Physical and Microscopical Examinations of Tape Evidence

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Physical Examinations of Tape Evidence

1 INTRODUCTION

This technical procedure describes how to conduct physical examinations to characterize and compare tape specimens.

2 SCOPE

This procedure applies to Chemistry Unit caseworking personnel who conduct physical examinations on a variety of tape specimens.

3 EQUIPMENT

- Stereobinocular microscope (~6X to ~50X magnification) with appropriate light source (e.g., annular ring light, fiber optic light)
- Ultraviolet light with long wavelength (~365nm) source
- Digital microscope
- Cold source (e.g., liquid nitrogen, freezer)
- Heat source (e.g., air dryer, heat lamp)
- General Laboratory Supplies
- Ruler with metric (1 mm) and/or English (1/64") graduations
- Thin-layer chromatography glass chamber, or equivalent, with lid
- Heavy-gauge transparency film or KAPAK® tubular rollstock
- Munsell Neutral Value Scale and Soil Color Charts (e.g., X-Rite, Inc.)

4 SAMPLING

Refer to the current version of PP-800 for guidance on sample(s) selection. Record the samples selected for analysis in the case notes.

5 PROCEDURE

As with any procedure involving trace evidence, ensure actions minimize the potential damage to the sample, particularly with respect to tearing or distorting of the tape ends.

5.1 Separating Tape Pieces

If the tape evidence is received as a tangled mass or a series of overlapping strips, separate, flatten, and arrange each piece on heavy-gauge transparency film (or equivalent clear, colorless plastic sheets) for comparison of physical properties.

Vinyl plastic document protectors are not suitable due to the presence of volatile plasticizers (e.g., phthalates) within their matrix; however, clear and colorless plastic evidence storage bags (e.g., KAPAK®) are acceptable.

Tape specimens that are wadded together or overlapped require special attention in order to free the adhesive layers. Suggested methods to aid in the separation are described below and

should be ordered to minimize alteration of the items received (e.g., adhesive removal, fabric or backing distortion, damage to the free ends).

A. Gently heat the tape with an air dryer while applying tension on opposite sides of the wadded area in order to gradually reduce the tack of the adhesive without tearing or distortion of the tape during manipulation.

B. Fill a porcelain dish or crucible with liquid nitrogen and immerse the tape for approximately one minute. If freezing does not enable quick and easy unpeeling, attempt this process a second time before trying another separation technique. Alternatively, the tape can be placed in an evidence freezer overnight (under proper seal and appropriately labeled).

C. If the tape is so entwined as to risk damage or tearing with the methods mentioned above, suspend the mass in a thin-layer chromatography tank along with approximately 100 mL of chloroform (in two 50 mL beakers placed at opposite ends of the tank with the wadded tape in between). Cover the appropriately-labeled tank, and place it under proper seal in fume hood for several hours or overnight.

D. Under a vented fume hood, apply an appropriate solvent drop wise to the edges of a wadded area or adhesive/substrate interface and gently pry the edges apart. Moderate heating can be helpful in conjunction with the solvent application.

5.2 Visual and Microscopical Examinations

Use written descriptions, sketches, photography, or other imaging methods to capture both macroscopical and microscopical characteristics and observations.

Observe the separate components of the tape specimen using both the unaided eye and a stereo microscope with ~6X to ~50X magnification. If any of the tape characteristics described below differ in manufactured properties, the tapes are considered different, and exams cease.

5.2.1 Adhesive Examinations

Record observations regarding the adhesive color. Provided color attributes have not been obscured by environmental effects or previous forensic examinations (e.g., weathering, latent fingerprint processing), differences will quickly disassociate items of evidence. Duct tape adhesive color comparisons can be facilitated using the matte version of the Munsell Neutral Value Scale or Soil Color Charts.

5.2.2 Backing Examinations

Record observations describing the tape backings (e.g., color, degree of gloss, texture, fabrication markings). If necessary, clean the tape backing with a mild solvent and a cotton swab. Evaluate the layer structure of a duct tape backing. This can be accomplished by freezing the backing to ensure rigidity, taking a cross-section with a clean razor blade, and viewing the cross-section in transmitted light with a compound or digital microscope.

Tape width is another possible point of comparison between full width specimens. Measure and record the observed widths to the nearest 1/64" or 0.5 mm using a ruler. A simple observation is often all that is needed when widths are different (e.g., 2” versus 3” wide duct tape). Additionally, some tapes will permanently deform when stretched, torn, or stressed. Therefore, only conduct width measurements on items that do not appear to have been severely distorted or degraded.

If the backing is a clear, colorless polymeric film, place the samples being compared on a glass microscope slide oriented with their machine directions parallel to each other. The tape adhesive can be used to hold the backing in place unless it is contaminated.

A. Monoaxial or biaxial orientation: Examine the tape at an appropriate magnification using a PLM with crossed polars by rotating the stage just off extinction (i.e., ~ 5 degrees). Record whether the film is monaxial, biaxial, or unable to be determined.

