Guideline for Assessing Physical Characteristics in Forensic Tape Examinations

Scientific Working Group on Materials Analysis (SWGMAT)

1.0 Scope

This document is part of a series of SWGMAT guidelines relating to the forensic analysis of tape and is intended to assist individuals and laboratories that conduct physical examinations and comparisons of pressure sensitive tapes. Its aim is to provide a description of the methods used to assess the physical characteristics of tape evidence.

2.0 Reference Documents

ASTM International Standards

D 1535 *Method for Specifying Color by Munsell System*
E308 *Test Method for Computing the Colors of Objects by using the CIE System*
E1459-92 (2005) *Standard Guide for Physical Evidence Labeling and Related Documentation*
E1492-05 *Standard Practice for Receiving, Documenting, Storing, and Retrieving in a Forensic Laboratory*

SWGMAT Trace Evidence Quality Assurance Guidelines [Online] (January 2000). Available: http://www.fbi.gov/hq/lab/fsc/backissu/jan2000/swgmat.htm.

SWGMAT Trace Recovery Guidelines [Online] (October 1999). Available: http://www.fbi.gov/hq/lab/fsc/backissu/oct1999/index.htm

SWGMAT Forensic Fiber Examination Guideline [Online] (April 1999) Available: http://www.fbi.gov/hq/lab/fsc/backissu/april1999/index.htm

SWGMAT Guideline for the Forensic Examination of Pressure-Sensitive Tapes [Online] (October 2008) Available: http://www.fbi.gov/hq/lab/fsc/backissu/Oct2008/index.htm

3.0 Terminology

Adhesive: A material that will hold two or more objects together solely by intimate surface contact.

Backing: A thin flexible material to which the adhesive is applied.

*Calendering:*The use of a multi-roll device to apply pressure sensitive adhesive at 100% solids to various backings by heat and pressure to produce adhesive tape.

CIE: International Commission on Illumination

Duct tape: Fabric-reinforced tape used for air duct installation or for general utility applications

Electrical tape: PVC-backed tape with specific dielectric properties designed for electrical applications

Fill yarn: Yarns in the scrim fabric of reinforced tape that run crosswise, perpendicular to the warp direction. Also called weft yarns

Filament tape: A fiber-reinforced tape in which the reinforcing fibers are only in the warp direction. Also referred to as strapping tape

Long-wave UV illumination: In the wavelength range from 400 nm – 315 nm with peak wavelength energy at 366 nm

*Machine direction:*The direction of the tape that runs the length of the tape.

Masking tape: Paper-backed tape having a creped, usually beige or buff-colored backing

Nominal width: The design width of the tape, usually in terms of round numbers. Measured width can vary from nominal width due to stretching or weathering.

Packaging tape: a) Pressure-sensitive tape consisting of an oriented polymer with a brown or clear adhesive layer, or b) Paper-backed tape, which has a moistenable adhesive.

Physical end match: A one-of-a-kind fit between two pieces of torn or cut ends

Scrim: A loosely-woven gauze-type cloth added to duct tape for reinforcement and strength

Scrim: The dimensional count of the scrim, in terms of threads per inch, expressed as warp count by fill count

*Short-wave UV illumination:*In the wavelength range from 280 nm- 100 nm with the peak wavelength energy at 254 nm

Stereomicroscope: A microscope containing two separate optical systems, one for each eye, giving a stereoscopic view of a specimen

Strapping tape: See filament tape.

Texturized yarn: A crimped feature in reinforcement fibers designed to give bulk

Twist: The direction of twist in yarns is indicated by the capital letters S and Z. Yarn has an S-twist if when it is held vertically, the spirals around its central axis slope in the same direction as the middle portion of the letter S, and Z-twist if they slope in the same direction as the middle portion of the letter Z.

Warp yarns: Yarns in scrim fabric of reinforced tape that run lengthwise (in the machine direction)

*Weft yarns:*See fill yarns.

