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# Plastics — Method of exposure to electrodeless plasma radiation sources



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# Foreword

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# Plastics — Method of exposure to electrodeless plasma radiation sources

## 1 Scope

This document specifies methods for an accelerated photo-degradation test using an electrodeless plasma radiation source. This method is suitable for evaluating or predicting degradation and failure caused by the photo-degradation of a material and a product within a short-term period.

Specimen preparation and evaluation of the results are covered in other International Standards for specific materials.

## 2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 4582, *Plastics — Determination of changes in colour and variations in properties after exposure to glass-filtered solar radiation, natural weathering or laboratory radiation sources*



ISO 4892-1, *Plastics — Methods of exposure to laboratory light sources — Part 1: General guidance*



ISO 9370, *Plastics — Instrumental determination of radiant exposure in weathering tests — General guidance and basic test method*



## 3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 4892-1 and the following apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

**3.1**
**electrodeless plasma lamp**
gas discharge lamp that produces radiation by radio frequency or electromagnetic field through the gas in a glass bulb without using metal electrodes

## 4 Principle

Electrodeless plasma lamps are used to simulate the UV part of global solar radiation.

Specimens can be exposed to various levels of radiation and heat under controlled environmental conditions.

The procedure(s) may include measurement of the irradiance and the radiant exposure in the plane of the specimen.

It is recommended that a similar material of known performance (a control) be exposed simultaneously with the test specimens to provide a standard for comparative purposes.

Inter-comparison of results obtained from specimens exposed in different apparatuses should not be made unless an appropriate statistical relationship has been established between the apparatuses for the particular material exposed.

# 5 Apparatus

## 5.1 Laboratory radiation source

### 5.1.1 General

Electrodeless plasma lamps emit high-intensity UV and low-intensity visible radiation. The irradiance intensity of these lamps can be adjusted to meet test conditions.

The UV spectrum of electrodeless plasma lamps shall meet the conditions listed in Table 1.

### 5.1.2 Spectral irradiance of electrodeless plasma lamps

Table 1 shows the values of the relative spectral irradiance within the UV region of electrodeless plasma lamps with 300 nm cut-on filter that simulate global solar radiation (CIE 241, CIE-H1[1]).

**Table 1 — Relative UV spectral irradiance of electrodeless plasma lamps with 300nm cut-on filter applied**

| Spectral passband wavelength<br>nm | Minimum<br>% | CIE 241, CIE-H1<br>% | Maximum<br>% |
|---|---|---|---|
| λ < 290 | – | 0 | 0,04 |
| 290 ≤ λ ≤ 320 | 3,2 | 5,9 | 8,0 |
| 320 < λ ≤ 360 | 31,3 | 40,4 | 35,5 |
| 360 < λ ≤ 400 | 54,7 | 53,8 | 65,3 |
| For the solar spectrum given in CIE 241, CIE-H1 UV irradiance (290 nm to 400 nm) is 11 %, and visible light irradiance (400 nm to 800 nm) is 89 %, where the units are the percentage of the total irradiance at 290 nm to 800 nm. | | | |



An example of the spectral irradiance of an electrodeless plasma lamp compared to global solar radiation is shown in Annex A, Figure A.1.

### 5.1.3 Irradiance uniformity

Exposure devices shall be designed such that the irradiance at any location in the area used for specimen exposures is at least 90 % of the maximum irradiance measured in this area. If these conditions are not met, refer to ISO 4892-1 to periodically adjust the test specimen position.

NOTE For some materials with high reflectivity, or with high sensitivity to irradiance and temperature, periodic repositioning of specimens is recommended to ensure uniformity of exposures, even when the irradiance uniformity in the exposure area is within the limits so that repositioning is not required.

## 5.2 Test chamber

The design of the exposure chamber can vary, but it shall be constructed from inert material and provide uniform irradiance in accordance with 5.1.3, with means for controlling the temperature.

## 5.3 Radiometer

When a radiometer is used, it shall conform with the requirements in ISO 4892-1 and ISO 9370.

### 5.4 Black-panel thermometer

The black-panel thermometer used shall conform with the requirements for these devices given in ISO 4892-1.

NOTE Black standard thermometer (BST) can be used upon agreement between the parties involved.

### 5.5 Specimen holders

Specimen holders may be in the form of an open frame, leaving the backs of the specimens exposed, or they may provide the specimens with a solid backing. They shall be made from inert materials that will not affect the results of the exposure, for example, non-oxidizing alloys of aluminium or stainless steel. Brass, steel or copper shall not be used in the vicinity of the test specimens. The backing can affect the results, as can any space between the backing and the test specimen, particularly with transparent specimens, and shall be agreed on between the interested parties.

## 6 Test specimens

Specimens shall be in accordance with ISO 4892-1.

## 7 Exposure conditions

### 7.1 Radiation



Unless otherwise specified, control the UV irradiance at the levels of (300 ± 15) W/m$^2$ (broadband 300 nm to 400 nm). Other irradiance levels may be used when agreed upon by all interested parties. The irradiance and wavelength passband in which it was measured shall be included in the test report. The relative spectral irradiance of the electrodeless plasma lamp shall be according to Table 1.



### 7.2 Temperature

Unless otherwise specified, control the black-panel temperature at (70 ± 3) °C.

NOTE 1 The black panel temperature can be adjusted upon agreement by the parties involved.

NOTE 2 BST can be used upon agreement between the parties involved.

## 8 Procedure

### 8.1 General

It is recommended that at least three test specimens of each material evaluated be exposed in each run to allow statistical evaluation of the results.

### 8.2 Mounting the test specimens

Attach the specimens to the specimen holders in the equipment in such a manner that the specimens are not subject to any applied mechanical stress. Identify each test specimen by suitable indelible marking, avoiding areas to be used for subsequent testing. As a check, a plan of the test-specimen positions may be made.

