Designation: F 1721 – 04

Standard Practices for Determining Stability of Direct Thermal Imaging Products[1]

This standard is issued under the fixed designation F 1721; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 These practices cover the evaluation of the effect of various solvents, light, heat, and humidity on direct thermal imaging products.

1.2 These practices may be used to evaluate the performance of thermal products coated on paper, film, or other substrate for specific applications.

1.3 These practices may be used for manufacturing control, development, and research.

1.4 The sections in these practices appear in the following sequence:

1.5 *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:* [2]

D 2244 Test Method for Calculation of Color Differences from Instrumentally Measured Color

F 767 Test Method for Image Stability of Chemical Carbonless Paper to Light

F 1320 Test Method for Evaluating Thermal Paper Employing a Facsimile Thermal Printer as a Test Instrument

F 1405 Test Method for Determining the Dynamic Thermal Response of Direct Thermal Imaging Products—Atlantek Method

F 1444 Test Method for Determining the Dynamic Thermal Response of Direct Thermal Paper—Label Printer Method

2.2 *ANSI Standard:*

ANSI/CGATS 4-1993 Graphic Technology—Graphic Arts Reflection Densitometry Measurements—Terminology, Equations, Image Elements and Procedures[3]

3. Terminology

3.1 *Definition:*

3.1.1 *direct thermal imaging product, n*—paper, film, or other substrate upon which a coating is applied; the imaging components consist of a color former (leuco dye), a developer, a sensitizer, and antioxidants which react to form an image when sufficiently heated from a thermal printhead.

SOLVENT RESISTANCE

4. Summary of Practice

4.1 Select one or more of the solvents appropriate to the application for which the product will be used.

4.2 Imaged samples including a control are measured for optical density then subjected to contact by various solvent materials for a specified time. Optionally, L*, a*, b* values can be measured for the background using a spectrodensitometer. After the test time is completed, the samples are again measured for optical density and L*, a*, b* and compared to a control. The L*, a*, b* measurements will indicate changes in image color.

4.2.1 Most units which measure L*, a*, b* can provide the difference values in the form of ΔL*, Δa*, Δb* and ΔE. Refer to the technical literature on color measurement for the interpretation of these results.

5. Significance and Use

5.1 These procedures enable comparison of samples with a control under various solvent conditions to determine the stability of the image. The various solvents simulate conditions which may be encountered in the environment.

5.2 The test may be used to judge which materials are suitable for a specific situation and usage. The sensitivity of the products should match and the products should be for the same application.

[1] These practices are under the jurisdiction of ASTM Committee F05 on Business Imaging Products and are the direct responsibility of Subcommittee F05.06 on Carbonless and Thermal Imaging Products.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] Available from American National Standards Institute, 25 W. 43rd St., 4th Floor, New York, NY 10036.

5.3 The procedure may be used for the evaluation of direct imaging coatings on paper, film, or other substrate. The method of imaging should be with the type of imaging unit for which the product has been designed.

6. Interferences

6.1 Backing material will affect the reading taken with a spectrodensitometer. Specify which backing is used when taking a reading.

6.2 When reading L*, a*, b* values, also record observer, illuminator, and geometry of the instrument.

7. Apparatus and Materials

7.1 *Spectrodensitometer*, with an aperture smaller than the image area to be measured and meeting the requirements of ANSI/CGATS 4-1993, operating in visual density mode.

7.2 *Oven*, operated at 100 ± 4°F (38 ± 2°C).

7.3 *Printer or Alternative Imaging Device*.

7.4 *Weight*—2.5 lb/in.^{2} (0.176 kg/cm^2).

7.5 *PVC Film*.

7.6 *Cottonseed Oil*.

7.7 *Castor Oil*.

7.8 *Saturated Salt Solution*.

7.9 *Ethyl Alcohol*, 20 % v/v water, denatured.

7.10 *Isopropyl Alcohol*.

7.11 *Pipette*.

7.12 *Option*—Instrument for the measurement of L*, a*, b*.