Yarn: For the purposes of this document, yarns refer to lengths of fiber reinforcement: twisted staple fibers or filament fibers.

4.0 Summary of Guide

Tape specimens can be examined to determine a common source or possible manufacturer. This guide covers the visual and stereomicroscopic examinations of color, thickness, reinforcement, and backing and adhesive features. Structural details, such as design, construction, and composition, can provide information that may assist the analyst in reaching a conclusion.

A goal of a tape comparison is to assess the significance of any observed differences. If no significant physical differences are found between samples, instrumental analyses are warranted.

5.0 Significance and Use

Physical characterization of tape specimens is the initial step of a comprehensive forensic pressure sensitive tape analysis. The construction, composition, and color of tapes vary and, therefore, are useful characteristics for forensic examinations. Visual characteristics and physical measurements are the quickest, most discriminating and least invasive examinations.

6.0 Sample Handling

6.1 An effort should be made not to alter the condition of a questioned specimen before the preliminary examination. In some circumstances, it may be desirable to obtain a sample cutting from the tape before a sample is analyzed for latent fingerprints. Necessary precautions should be taken to eliminate loss or contamination of other types of evidence (e.g., latent prints, DNA, and other trace evidence).

6.2 Samples for testing should not be cut from the ends of the tape if there is a possibility of a physical end match between specimens. A sample should be obtained from an area that does not interfere with the existing end(s), and the location should be marked.

6.3 If tape is received in a tangled condition an attempt should be made to separate it manually with a careful peel. More aggressive techniques such as gentle heat, liquid nitrogen, freezing, or solvents can be used if necessary. However, these techniques could affect the outcome of subsequent analyses and should, therefore, be applied only to the extent necessary.

6.4 All procedures must be conducted in such a manner to ensure that no cross-contamination occurs. The item must be photographed or described prior to conducting any analyses in order to provide documentation of original condition. Transient evidence (e.g., hair, fiber, paint) should be preserved and documented.

6.5 Tape may not be in its original state due to weathering, stretching, chemicals, etc. These changes may limit the information obtained from the analyses. Tape does not always allow for the full range of examinations, the examinations and analyses that are performed should be reflected in the analyst's notes.

7.0 Analysis

Written descriptions, sketches, photography, or other imaging methods must be used to document each sample's characteristics.

Preliminary examination of tape construction should include its general appearance macroscopically and under a stereomicroscope, including any adhering matter.

For all pressure sensitive tapes, document and record any physical damage (e.g., worn, cut, torn, frayed). The following general macroscopic characteristics should be observed and documented:

- General condition
- Wad, flat pieces, or fragments
- Dimensions (e.g., nominal width and length)
- Number of pieces
- Colors

- Severed ends for possible physical matches

7.1 Physical end match
When conducting comparison examinations between two or more tape specimens, the free ends should be carefully examined for possible physical end matches. A physical end match is defined as free ends of separate pieces of tapes that physically fit together demonstrating that the two pieces were once one continuous piece. Even though this type of association is the most compelling type of association, the analyst may elect to continue with a complete analytical analysis of these specimens depending upon the quality of the end match.

7.1.1 General guidelines for examination of tape evidence for possible physical end matches:

- Observe the tear or cut pattern from the backing and adhesive side of both specimens to determine if a physical association is plausible. For finer detail, a stereomicroscope should be used to examine the ends.

- If the backing is distorted or folded over and adhered to the adhesive layer, gently straighten it out to restore the torn/cut edge. This may be accomplished with the careful use of forceps, gentle heat, or mild solvent.

- Depending on the type of tape, manufacturing marks, creping on a paper backing, printing or any other continuous surface features may be present across fractured edges and would provide additional points of comparison.

- Determine if there are individualizing characteristics (e.g., a flaw or mark) that extends across the fracture. This would be an accidental or anomalous mark that initiates on one piece and terminates across the fracture edge on the other.