B. Extinction angle relative to machine edge: Keeping the PLM under crossed polars viewing, rotate the stage such that the machine edge of the film is parallel to the y-axis in the eyepiece. If the film is not black in appearance (i.e., at maximum darkness/extinct), record the initial stage position and rotate the stage to the point where extinction is observed. Record this number. The absolute value of the difference between the two values is the extinction angle, usually less than 10 degrees for typical polypropylene packaging tape films. Note: the extinction angle can be affected by deformation of the tape film so use caution in performing this exam on damaged polymeric films.

C. Relative retardation: Using a quarter wave or full wave plate (i.e., compensator), starting with the film edges at ~45 degrees relative to vertical/horizontal, rotate the stage in ~ 90 degree increments, and compare and record the colors of the films.

5.2.3 Fabric Examinations

Tape samples containing fiber or fabric reinforcement can be differentiated based on yarn (e.g., scrim) count, yarn composition and construction, and fabric weave once the adhesive has been removed.

A. Determine the weave pattern and a general description of the warp and fill yarns to include the direction of twist (e.g., “S”, “Z”) for yarns constructed of single fibers bundled together to form a strand of yarn. Plain weave and weft-insertion are common examples of fabrics encountered in duct tape samples. Record the weave and yarn characteristics in the case notes (e.g., description, sketch, photocopy, photograph).

B. Determine the scrim count by counting the number of yarns in a one square inch section of the tape in both the machine direction (i.e., m.d., warp) and cross direction (i.e., c.d., fill, weft). If the sample is large enough, consider taking repeat

measurements. If the sample is limited in size, determine the scrim count in the machine and/or cross direction on an area less than one inch. Record the area measured in the case notes.

C. Determine and record whether yarns in the machine and/or cross directions fluoresce under UV exposure at ~365 nm.

D. If two or more tape samples have not been discriminated at the conclusion of all examinations, forward samples containing non-PP discipline materials (e.g., glass filament reinforcement) to the appropriate personnel for additional testing. Paints & Polymers (PP) personnel should disclose any additional (pending) exams in the PP discipline's *Laboratory Report*.

5.2.4 *Physical Fit Evaluations*

A. Evaluate for possible physical fit between specimens.

1. If a possible physical fit is observed, examine the tear pattern from the backing and adhesive sides of both specimens with the aid of a stereomicroscope to determine whether physical fit remains plausible.

2. If the backing is distorted or folded over and adhered to the adhesive layer, carefully straighten it out to restore the edge.

3. Determine if there are individualizing characteristics such as a defect in the backing or in the fabric reinforcement that extends across the fracture. The beginning and end point of the defect must be apparent on both specimens to ensure that it is not continuous along the entire roll of tape.

4. If the tape has fiber or fabric reinforcement, remove enough of the adhesive layer to expose the reinforcing scrim. Ensure that the yarns in the machine (and if present, fill) direction line up along the fracture.

5. Depending on the type of tape, fabrication marks such as striations from extruders or embossed marks from calendar rolls can align across fractured edges providing additional features to corroborate a physical fit.

6. Record any physical fit determinations with descriptive notes.

B. A second PP qualified analyst will observe and record suspected physical fit associations between known and question items.

C. Unless deemed necessary based on case details, a second PP qualified analyst does not need to confirm physical fits that are observed within an item or between items from the same location. Furthermore, one piece of the reconstructed strip can be used for the remaining examinations.

5.2.5 *Fiber Examinations (Fiber-reinforced Tapes Only)*

Refer to Sections 4 through 6, 9, and 10 in the latest version of HRFBR-405 for relevant details in the microscopical analysis of duct tape fibers.

6 ACCEPTANCE CRITERIA

- If all physical and microscopical characteristics are consistent between specimens being compared, proceed with instrumental examinations according to the applicable PP technical procedures.
- If physical or microscopical characteristics of two specimens differ, cease examinations, and report that the specimens are different.
- According to duct tape industry contacts, a scrim count variation of ±1 yarn in either or both directions is acceptable within-roll variation.
- Decision criteria for a physical fit are described in section 5.2.4.

7 LIMITATIONS

- Sample size and condition can preclude conducting certain examinations.
- Color, width, thickness, and/or scrim count assessments can be affected by sample condition.
- In the absence of a physical fit determination, a tape specimen cannot be definitively associated to a particular roll of tape.

8 REFERENCES

PP-800, FBI Laboratory, Chemistry Unit – Paints/Polymers

HRFBR-405, FBI Laboratory, Trace Evidence Unit – Hairs/Fibers

Smith, J., *and Weaver, R*. "PLM Examinations of Clear Polymer Films: Identification of Monoaxial and Biaxial Orientation and Other Observations," The Microscope, Vol 53, No. 3/4, 2004, pp. 112–118.

9 REVISION HISTORY

Revision	Issued	Changes
08	01/02/2025	Edited Section 5.2.4 to specify who can verify physical fit. Added Section 5.2.5 to include the relevant sections of the HRFBR-405 technical procedure. Minor grammar edits throughout as well as removal of training material (e.g., how to remove adhesive or straighten tape).