8. Test Specimens

8.1 The test specimens and control shall be sheets or taken from a roll of direct thermal imaging product.

8.2 Cut samples into individual sheets approximately 8½ by 11 in. (216 by 279 mm). A maximum of six sheets per sample are required for testing.

8.3 Employ a control sample whose characteristics have been previously established or to which all results will be compared.

9. Calibration

9.1 *Spectrodensitometer*—Calibrate the densitometer in accordance with the manufacturer's recommendations.

9.2 *Option—L*, a*, b* Instrument*—Calibrate the unit in accordance with the manufacturer's recommendations.

10. Procedure

10.1 Image the samples and control with a printer to provide a series of images. Imaging may be achieved with a facsimile thermal printer employing a suitable test target (see Test Method F 1320) or by imaging systems described in Test Methods F 1405 or F 1444. If possible, have some images be a solid block at least ¼ by ¼ in. (0.6 by 0.6 cm). Image all samples in the same manner.

10.2 Using the reflectance spectrodensitometer, measure the image density of the samples and control after full density development. Optionally, L*, a*, b* values may be measured for the background. A minimum of five measurements should be taken and averaged to improve accuracy. Measurements should be made in the same relative location on each sample.

10.3 Wrap each imaged sample and imaged control with three layers of PVC film, taking care to keep the samples flat and the film wrap wrinkle free. Place samples in an oven established at 100 ± 4°F (38± 2°C) under a weight of 2.5 lb/in.^{2} for 16 h.

10.4 Coat an imaged sample and imaged control with cottonseed oil or castor oil and place in an oven established at 100 ± 4°F (38 ± 2°C) for 16 h. Use a pipet or similar device to ensure that an equivalent amount of oil is applied to each sample.

10.5 Immerse imaged sample and imaged control in water for 16 h at room temperature. Upon removal, absorb excess water with paper toweling and allow samples and control to air dry at room temperature.

10.6 Immerse imaged sample and imaged control in a saturated sodium chloride salt solution for one hour at room temperature. Upon removal, absorb excess moisture with paper toweling and allow the samples to air dry at room temperature.

10.7 Immerse imaged sample and imaged control in ethyl alcohol (20 %, denatured) for 1 h at room temperature. Upon removal, blot excess solvent and allow the samples to air dry at room temperature.

10.8 Measure the optical density and L*, a*, b* of the imaged samples and the imaged control samples from 10.3 to 10.7. Measure the same locations as originally measured in 10.2. Most L*, a*, b* units will permit the measurement of the change in color (4.2.1).

10.9 Wipe an imaged sample and imaged control with a swab dampened with isopropyl alcohol. Visually compare the image of the sample to the control.

10.10 Compare the results of the samples to the control and establish a ranking order.

11. Report

11.1 Report the following information:

11.1.1 Dates that the test was conducted.

11.1.2 Sample and control identification.

11.1.3 Information regarding the equipment and materials employed in the tests.

11.1.4 Method used to image the samples.

11.1.5 Results of the individual tests including the number of readings taken on each sample; the high, low, and average of the optical density and L*, a*, b* before and after each test; and relative results compared to the control.

11.1.6 Any additional information regarding the test, the samples, or the test conditions.

LIGHT STABILITY

12. Summary of Practice

12.1 Samples and control are imaged on an appropriate printer. Background and image densities are measured with a spectrodensitometer. Optionally, L*, a*, b* values can be measured for the background and images using a colorimeter or spectrodensitometer. Samples and control are placed in a 5000-lux light chamber for 100 h. A longer time can be chosen depending on stability requirements. The minimum exposure time shall be long enough to allow differentiation between images that have acceptable stability and those that have poor

stability. Following exposure, the background, and image densities, or optionally L*, a*, b*, are remeasured and compared to the original values. The L*, a*, b* measurements will indicate changes in color.

12.1.1 Most instruments that measure L*, a*, b* can provide the difference values in the form of ΔL*, Δa*, Δb* and ΔE. Refer to Test Method D 2244 for calculation of color differences based on instrumentally measured color coordinates.