If desired, in the case of specimens used to determine change in colour and appearance, a portion of each test specimen may be shielded by an opaque cover throughout the exposure. This gives an unexposed area adjacent to the exposed area for comparison. This is useful for checking the progress of the exposure, but the data reported shall always be based on a comparison with file specimens stored in the dark.

### 8.3 Exposure

Before placing the specimens in the test chamber, ensure that the apparatus is operating under the desired conditions (see Clause 7). Maintain these conditions throughout the exposure, minimizing any interruptions to service the apparatus and to inspect the specimens.

Expose the test specimens and, if used, the irradiance-measuring instrument for the specified period. Repositioning of the specimens during exposure is desirable and can be necessary. Follow the guidance in ISO 4892-1.

If it is necessary to remove a test specimen for periodic inspection, take care not to touch the exposed surface or alter it in any way. After inspection, return the specimen to its holder or to its place in the test chamber with its exposed surface oriented in the same direction as before.

### 8.4 Measurement of radiant exposure

If used, mount and calibrate the radiometer so that it measures the irradiance at the exposed surface of the test specimen.

When radiant exposures are used, express the exposure interval in terms of incident radiant energy per unit area of the exposure plane, in joules per square metre ($J/m^2$), in the wavelength band from 300 nm to 400 nm, or in joules per square metre per nanometre [$J/(m^2 \cdot nm)$] at the wavelength selected (e.g. 340 nm).

### 8.5 Determination of changes in properties after exposure



These shall be determined as specified in ISO 4582 in insofar as possible.

## 9 Test report



The test report shall be prepared according to ISO 4892-1. Additionally, it shall clearly state with which spectral irradiance of the electrodeless plasma lamps the test was performed, i.e. with 300 nm cut-on filter applied according to Table 1 (see 5.1.2).

# Annex A
(informative)

# Spectral irradiance of electrodeless plasma lamps

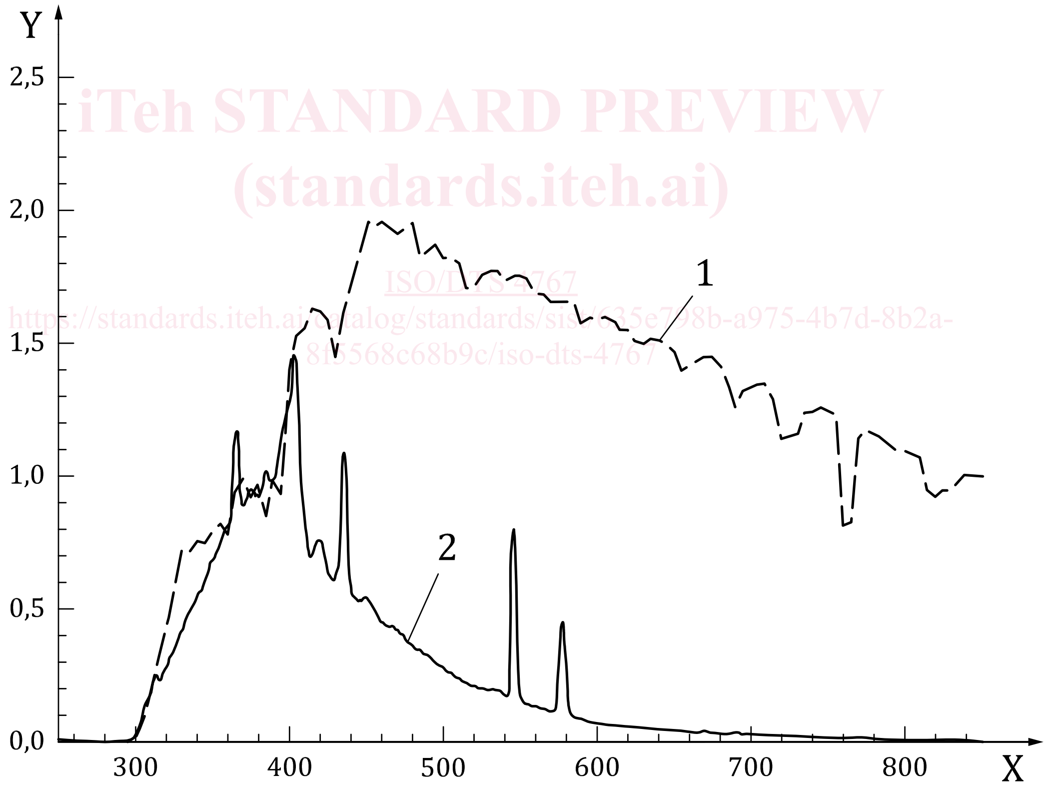
## A.1 General

A variety of electrodeless plasma lamps can be used for the purposes of exposure.

## A.2 Spectral irradiance data

Figure A.1 shows the relative spectral irradiance from an electrodeless plasma lamp compared to CIE 241, CIE-H1 daylight. The UV radiation (290 nm to 400 nm) is 43,5 %, and visible irradiance (400 nm to 800 nm) is 56,5 % for 300 nm cut-on filter applied. The units are the percentage of the total irradiance at 290 nm to 800 nm.






**Key**

X wavelength λ (nm)

Y spectral irradiance (W/m²·nm)

1 CIE 241, CIE-H1 global solar radiation

2 normalized electrodeless plasma lamp spectral irradiance with 300 nm cut-on filter applied

**Figure A.1 — Spectral irradiance of electrodeless plasma lamps compared to CIE 241, CIE-H1 global solar radiation**

# Bibliography

[1] CIE 241, *Recommended reference solar spectra for industrial applications*