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Standard Guide for Forensic Paint Analysis and Comparison[1]

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INTRODUCTION

Forensic paint sample analyses and comparisons are typically distinguished by a limited amount sample that precludes the application of standard industrial paint analysis procedures or protocols to these analyses. The issues before a case or investigation, sequence of events at the scene in question, sample size, complexity and condition, environmental effects, and collection methods generally force a criminalist to address the issues of test choice, sample preparation scheme, test sequence, and degree of sample alteration and consumption that are efficacious to each specific case as well as the interests of all parties to a litigation.

1. Scope

1.1 This guide is intended to assist individuals and laboratories that conduct forensic paint analyses in their selection, application, and evaluation of tests that can be of value to their investigation. It is not intended as a detailed methods description or protocol for the analysis and comparison of paints but as a guide to a reasonable order for testing and to the strengths, limitations, and possible pitfalls of each of a variety of potentially useful analytical methods. Numerous detailed materials are available that discuss each method, and selected references are noted as appropriate.

1.2 This guide is intended for application to the analysis of industrial and commercially prepared paints and related coatings. It does not propose to address the unique requirements of artistic, historical, or restorative paint analysis, although some of the methods discussed herein may be applied to those fields.

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*

D 16 Terminology for Paint, Related Coatings, Materials, and Applications [2]

D 1535 Practice for Specifying Color by the Munsell System[2]

D 2244 Test Method for Calculation of Color Differences from Instrumentally Measured Color Coordinates[2]

D 3168 Practice for Qualitative Identification of Polymers in Emulsion Paints[2]

D 4764 Test Method for Determination by X-Ray Fluorescence Spectroscopy of Titanium Dioxide Content in Paint[2]

E 105 Practice for Probability Sampling of Materials[3]

E 141 Practice for Acceptance of Evidence Based on the Results of Probability Sampling[3]

E 275 Practice for Describing and Measuring Performance of Ultraviolet, Visible, and Near —Infrared Spectrophotometers[4]

E 308 Test Method for Computing the Colors of Objects by Using the CIE System[2]

E 334 Practices for General Techniques of Infrared Microanalysis[4]

E 380 Practice for Use of the International System of Units (SI) : the Modernized Metric System[3]

E 805 Practice for Identification of Instrumental Methods of Color or Color-Difference, Measurement of Materials[2]

E 860 Practice for Examining and Testing Items that Are or May Become Involved in Products Liability Litigation[3]

E 1360 Practice for Specifying Color by Using the Optical Society of America Uniform Color Scales System[2]

E 1492 Practice for Receiving, Documenting, Storing, and Retrieving Evidence in a Forensic Science Laboratory[3]

E 1508 Guide for Quantitative Analysis by Energy-Dispersive Spectroscopy[5]

3. Terminology

3.1 *Definitions*—For definitions of terms used in this guide, see Terminology D 16.

[1] This guide is under the jurisdiction of ASTM Committee E30 on Forensic Sciences and is the direct responsibility of Subcommittee E30.01 on Criminalistics.

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[2] *Annual Book of ASTM Standards*, Vol 06.01.

[3] *Annual Book of ASTM Standards*, Vol 14.01.

[4] *Annual Book of ASTM Standards*, Vol 14.02.

[5] *Annual Book of ASTM Standards*, Vol 03.01.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *discriminate*—to distinguish between two samples based on differences; to differentiate.

3.2.2 *discriminating power*—the measure of an analytical procedure is the ability to distinguish between two items of different origin.

3.2.3 *known, , adj*—an item of established origin.

3.2.4 *questioned, , adj*—for the purpose of classification.

3.2.5 *significant difference*—a difference between two samples that establishes different origins for the two samples.

4. Summary of Practice

4.1 Paint films are characterized by a number of physical and chemical features such as the following: color, surface texture, contamination, and weathering; striae due to wear, impact, application techniques, or underlying surface irregularities; and paint layering order and thickness, presence of pigments or dyes, or both, and vehicles or resins and modifiers in the paint. These features can be determined and evaluated by a variety of visual, macro and microscopical, chemical, and instrumental methods. Limited sample size and sample preservation requirements dictate that these methods be selected and applied in a reasonable sequence in order to maximize the discriminating power of the test results.

