TECHNICAL REPORT

ISO/TR 18930

First edition
2001-06-01

Imaging materials — Protocols for outdoor weathering experiments

Matériaux pour l'image — Protocoles pour expériences de temps en extérieur

Reference number
ISO/TR 18930:2001(E)

PDF disclaimer

This PDF file may contain embedded typefaces. In accordance with Adobe's licensing policy, this file may be printed or viewed but shall not be edited unless the typefaces which are embedded are licensed to and installed on the computer performing the editing. In downloading this file, parties accept therein the responsibility of not infringing Adobe's licensing policy. The ISO Central Secretariat accepts no liability in this area.

Adobe is a trademark of Adobe Systems Incorporated.

Details of the software products used to create this PDF file can be found in the General Info relative to the file; the PDF-creation parameters were optimized for printing. Every care has been taken to ensure that the file is suitable for use by ISO member bodies. In the unlikely event that a problem relating to it is found, please inform the Central Secretariat at the address given below.

ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.ch
Web www.iso.ch

Printed in Switzerland

Contents

Page

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least seventy-five percent of the member bodies casting a vote.

In exceptional circumstances, when a technical committee has collected data of a different kind from that which is normally published as an International Standard ("state of the art", for example), it may decide by a simple majority vote of its participating members to publish a Technical Report. A Technical Report is entirely informative in nature and does not have to be reviewed until the data it provides are considered to be no longer valid or useful.

Attention is drawn to the possibility that some of the elements of this Technical Report may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO/TR 18930 was prepared by Technical Committee ISO/TC 42, *Photography.*

Introduction

A new application for imaging materials is opening up with the appearance of water and light-resistant ink-jet inks and substrates. This is the outdoor market, with signage being the predominant use.

Materials need to survive typical climate conditions for several years in order to be effective in this market. To test this requirement, it is common to send materials to an outdoor weathering site or to simulate outdoor conditions with an appropriate "weatherometer." Outdoor testing sites, known to this committee at the time of publication, are listed in annex A.

Recommendations in this Technical Report are based on the outdoor weathering experiences of the members of the committee that prepared this document. The report does not attempt to standardize procedures, such as that for washing the specimens. Although this is an important factor and different washing procedures may cause different results, this sort of decision is best left to the experimenter. It should be stressed that procedures such as washing are listed in clause 8 on data reporting and should be reported in significant detail.

Imaging materials — Protocols for outdoor weathering experiments

1 Scope

This Technical Report discusses a recommended way to prepare and submit specimens for outdoor weathering testing in a variety of locations and covers issues of durability to weather, temperature and environmental influences.

This Technical Report describes the pertinent information to request from the testing service, how to instruct the testing service in the appropriate placement of the test specimens, and lists the type of information to report upon completion of a weathering test.

This Technical Report does not discuss what to measure or how to make the measurement as these are best left to the discretion of the experimenter.

2 References

ASTM G 7-97, *Standard Practice for Atmospheric Environmental Exposure Testing of Nonmetallic Materials*[1)]

ASTM G 90-98, *Standard Practice for Performing Accelerated Outdoor Weathering of Nonmetallic Materials Using Concentrated Natural Sunlight*[1)]

ISO 291:1997, *Plastics — Standard atmospheres for conditioning and testing*[2)]

ISO 10977:1993, *Photography — Processed photographic colour films and paper prints — Methods for measuring image stability*[2)]

3 Terms and definitions

For the purposes of this Technical Report, the following terms and definitions apply.

3.1
encapsulation
sealing of all edges of a specimen that has been laminated on both front and back surfaces

NOTE This process is usually done by laminating with sheets that are larger in dimension than the specimen and then sealing at the overlaps.

1) Available from the American Society for Testing and Materials, 100 Barr Harbor Drive, W. Conshohocken, PA 19428-2959, USA.

2) For electronic copies of these standards, visit the ANSI Electronic Standards Store (ESS) at www.ansi.org. For printed versions of all these standards, contact Global Engineering Documents, 15 Inverness Way East, Englewood, CO 80112-5704, USA. Tel: (800) 854-7179.

3.2
laminate
layer of material that goes over the top or bottom of a specimen

NOTE The material is usually water resistant in order to provide physical and/or ultraviolet (UV) light protection of the specimen during a weathering test.

3.3
outdoor weathering
actual placement of specimens outdoors in specific locations, often those of climatic extremes

NOTE This is differentiated from simulated weathering where instruments (weatherometers) are used to obtain very controlled conditions that simulate, to some degree, outdoor weathering results. Use of such instruments is described in ISO 10977.