- If the tape has a fabric reinforcement layer, solvent (e.g., hexane, chloroform, or xylene) may be used to remove a sufficient amount of adhesive to expose the fabric and ensure alignment of the yarns that have broken across the torn ends.

- Any physical associations must be documented with descriptive notes. Physical associations between specimens that link a suspect to a crime scene or to a victim should be imaged. The imaging method should be dimensionally accurate and include a measuring scale.

- It is strongly recommended that any/all associations between a question specimen and a known specimen be confirmed by another qualified analyst.

7.2 Physical Features
Tape examinations involve a process of documenting all of the physical characteristics exhibited.

The following characteristics should be documented when applicable:

- Color of adhesive and backing
- Surface texture
- Width measurement
- Overall thickness
- Backing thickness

Each of these characteristics can have a number of sub-elements, all of which can be characterized to complete the examination. Physical characteristics of a tape may change after removal from the original roll. The analyst must decide what is within an acceptable tolerance. Any measuring devices used should be properly checked with applicable quality assurance and control procedures.

7.2.1 Backing
The type of backing must be recorded (e.g., paper, polymer film). The backing should be examined both macroscopically and by using a stereomicroscope for color, texture and appearance under multiple illumination sources. For comparative examinations, a side-by-side color comparison of two or more backings is appropriate; otherwise, the Munsell or CIE color systems may be utilized.

7.2.1.1 Markings on the Backing
Under the stereomicroscope the tape should be examined for features such as calendering marks, striations, dimples, and inclusions. The shapes and type of markings should be documented.

7.2.1.2.1 Multiple Layer Backings
Multiple layers may be present in tape backing and should be examined to determine if multiple layers are present. There are a number of ways to cross-section tapes (e.g. hand sectioning, microtome). The multiple layers should be characterized and then analyzed with appropriate analytical instrumentation.

7.2.2 Adhesive
The adhesive should be examined both macroscopically and by utilizing a stereomicroscope for color and appearance under multiple illumination sources. For comparative examinations, a side-by-side color comparison of two or more adhesives is appropriate; otherwise, the Munsell or CIE color systems may be utilized.

7.2.3 Reinforcement
If reinforcement is present in a tape, it should be characterized.

7.2.3.1 Duct Tape Reinforcement
The three main features to examine in duct tape reinforcement are weave, yarn description and scrim count.

Assess the weave of the scrim fabric under the stereomicroscope. This may require separating the adhesive from the scrim. The most frequently encountered weave patterns are weft-insertion and plain weave. Weft-insertion has chain-stitch warp yarns with texturized filaments in the fill direction. A plain weave has a one over/one under pattern; the warp and fill directions can be a combination of any of the following types of yarns:

- twisted yarns (Z- or S-twist)
- filament fibers bound by another filament fiber
- texturized filament fibers
- straight filament fibers

The fluorescence of the threads should be examined using short- and/or long- wavelength illumination.

The number of filaments per bundle in the fill and warp directions may be counted.

The scrim count is the warp count per inch and the fill count per inch and should be recorded.

7.2.3.2 Strapping (Filament) Tape Reinforcement

The fibers in filament tape most often consist of synthetic or glass fibers. The fibers are only in the warp direction. The number of bundles across the width of the tape may be counted, and the fluorescence of the threads should be examined using short- and/or long- wavelength illumination.

8.0 Report Documentation

The goal is to produce documentation that will be meaningful to a reviewer in the absence of the recording analyst. The resulting notes must be sufficient to document the conclusions reached in the analyst's report. All pertinent data, including any documentation of physical end matches, should be placed into or referenced within the case file. For comparative tape examinations, if differences are observed in physical characteristics, no further testing is necessary, and a report can be issued. If no significant differences are observed, instrumental examinations should be performed before a report is issued. In sourcing cases, instrumental examinations may be necessary before a report is issued.

9.0 Bibliography

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