recovered from a suspect.
4. To determine if questioned and known tapes have consistencies or dissimilarities in their construction and structural or physical characteristics.
5. To determine (especially in the case of black electrical tape) if a physical match exists between questioned and known tape by a matching of marks or impressions introduced during the manufacturing process, as shown in the electron micrographs of two different electrical tapes (Figs. 1*a* and 1*b*).
6. To recover trace evidence materials (hair, fibers, paint, and so forth) from both the adhesive and nonadhesive tape surfaces.

The success of any or all of the above-mentioned examinations, which could establish a link between the suspect or suspects and the tape or crime scene, or both, is often dependent upon unraveling the tangled/adhered adhesive tape without affecting its physical condition or any latent prints that may be present.

Adhesive materials normally used in tape construction form a strong bond with other surfaces, especially adhesive ones. Mechanical separation of pieces of tape that are stuck together by their adhesive surfaces often cannot be achieved without damage to the tape. The previously reported freezing [*1*] and heating [*2*] techniques are sometimes found to be ineffective and inadequate.

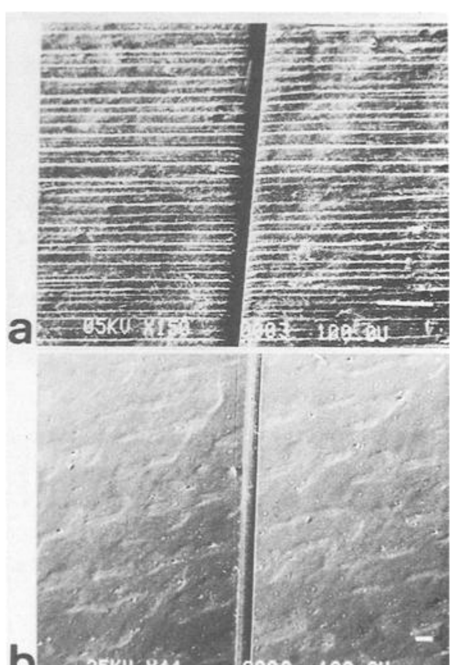

FIG. 1—*Electron micrographs exhibiting comparisons of extrusion marks present on two different black electrical tapes.*

The freezing technique involves either freezing the tape in a conventional freezer or spraying it with a freezing agent in an attempt to harden the adhesive and, thereby, facilitate unraveling. This method has the inherent disadvantages of frosting, thawing, condensation, and limitations of time (the tape must be manipulated prior to thawing). The heating process employs heat generated by a microwave oven or by an electric heat gun which softens the adhesive material, thereby facilitating a mechanical separation. Often, wiping, stretching, and deformation of the tape occur when the freezing or heating technique is used, because of the considerable force that must be applied to separate the pieces (especially as the tape begins to return to room temperature). Neither method has proven satisfactory in many cases processed at the U.S. Army Criminal Investigation Laboratory for the Continental United States (CONUS). In a rape and murder investigation, crumpled strips of green-colored adhesive duct tape (commonly referred to as "Army tape" or "100 mile per hour" tape) were received. The tape had been used to seal the victim's mouth. This case highlighted the need for an effective and reliable method for separating and unfolding the tape. Hence, a simple, rapid, and nondestructive method for unraveling crumpled adhesive tapes was developed and is described herein.

Materials and Methods

Nine different types of commercially available adhesive tapes were procured: black electrical tape, gray Kendall tape, gray Nashua tape, fiber tape, an NCHR brown tape, masking tape, and colored paper tape.

Preparation of Samples

Strips approximately 80 mm long were removed from a roll of each tape and mounted on glass plates (100 by 200 mm) with the adhesive side facing up. Latent fingerprints of normal (uncontaminated) eccrine gland secretions were placed on the adhesive surface of each strip of tape. The strips were then cut lengthwise into two halves using a sharp razor blade, as shown in Fig. 2. One half of the cut tape was used as a control strip and the other half was folded together (adhesive surface to adhesive surface).

Preliminary studies were conducted on cut sections of green duct tape to determine what chemical solvent would best unravel or separate crumpled or adhered tape. Further, the effect of the solvent was observed with a stereomicroscope as it was applied to the adhesive surface of the tape. A range of mild to strongly affecting reagents was tried, including methanol, chloroform, acetone, hexane, xylene, ethyl acetate, chlorobenzene, and Shandon solvent.