3.4
reciprocity law failure
non-equivalence in weathering results between a long exposure/low-intensity experiment and its counterpart with an equivalent intensity-time product where exposure time is short and intensity is high

3.5
total UV radiation
radiation in the range from 295 nm to 385 nm integrated over the duration of a test

NOTE This quantity is usually fairly consistent from year to year in a given location and is usually expressed as MJ/m^2.

4 Specimen preparation

4.1 General

Perhaps the most important requirement is that the material be readily adaptable to the outdoor environment. The semi-tropics are hot and humid. The high desert is hot and dry with a very high ultraviolet radiation content. Other outdoor environments can be high in environmental pollutants, including ozone, sulfur dioxide, hydrogen sulfide, hydrogen peroxide, nitrogen oxides, particulates, or salt spray (oceanside locations).

4.2 Size and mounting of specimens

Several sites have pre-built racks in which to install the specimens. It should be determined if the specimens need to be mounted on an additional substrate in order to fit rack size requirements. For example, one testing service uses racks in which one dimension of the specimen must be 30,5 cm.

When fastening images to plastic, care should be given to the nature of the fasteners. Metal staples may hold up well in the high desert, but they rust very quickly in semi-tropical locations and are thus not suitable in this environment. Alternatives would be sewing the specimens to the plastic or fastening with plastic button fasteners.

If the method of fastening is the same as that in actual use, it might be important to note failures such as cracks and tears in the material around the fastening points.

4.3 Number of specimens

The number of specimens for each exposure stage should be determined on the basis of the purpose of the weathering tests and the consistency of the test results in physical measurements.

Because of the variability inherent in any outdoor test, use of duplicate specimens is strongly suggested. Repositioning of specimens during an exposure test will always improve variability.

If more than one specimen is placed on a panel, the panel should be periodically rotated to randomize the effects of water that collects at the bottom of the panel.

4.4 Virgin specimens

In order to compare exposed specimens to unexposed specimens, virgin specimens should be prepared at the same time and should be preserved in the standard condition prescribed by ISO 291.

4.5 Identification of specimens

Identification exposed in the actual specimen may fade during weathering. Therefore, it is necessary to identify specimens in such a way that the identification will not become unusable when the specimens fade.

Certain marking inks can spread, especially under very humid conditions, and, in time, become unreadable. Another problem with inks is that they can bleed through the back of the specimen and possibly affect the image.

Typing information onto gummed labels and placing these labels on the back of the specimens is acceptable for opaque materials. Solvent migration may cause specimen damage. With label applications, care should be taken with regard to solvents found in the adhesive.

Codes punched into the actual specimen may be necessary for translucent or transparent materials, since a label on the back surface would change the pattern of light transmission through the specimen.

5 Simulation of use conditions

5.1 General

Considerable thought should be given to the way in which the specimens will actually be used in the trade. Of particular importance are the backing materials.

5.2 Billboards

If an imaging material is to be used as a billboard, it might be advisable to have the specimen mounted perpendicular to the ground and backed by plywood. However, 90° mounting has the disadvantage that it is very sensitive to the angle of the sun. A winter test (with the sun more nearly perpendicular to the specimen) might given different results than a summer test when the sun will be higher in the sky. However, when this variation in sun angle is part of the actual use of the product, this is the proper test to run, especially over a long duration.

5.3 Other applications

For applications other than billboard use, care should also be taken to choose the appropriate backing material. The darker the backing material, the warmer the specimens will be during daylight hours. For most non-billboard uses, clear polyester sheeting is a suitable backing material. In no case should the backing interfere with specimen weathering.

5.4 Laminates and encapsulation

Another important consideration is the type of laminates and method of application. If the material is on a paper base, it probably needs to be laminated for protection of the paper support and any water-soluble coated materials. Also, gelatin-containing materials do not hold up well without lamination.

A product intended for outdoor use without lamination should be tested without lamination.

Different fading results can occur between simple lamination, where the edges of the material are not sealed, and encapsulation, where a tight seal is effected all around the specimen. For encapsulated specimens, staple holes, etc., should not pierce the capsule, but should be made outside the sealed edges. On some products, a single staple hole can have the same effect on an encapsulated specimen as cutting off the overlapping laminate and thus destroying the capsule.

Care should be taken that hot laminates do not destroy the integrity of the specimen.