12.2 This practice can be used for the evaluation of direct imaging coatings on paper, film, or other substrate. The method of imaging should be with the type of imaging unit for which the product has been designed.

13. Significance and Use

13.1 This practice enables comparison of samples with a control under accelerated light conditions to determine the stability of the image and the background.

14. Apparatus

14.1 *Spectrodensitometer*, with an aperture smaller than the image area to be measured and meeting the requirements of ANSI/CGATS 4-1993, operating in visual density mode.

14.2 *Cool White Fluorescent Lamp Light Box*—described in Test Method F 767 and operated to provide 5000 lux of total radiation on the sample surface or alternate equipment such as an exposure device that uses xenon arc radiation filtered to simulate solar radiation through window glass. Test results may differ between laboratories, particularly when different types of equipment are used, and will require comparative testing to determine exposure times to produce equivalent test results.

14.3 *Option*—Instrument for the measurement of L*, a*, b*.

15. Test Specimens

15.1 The test specimens and control shall be sheets or taken from a roll of direct thermal product.

15.2 Cut samples into individual sheets approximately 8½ by 11 in. (216 by 279 mm).

15.3 Employ a control sample whose characteristics have been previously established or to which all results will be compared.

16. Calibration

16.1 *Spectrodensitometer*—Calibrate the densitometer in accordance with the manufacturer's recommendations.

16.2 *Option—L*, a*, b* Instrument*—Calibrate the unit in accordance with the manufacturer's recommendations.

17. Procedure

17.1 Image the samples and control with a printer to provide a series of images. Imaging may be achieved with a facsimile thermal printer employing a suitable test target (see Test Method F 1320) or by units described in Test Methods F 1405 or F 1444. If possible, have some images be a solid block at least ¼ by ¼ in. (0.6 by 0.6 cm). Image all samples in the same manner.

17.2 Using the reflectance spectrodensitometer, measure the background and image densities of the samples and control after full density development. A minimum of five measurements shall be taken and averaged to improve accuracy. Measurements shall be made in the same relative location on each sample.

17.3 Option: Using the L*, a*, b* instrument, measure the background and image colors of the samples and the control. A minimum of five measurements shall be taken and averaged to improve accuracy. Measurements shall be made in the same relative location on each sample.

17.4 Place the samples in a 5000-lx light chamber for 100 h. Caution must be taken to ensure that the samples are maintained at constant temperature below 30°C to avoid any potential results from heat aging.

NOTE 1—A longer exposure time can be employed depending on the stability requirements of the application.

17.5 After exposure, remeasure the image and background densities, or color (L*, a*, b*) of each in both the samples and control using the same areas as used in 17.2 and 17.3.

17.6 Compare the results for the samples and control with measurements of the background and image obtained prior to exposure. Most L*, a*, b* instruments will provide data on the change in color (12.1.1).

18. Report

18.1 Report the following information:

18.1.1 Dates that the test was conducted.

18.1.2 Sample and control identification.

18.1.3 Information regarding the equipment employed in the tests.

18.1.4 Method used to image the samples.

18.1.5 Initial and final results of the individual tests including the number of measurements made on each sample; the high, low, and average readings; and relative results compared to the control.

18.1.6 Any additional information regarding the test, the samples, or the test conditions.

HEAT AND HUMIDITY STABILITY

19. Summary of Practice

19.1 This practice employs samples that have been imaged and unimaged. Samples and control are imaged using an appropriate printer. Background and image density of each sample are measured and recorded. Optionally, L*, a*, b* values can be measured for the background using a spectrodensitometer. Part of the samples are placed in a 140 ± 4°F (60 ± 2°C) laboratory oven for 24 h. The other samples are placed in a temperature humidity chamber maintained at 104 ± 4°F (40 ± 2°C) and 90 ± 5 % relative humidity for 14 days. At the end of the exposure time the background, image densities, and L*, a*, b* of the samples are reread and compared to the control. The L*, a*, b* measurements will indicate changes in image color.