Chemical Treatment

Both ends of each strip of folded tape were held slightly apart using two pairs of tweezers. A drop of solvent (95% Shandon xylene substitute[2] and 5% chloroform) was applied to the adhesive surfaces, as shown in Fig. 3. Upon contact with the solvent, the joined adhesive surfaces began to separate from each other quite easily. A second drop of solvent was added to the adhesive surfaces as the effect of the first drop of solvent began to diminish. The process was repeated until the entire strip of tape was unfolded.

[2]Shandon xylene substitute is manufactured and distributed by Shandon, Inc., 171 Industry Drive, Pittsburgh, PA 15275.

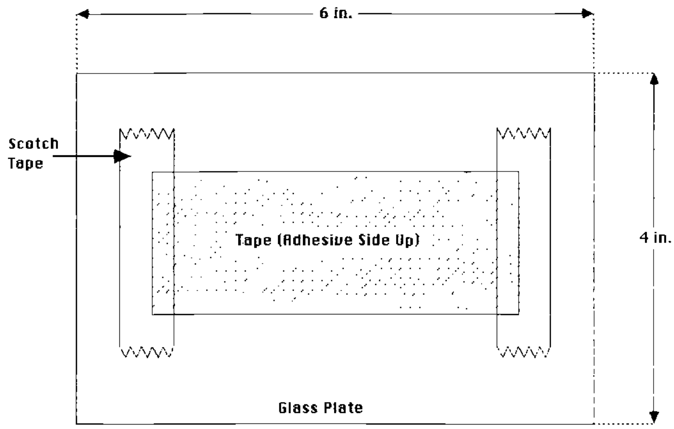

FIG. 2*a*—*Graphical illustration of a strip of adhesive tape mounted on a glass plate.*

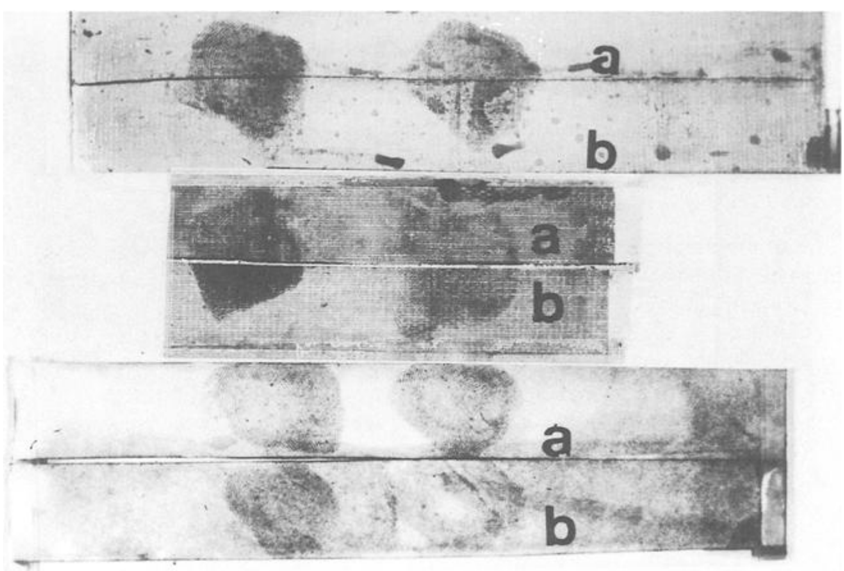

FIG. 2*b*—*Latent prints developed on the adhesive surface of three different types of tape:* (a) *control and* (b) *solvent-treated and unraveled tape strips.*

Development of Latent Prints

Both the control strip and the unraveled (chemically treated) strip of tape were subjected to cyanoacrylate ester (super glue) fumes [*3*] in an effort to develop latent prints on the nonadhesive surfaces of the tape. The strips were then subjected to staining with gentian violet (also referred to as crystal violet) [*4,5*] in an effort to develop latent prints on the adhesive surfaces. Both strips of tape were air dried for one hour. The cyanoacrylate fuming prior to gentian violet staining does not obscure latent prints on the adhesive surface of the tape.

