Visual and Microscopical Examination of Polymeric Material Evidence

1 Scope

This procedure applies to Chemistry Unit caseworking personnel who perform visual and microscopical examinations to characterize and compare a variety of polymeric samples.

2 Equipment/Materials/Reagents

a. Stereo microscope (~6X to ~100X) with appropriate lighting (such as an annular ring light or fiber optic lights)

b. Glass microscope slides

c. Scalpel handle and blades

d. Tweezers

e. Probes (e.g., steel, tungsten, wood, or Teflon™)

f. Disposable wipes

g. Well slides

h. Pillboxes

i. Compressed-gas duster

j. Large sheets of untreated kraft paper (or equivalent)

k. Large, flat-bladed spatula

l. Micrometer, 0-1” range, accurate to 0.0001”, or equivalent

m. Ruler with a minimum of 1/16” gradations

n. Digital camera

3 Standards and Controls

Not applicable.

4 Sample Selection

Refer to the Paints and Polymers Standard Operating Procedure (P&P SOP) *General Approach for Polymeric Casework* for guidance on sample(s) selection. Record the samples selected for analysis in the case notes.

5 Procedure

5.1 Visual and Microscopical Examination

Use written descriptions, sketches, photography, or other imaging methods to capture both visual and microscopical characteristics and observations. If the items are suitable for further examination, record a detailed description of each item to include comparative features or any unusual conditions (e.g., commingled material).

1. Process each item separately to prevent cross-contamination.

2. Transfer the item from its original container to a suitable substrate (e.g., paper, glass microscope slide, pillbox) to examine both visually and microscopically. Evidence that is too large or bulky to fit under a conventional stereomicroscope for examination can be handled as follows.

    a. Use a modified base for the stereomicroscope.

    b. Alternatively, section and examine an area of interest from the bulk material.

3. Some specimens require processing or preparation prior to examination.

    a. Clothing: Examine each article of clothing visually and microscopically for evidence of a polymeric material transfer.

        i. If a potential polymeric material transfer is embedded or abraded onto the fabric, take a cutting which includes a sample of the transferred substance and preserve it for future examination. See 3.b. for further instructions regarding smears.

ii. Process each article of clothing as it was received (i.e., individually or collectively packaged) and isolate the debris in the same manner (i.e., one pillbox per package).

iii. Suspend the item from a rack over a large sheet of paper and carefully scrape all surfaces in a downward motion with the edge of a large flat-bladed spatula or similar tool to dislodge any remaining polymeric evidence.

iv. Collect the deposited debris and transfer it to a pillbox or other container for microscopical examination. Label the top and bottom of the container with the laboratory number, item number, and initial. See 3.c. for further instructions regarding debris.

b. Smears: Oftentimes, the amount of energy imparted in a transfer of polymeric material will cause it to melt or soften and resolidify, fusing the polymer to the substrate.

i. If fused or embedded onto a surface, remove particles and fragments using a scalpel blade, probe, tweezers, or similar tool while observing under a microscope. If the item will be subsequently examined for toolmark comparisons, relatively soft, pliable materials such as wood or Teflon™ should be used to dislodge the suspected polymeric material from the surface. Metal blades should not be used as they can alter the surface and thereby affect a toolmark examination.

ii. The fabric weave of an article of clothing can be stretched in order to facilitate removal/dislodging polymeric particles.

iii. Transfer isolated particles/fragments to a well slide or pillbox for future examination. Label the slide or pillbox with the laboratory number, item number, and initial.

iv. Smeared samples can be contaminated with material from the surface upon which it is impacted (e.g., soil, fibers, paint, wood) thereby affecting the chemistry and/or color of the sample. If appropriate, take a control sample of the substrate close to but not within the area containing the smear.

c. Debris: Polymeric evidence can be mixed in with other materials that are not probative for examination by P&P personnel (e.g., fibers, glass, soil).

i. Examine the contents of the debris microscopically, manipulating it with the appropriate tools (e.g., tweezers, scalpel, probe) and isolate any plastic-like materials.

ii. Transfer these materials to a well slide or pillbox for future examination. Label the slide or pillbox with the laboratory number, item number, and initial.

iii. To decrease the likelihood that polymeric evidence has been overlooked, a second P&P examiner can examine the debris. Alternatively, the primary examiner should re-examine the debris on a different day. Record the results of these subsequent analyses in the case notes.

4. Once isolated, observe the surface of the specimen(s) and record color, morphology, degree of gloss, texture, the presence of manufacturer markings, the presence of surface striae, defects, or any other characteristics that help to describe the item.