5.5 Environmental factors

When specimens are set out in the weather, another component for consideration is environmental contaminates, both polluting gases and materials left by fauna and flora. Specimens weathering in the high desert have been observed with tumbleweed seeds embedded in the emulsion. In climates near a large body of water, an unfortunate side effect may be seagull droppings. Unless resistance to these environmental effects is desired to be measured, these materials can be removed from the specimens by request, thus assuring a more controlled test.

Polluting gasses can be examined or eliminated based on the weathering-site location. Miami and Arizona locations in the USA and Choshi and Miyakojima locations in Japan are fairly pristine testing environments, while Chicago and Tokyo are more useful for assessing the effects of urban pollutants.

One additional factor can be forest or peat fires. Such fires have taken place over the last few years in several of the sub-tropical sites and can turn a relatively pristine environment into a polluted one overnight. This may affect test results and specimens might have to be removed or the test might have to be restarted.

5.6 Testing time consideration

Care should be given to observe the time of year in which the specimens were initially submitted for weathering. Some materials originally weathered in the summer can give different results than those originally weathered in the winter for the same length of time.

6 Accelerated weathering versus actual weathering

6.1 Outdoor exposure

Most weathering testing is real-time weathering in which the specimens are placed at a fixed angle to the ground and specimens remain that way for fixed periods of time or until a certain integrated light intensity has struck them.

There are other ways of treating specimens in a more accelerated fashion, e.g., use of movable racks that track the path of the sun so the specimens always remain perpendicular, or use of Fresnel concentration mirrors that impart the optimal angle at more than one sun intensity. A description of this practice is provided in ASTM G 90. These tests provide results more quickly than real-time weathering, but may be invalid due to reciprocity law failure which is known to happen with gelatin binder systems and may happen in other systems.

6.2 Weatherometers

Commercial xenon-arc-based weatherometers are available with controllable temperature, relative humidity, moisture (rain) and day/night cycling. They approximate outdoor exposure with the added advantage of greater consistency from run to run. However, they do not take climatological fluctuations or environmental pollutants into account.

7 Data to request from the testing service

7.1 Measurements and observations

In addition to receiving weathered specimens back for observation, consideration should be given to having the testing service make periodic measurements of optical density change and physical change or gloss change if such inputs are desired. Sometimes, it is easier to have the testing service make these measurements at specified intervals rather than shipping the specimens back to the originating laboratory to perform this work. In this case, the exposed specimens should be preserved in the standard condition prescribed in ISO 291.

7.2 Endpoint

A rather well defined endpoint should be given to the testing service. It can either be a duration requirement, a specimen failure point, or the shorter of these two alternatives.

Duration is usually measured as a percent of a year's worth of the total UV radiation that falls upon a detector placed at a 45° angle to the horizon. Even for billboard work where the specimens are perpendicular to the ground, this endpoint is useful. By using this endpoint, instead of elapsed calendar time, better reproducibility can be obtained for tests conducted during different seasons of the year, as this technique evens out irradiation differences.

Failure criteria might be the appearance of cracks, loss of 30 % of the density of a particular dye, loss of adhesion of the base to the emulsion, etc. The specific failure level depends upon the nature and the use requirements of the material.

7.3 Environmental data

Other seasonal differences, such as temperature and relative humidity (RH), will occur when tests are run at different times of the year. The testing service should provide information on the total UV at 45° for the specimens tested, as well as a tabulation on a day-to-day basis of the temperature and RH highs, lows and means. Often, this information is published in a newsletter which is routinely sent to customers of the testing service.

Information about the levels of common pollutants may also be available. If not available from the testing service, this information might be found on meteorological or climatological sites on the Internet.

8 Reporting of data

If available, the following test information should be reported:

— location at which the exposure test was conducted;

— direction at which the exposure test was oriented;

— angle at which the exposure test was conducted;

— whether the specimen was backed or unbacked and, if backed, by what material;

— exposure time required to reach the endpoint and the method of determining the endpoint, e.g., a change of 10 units in minimum density by CIELAB analysis;

— amount of energy (in total UV and total irradiation) reaching the specimens at the endpoint;

— approximate time of the year for the test, along with the percent of total sunshine;

— temperature range during the weathering test and the amount (cm) of rainfall, including the number of hours of wetness;

— information on the level of pollutants and particulate matter;

— specimen lamination or encapsulation, plus type and thickness of the laminate;

— washing parameters, if used, including frequency, wash solution, method of washing and method of drying;

— various specimen parameters, including type of colourants, test target, age of specimen before irradiation, age of specimen before lamination, and number of replicates.

For an example of a typical report, see page 6 of ASTM G 7-97.