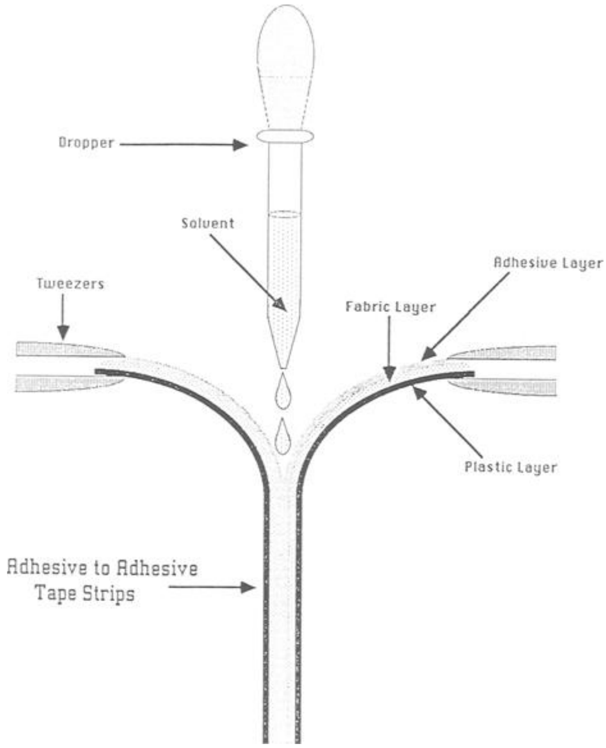

FIG. 3—*Graphical illustration of the solvent application for separating two adhered tape strips.*

Results and Discussion

It was found that 95% Shandon (a blend of aliphatic and halogenated hydrocarbons) mixed with 5% chloroform worked best with most types of commercially produced adhesive tapes. Other reagents used were found to be ineffective or destructive (that is, completely dissolving the adhesive material, as in the case of xylene). Figures 4 through 7 depict developed latent prints on the adhesive side of the control, the solvent-treated tape, and unraveled strips of tape. Comparisons of these developed latent prints demonstrate that the solvent (a mixture of Shandon and chloroform) has minimal effect on the clarity of latent prints. However, the unraveling process should be carried out using a stereomicroscope and minimal amounts of the solvent.

The solvent treatment utilized in this new technique does not require the use of considerable force to pull the two adhesive surfaces apart, as was necessary in previously described techniques [*1*,*2*]. Although the proposed technique enabled the separation of every type of tape, poor results (Fig. 8) or no latent prints were detected on the adhesive sides of inexpensive or low-quality tapes. This was due to a grainy or nonhomogenous adhesive material layer on the thinly woven fabric portion of the tapes. However, the technique has exhibited its usefulness for potential detection of latent prints on the nonadhesive side of even low-quality tapes, and for recovery of trace evidence material. This also facilitates additional examinations to establish the following: (1) a physical match between the ends of questioned and control strips of tape, (2) a comparison in

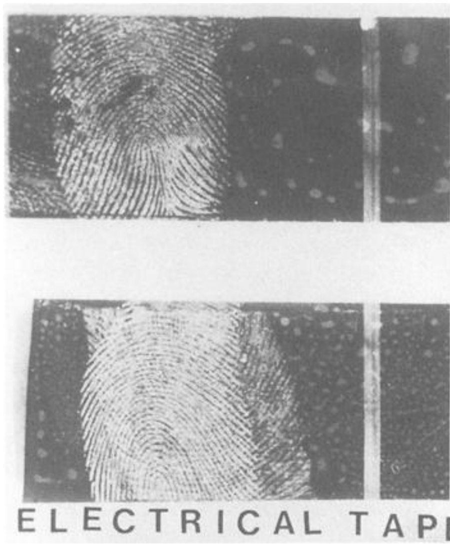

FIG. 4—*Latent prints developed on the adhesive surface of black electrical tape with super glue:* (top) *control and* (bottom) *solvent-treated.*

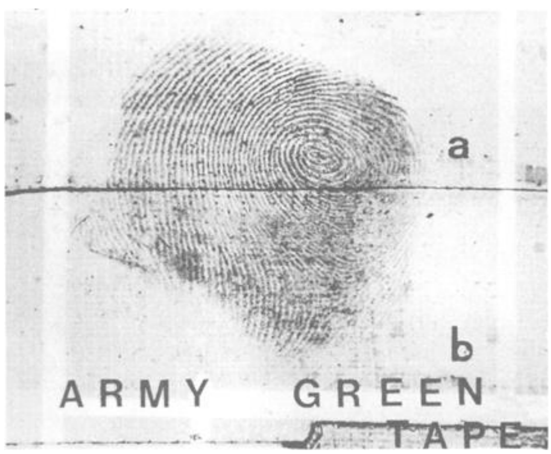

FIG. 5—*Latent prints developed on the adhesive surface of a typical green duct tape:* (a) *control and* (b) *solvent-treated.*

their physical characteristics, and (3) a physical match between the extrusion marks present on the adhesive layer of tape.