5. Record the overall shape and nominal dimensions of the item such as length, width, and thickness. Nominal measurements can be taken with a ruler. If appropriate, obtain thickness measurements for comparison between specimens.

   a. Using a micrometer, obtain thickness measurements from at least three different areas on the sample. Record the instrument manufacturer, ID number, date of next calibration, and any individual readings taken (to the nearest 0.00005”). Some polymers will permanently deform when stretched or stressed; therefore, only conduct thickness measurements on items that do not appear to have been severely distorted or degraded.

6. View the specimen(s) at ~6X to ~100X magnification and determine if it is multi-layered. Record all observations in the case notes.

   a. Obvious layers can be exposed/observed by a number of techniques which include, but are not limited to viewing the sample on edge, cross-sectioning by hand, cross-sectioning by encapsulation and microtomy or polishing, making an oblique (bias) cut through the sample, or taking a series of thin peels through each layer.

   b. A combination of techniques can be used to fully characterize the layer structure. The extent of sample manipulation and preparation will depend on the amount of sample available, its complexity, and its characteristics.

5.2 Sourcing Examination

1. Record any observed manufacturer markings found on a sample with descriptive notes to include any letters, numbers, or symbols observed on the item as well as the relative location of the marking. If imaging techniques such as photography are used, include a scale or notation of the magnification in the image.

2. Employ resources within and outside the FBI Laboratory as applicable to develop additional information about the potential source(s) of the item.

5.3 Physical Reconstruction Examination

1. Observe the specimens for possible fracture (physical) matches. A fracture match can be recognized by the alignment of broken edges, manufacturer markings, and/or surface anomalies (e.g., striae, texture).

    a. Fracture matches are the most conclusive type of examination and must be recorded with descriptive notes and imaging techniques

    b. Include a measuring scale in any collected images when practicable. If not practicable, annotate the image with the magnification used.

2. A second P&P examiner must confirm and record suspected fracture matches between known and question specimens.

6 Decision Criteria

a. If physical characteristics of two (or more) specimens being compared differ, cease examinations and report that the specimens differ.

b. Decision criteria for a fracture match are described in section 5.3.

7 Calculations

Not applicable.

8 Measurement Uncertainty

Not applicable.

9 Limitations

a. Sample size and condition can preclude conducting certain examinations, including color assessment.

b. Sourcing capabilities of common synthetic polymeric materials is limited. This is directly related to the abundance of such materials in the marketplace and the number of end uses for a particular polymeric material.

c. Reporting a potential source for automotive parts (i.e., vehicle make/model/year) is limited to the manufacturer's part numbers. For automotive parts, the SAE (Society of Automotive Engineers) numbers can only provide information as to the function of the part on the automobile.

10 Precautionary Statement

As with any procedure involving trace evidence, ensure actions minimize the potential for loss or contamination.

11 Safety

Use standard precautions for the handling of potentially biohazardous materials, chemicals or sharps. Refer to the *FBI Laboratory Safety Manual* for guidance.

12 References

Alger, M.S.M. *Polymer Science Dictionary*. NY: Elsevier Science, 1989

FBI Laboratory Safety Manual

General Approach for Polymeric Casework, FBI Laboratory, Chemistry Unit – Paints and Polymers SOP

Parsons, N.S., and Mountain, C.A. Investigating Polyurethane Foam as a Form of Trace Evidence. *Science and Justice* 2007; 47:24-33.

Seymour, R.B., Carraher, Jr., C.E. *Polymer Chemistry: An Introduction*, 2d ed. NY: Marcel Dekker, 1988.

Rev. #	Issue Date	History
0	06/21/06	New document that replaces previous document also titled *Macroscopic and Microscopic Examination of Polymeric Material Evidence*.
1	09/30/09	Changed the sampling plan guidelines and updated references.
2	03/14/12	Updated microscopic and macroscopic to microscopical and macroscopical where appropriate throughout document. Changed "sampling" plan to "sample selection" plan in section 8. Addressed decision criteria for comparison of thickness measurements in section 10.
3	02/03/14	Changed "macroscopical" to "visual" throughout to simplify terminology, edited equipment list to be less specific, removed discussions related to thickness comparisons in Section 9.1, 5a, and made minor grammatical editing. Photography documentation requirements edited in Section 9.3, 1b. Deleted calculations in Section 11.
4	09/18/18	Modified scope, deleted sections that do not describe procedural content, changed section titles as needed to reflect LOM or practice changes, added procedural details as warranted for clarification, minor grammatical edits throughout.

Redacted - Signatures on File

Approval

Paints and Polymers Technical Leader: Date: 09/17/2018

Chemistry Unit Chief: Date: 09/17/2018

QA Approval

Quality Manager: Date: 09/17/2018