4.2 Searching for significant differences between samples is the objective of forensic paint analysis and comparison. Differences almost always exist between samples. A forensic paint analyst's goal is to demonstrate which differences are significant. The absence of significant differences at the conclusion of an analysis is taken as evidence of common origin. The likelihood of common origin between specimens is a function of a number of factors, including the following: the type or number, or both, of matching features; the type of components in the paint film; the presence or absence of studies quantifying the uniqueness of these components; and the discriminating power of the test methods used.

4.3 The test procedure selected in a paint analysis and comparison generally begins with careful sample documentation. Some features of that documentation are described in Practices E 380, E 860, and E 1492. This documentation is usually followed by the development of an evidence sampling plan. Such plans are discussed in Practices E 105 and E 141. Although these practices are directed toward industrial and consumer product sampling environments, they offer some insight into the legal expectations in evidence sampling. Analysis generally proceeds with the simplest nondestructive tests available for the conditions of the case once sampling and specimen documentation are complete. If these initial tests do not discriminate between the samples, the examination will continue with other tests that can require an increasing degree of sample preparation or consumption and are selected based on the sample availability, and tests' potential for discriminating the samples.

5. Significance and Use

5.1 The guide is designed to assist in selecting and organizing an analytical scheme for identifying and comparing industrial, architectural, or automotive paint films.

5.2 The techniques discussed are generally applicable to films with layers >20 µm in thickness and for the identification of pigment elemental components of $Z > 6$, elemental concentrations of >1 %, and paint vehicle components in excess of 5 % by weight. These constraints are imposed by microscopical, infrared absorbance and energy dispersive X-ray analysis system constraints.

6. Test Specimens

6.1 *Suitable Known Specimens*:

6.1.1 Known paint specimens should be collected from areas immediately adjacent to the point, or points, of transfer. The point of impact or pressure transfer typically exhibits bare substrate or substrate with a damaged paint film. The collected known specimens should contain all paint layers of the undamaged paint film. Paint layers can begin and end as well as exhibit substantial variations in thickness over short distances across a painted surface. This is particularly true in automotive and architectural paint films at curves, corners, and edges, which are often impact or fulcrum points that may have been subject to previous damage, sanding, or overpainting.

6.1.2 The substrate or parent surface underlying the suspected transfer area should be included in the sample collected when possible. Adjacent sections of wallboard, ceiling portions, door and window frames, implement handles, doors, fenders, hoods, or entire automobiles are examples of items that can be valuable. A few minutes of comparative work with the parent surface(s) might resolve the questions in a case and save considerable time spent on other forms of laboratory analysis.

6.1.3 Simple scraping may not provide suitable materials for definitive comparison. Paint flakes containing all layers can be removed from the parent surface by a number of methods, including deformation by impact to the opposite side of the surface, by lifting particles already separated from the surface but still retained at one edge or prying up fragments using a tool that does not contaminate. It is important that the blade be inserted down to or adjacent to the parent surface and the paint popped from the surface with the latter technique.

6.2 *Suitable Questioned Specimens*:

6.2.1 Questioned specimens should include all loose or transferred paint material available at the scene in question. The scene can include such items as tools, floors, walls, glass fragments, hair, fingernails, a roadway, adjacent structures, transfers or smears on vehicles, or transfers to or from individuals such as damaged fabric with paint inclusions and fibers or fabric impressions on painted surfaces. Items with paint transfers should be packaged and submitted in their entirety for examination whenever possible, rather than attempting to remove paint from a substrate in the field. Representative or partial sampling can reduce or even eliminate the possibility of a conclusive comparison or physical match to known materials.

6.2.2 Flasks of whole paint films or films still attached to a substrate, such as a painted piece of wood or metal, provide the most useful questioned samples for analysis. Fragments of films that do not represent the complete layering structure of the original surface obviously offer fewer characteristics for comparison but can be useful in physical fits and other examinations.