With regard to the aforementioned rape and murder investigation, evidence submitted to the laboratory consisted of two rolls of green Army tape seized from two suspects, a crumpled strip of green Army tape recovered from the victim's mouth, and another strip of crumpled green Army tape recovered from the floor near the victim's body. The new technique was successfully applied to unravel these tapes after existing techniques failed

FIG. 6—*Latent prints developed on the adhesive surface of gray duct tape:* (a) *control and* (b) *solvent-treated.*

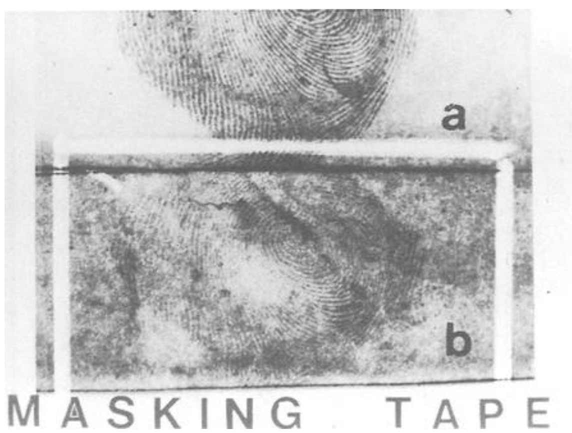

FIG. 7—*Latent prints developed on the adhesive surface of masking tape:* (a) *control and* (b) *solvent-treated.*

to produce satisfactory results. Although latent print ridge detail was detected on the adhesive surface of the tape, it was found to be unsuitable for identification. This, however, was not a result of using the solvent to separate the tape. A physical match (Fig. 9) was established between the tape removed from the victim's mouth and the tape recovered from the floor (crime scene). In addition, comparative examinations of the tape removed from the victim's mouth and the rolls of tape recovered from the suspects disclosed that the roll recovered from the first suspect was dissimilar and that the roll recovered from the second suspect was consistent in its physical characteristics with the tape recovered from the victim. The difference in the physical characteristics or constructional variations (single-strand versus double-strand woven fabric portions of the tapes) between these two types of tape recovered from the two suspects are shown in Fig. 10. Subsequently, the second suspect confessed to having committed the crime.

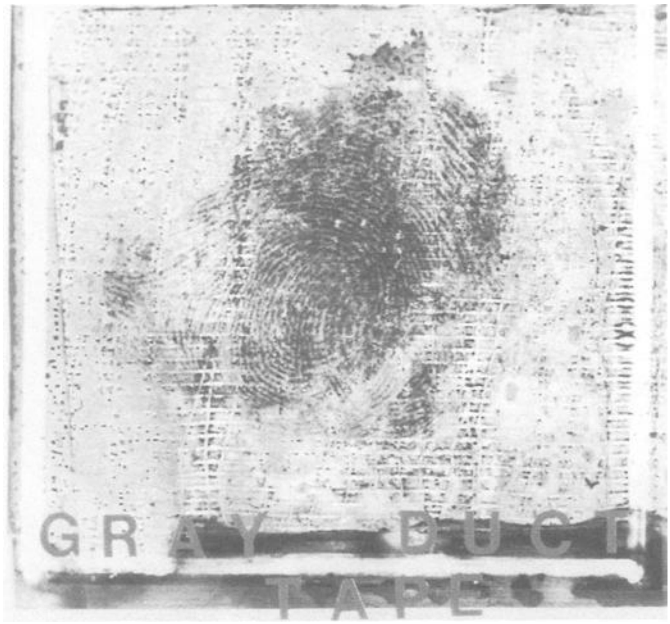

FIG. 8—*Latent prints developed on the solvent-treated adhesive surface of a poor-quality, inexpensive gray duct tape.*

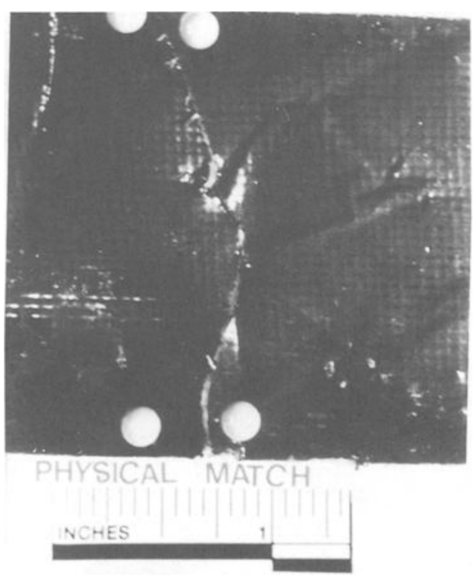

FIG. 9—*Physical match of cut ends of the strips of tape removed from the victim's mouth and the crime scene of a rape and murder case.*