19.1.1 Most units which measure L*, a*, b* can provide the difference values in the form of ΔL*, Δa*, Δb* and ΔE. Refer to the technical literature on color measurement for the interpretation of these results.

19.2 This practice can be used for the evaluation of direct imaging coatings on paper, film, or other substrate. The method

of imaging should be with the type of imaging unit for which the product has been designed.

20. Significance and Use

20.1 This practice enables comparison of samples with a control under accelerated aging conditions to determine the stability of the background, imaged and unimaged product to heat and humidity.

21. Apparatus

21.1 *Spectrodensitometer*, with an aperture smaller than the image area to be measured and meeting the requirements of ANSI/CGATS 4-1993, operating in visual density mode.

21.2 *Laboratory Oven*, operating at 140 ± 4°F (60 ± 2°C).

21.3 *Temperature Humidity Chamber*, operating at 104 ± 4°F (40 ± 2°C) and 90 ± 5 % relative humidity. Unit requirements to be established.

22. Test Specimens

22.1 The test specimens and control shall be sheets or taken from a roll of direct thermal paper of known specifications.

22.2 Cut samples into individual sheets approximately 8½ by 11 in. (216 by 279 mm). A minimum of four sheets of each sample is required for testing.

22.3 Employ a control sample whose characteristics have been previously established or to which all results will be compared.

23. Calibration

23.1 *Spectrodensitometer*—Calibrate the densitometer in accordance with the manufacturer's recommendations.

24. Procedure

24.1 Image the samples and control with a printer to provide a series of images. Imaging can be achieved with a facsimile thermal printer employing a suitable test target (see Test Method F 1320) or by units described in Test Methods F 1405 or F 1444. If possible, have some images be a solid block at least ¼ by ¼ in. (0.6 by 0.6 cm). Image all samples in the same manner.

24.2 Using the reflectance spectrodensitometer, measure the image density of the samples and control after full density development. A minimum of five measurements should be taken and averaged to improve accuracy. Measurements should be made in the same relative location on each sample.

24.3 *Option*—Using the L*, a*, b* instrument, measure the background color of the samples and the control. A minimum of five measurements should be taken and averaged to improve accuracy. Measurements should be made in the same relative location on each sample.

24.4 Place at least one sheet of the samples (imaged and unimaged) in a laboratory oven maintained at 140 ± 4°F (60± 2°C) for 24 h. Spread out the samples or hang them to avoid touching. Allow the samples to equilibrate in standard environment before re-reading.

NOTE 2—A longer exposure time can be employed depending on the stability requirements of the application.

24.5 Place the remainder of the samples (minimum three sheets of each) in a temperature humidity chamber maintained at 104 ± 4°F (40 ± 2°C) and 90 ± 5 % relative humidity for 14 days. Spread out the samples or hang them to avoid touching. Remove some of the samples after 1, 7, and 14 days. Record the operating conditions.

24.6 Condition the samples at room temperature and humidity. Remeasure the image density and background for each sample using the same areas as used in 24.2 and 24.3.

24.7 Image the unimaged test samples using the same printing device and procedure used in 24.1. Measure the image density and background for each sample in the same manner as in 24.2 and 24.3.

24.8 Record and compare the results for background color, and image density for all samples. Most L*, a*, b* units will permit the measurement of the change in color (20.1.1).

25. Report

25.1 Report the following information:

25.1.1 Dates that the test was conducted.

25.1.2 Sample and control identification.

25.1.3 Information regarding the equipment and materials employed in the tests.

25.1.4 Method used to image the samples.

25.1.5 Results of the individual tests, including the initial and final image density and background readings, including the high and low values, the average, and relative results of each sample compared to the control.

25.1.6 Any additional information regarding the test, the samples, or the test conditions.

26. Keywords

26.1 copy products facsimile printer; direct thermal paper product; heat and humidity stability; light stability; solvent resistance; thermal imaging