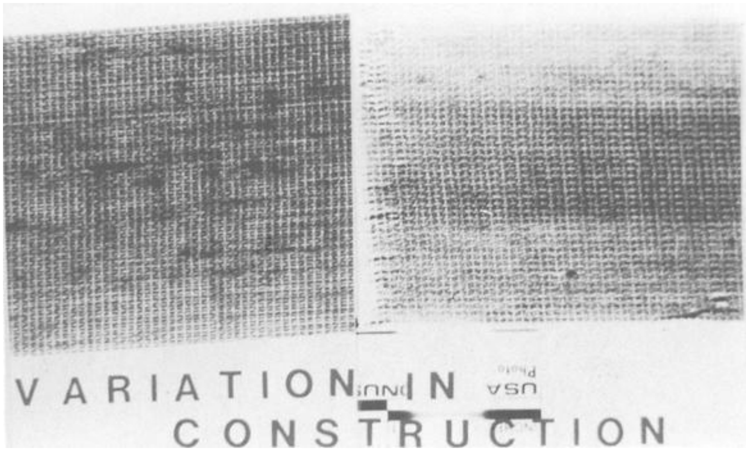

FIG. 10—*Variation in the physical characteristics between the rolls of tape recovered from the subjects from a rape and murder case.*

FIG. 11—*Two crumpled strips of gray duct tape used to bind the victims' hands from a double homicide case.*

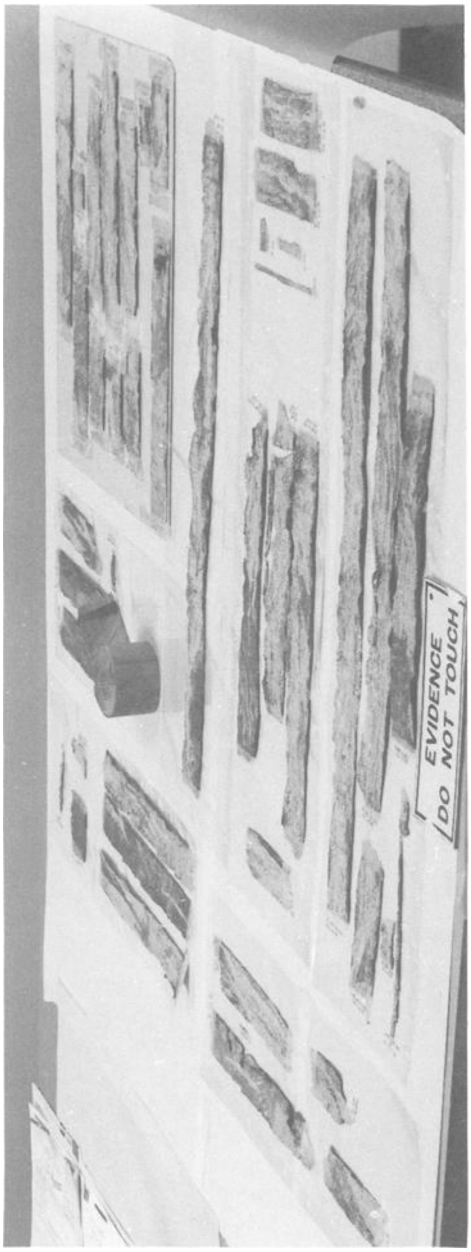

FIG. 12—*Numerous unraveled gray duct tape strips from the double homicide case.*

Figures 11 and 12 illustrate another example from a double homicide case where the proposed technique was successful in unfolding badly crumpled strips of gray duct tapes.

Conclusions

The new technique involving a solvent consisting of a blend of aliphatic and halogenated hydrocarbons is simple, rapid, convenient, and reliable for separating and unraveling various commercially produced adhesive tapes. Unlike the heating and freezing techniques, the proposed technique does not require excessive handling or the use of force to unravel the tape. Therefore, the solvent greatly facilitates the detection of latent prints on both the adhesive and nonadhesive surfaces of the tape and the recovery of trace evidence material from the tape. In addition, because the tape does not come into contact with any foreign materials or surfaces other than the solvent, the integrity of the trace evidence material present on the tape is maintained. The method has demonstrated its practicality in actual casework where existing methods failed to unravel or separate crumpled strips of adhesive tape.

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