Designation: D5272 – 08 (Reapproved 2021)

Standard Practice for Outdoor Exposure Testing of Photodegradable Plastics[1]

This standard is issued under the fixed designation D5272; 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 This practice defines test conditions applicable when Practices D1435 and G7/G7M are employed for the outdoor exposure testing of photodegradable plastics.

1.2 *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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

NOTE 1—There is no known ISO equivalent to this standard.

1.3 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D882 Test Method for Tensile Properties of Thin Plastic Sheeting
D883 Terminology Relating to Plastics
D1435 Practice for Outdoor Weathering of Plastics
D3593 Test Method for Molecular Weight Averages/ Distribution of Certain Polymers by Liquid Size-Exclusion Chromatography (Gel Permeation Chromatography GPC) Using Universal Calibration (Withdrawn 1993)[3]
D3826 Practice for Determining Degradation End Point in Degradable Polyethylene and Polypropylene Using a Tensile Test
E772 Terminology of Solar Energy Conversion
G7/G7M Practice for Natural Weathering of Materials
G169 Guide for Application of Basic Statistical Methods to Weathering Tests
G183 Practice for Field Use of Pyranometers, Pyrheliometers and UV Radiometers

3. Terminology

3.1 The terminology given in Terminology E772 and Terminology D883 is applicable to this practice.

4. Significance and Use

4.1 When discarded as litter, articles made using photodegradable plastics are subject to attack by daylight (particularly solar-ultraviolet radiation), oxygen, heat, and water. The 5° exposure angle used in this practice represents typical conditions for degradation experienced by litter.

4.2 This practice requires characterization of the duration of exposure in terms of solar-ultraviolet radiation. Solar-ultraviolet radiation varies considerably as a function of location and time of year. This can cause dramatic differences in the time required to produce a specified level of degradation in a polymer. Daro[4] has shown that when the same lot of polyethylene containing an iron-salt prodegradant is exposed at various times of the year in a single location, the time required to produce an average of two chain scissions per molecule varied by over 130 %. Daro, and Zerlaut and Anderson[5] have shown that this variability can be significantly reduced when total solar or solar-ultraviolet radiation, or both, is used to characterize the exposure increments.

4.3 In addition to variations in level of daylight and solar-ultraviolet radiation, there are significant differences in temperature, and moisture stresses between different locations, and between different years, or periods within a single year, at a single location. Because of this variability, results from this test cannot be used to predict the absolute rate at which photodegradable plastics degrade. Results from this test can be used to compare relative rates of degradation for materials exposed at the same time in the same location. Results from

[1] This practice is under the jurisdiction of ASTM Committee D20 on Plastics and is the direct responsibility of Subcommittee D20.50 on Durability of Plastics.

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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] The last approved version of this historical standard is referenced on www.astm.org.

[4] Daro, A., et al, "Degradation of Polymer Blends IV, Natural Weathering of Low Density and Linear Low Density Polyethylene," *European Polymer Journal*, Vol 26, No. 1, 1990, pp. 47–52.

[5] Zerlaut, G. L., and Anderson, T. A., "Ultraviolet Radiation as a Timing Technique for Outdoor Weathering of Materials," Society of Automotive Engineers, *SAE Technical Paper Number 850348* , 1985.

multiple exposures of a common lot of material (during different seasons over several years) at different sites can be used to compare the relative rates at which a particular photodegradable plastic will degrade in each location.

NOTE 2—An inherent limitation in solar-radiation measurements is that they do not reflect the effects of variations in temperature and moisture exposure, which often can be as important as solar radiation. The same solar-ultraviolet radiation increment will not necessarily give the same changes in properties of the test specimen in different exposure sites. Results from this practice must be regarded as giving only a general indication of the degree of degradability and should always be considered in terms of characteristics of the exposure site as well.

4.4 Where measurement of total solar-ultraviolet radiation is not possible, exposure duration can be determined by the number of days, weeks, or months exposed. When this practice is used, a reference material whose degradation properties have been well established must be exposed at the same time as the other materials being tested. The reference material used must be agreed upon by all interested parties. The time to produce a specified level of degradation for each material in this simultaneous exposure is then compared. It is also a good practice to use reference materials when exposure length is determined by total solar or solar UV radiant exposure.

NOTE 3—A reference material can be a single lot of material which has shown consistent results after a number of exposures. It is not necessary that the composition or properties of the reference material be characterized and certified by a recognized standards agency or group.

5. Apparatus

5.1 Use exposure racks constructed in accordance with the requirements of Practice G7/G7M. Unless otherwise specified, position the exposure racks so that specimens face the equator and so that the exposed surfaces are 5° from the horizontal. If other exposure rack orientations are used, they must be reported.

5.2 Use one of the following rack constructions for exposing photodegradable plastic specimens:

5.2.1 *Exposure Rack A*—Positionable mounting bars used for attaching specimens shall be arrayed over a regular mesh expanded-metal (aluminum or stainless steel) sheet backing. Use 16–18 gage metal with approximately 0.5-in. openings. It is recommended that the surface area of the expanded metal be 60 to 70 % open. Use a noncorroding material for the mounting bars. 6061T6 aluminum or untreated wood are typical materials used for the mounting bars. Fig. 1 is a top view showing typical rack construction.

5.2.2 *Exposure Rack B*—Unpainted exterior-grade plywood forms the rack surface to which specimens are directly attached. Replace the plywood when there is any evidence of delamination or fiber separation which could produce sharp edges and damage exposed specimens. Medium-density overlay (MDO) or high-density overlay (HDO) plywood are satisfactory substrates and will require less frequent replacement than plywood with no overlay.

NOTE 4—There is less air circulation around the specimens when Rack B exposures are used. Degradation rates from exposures using Rack B will be somewhat faster than those using Rack A because specimen temperatures will be higher. Comparisons between materials should only be made with exposures conducted at the same time and using the same rack type.

5.3 *Solar Radiometers:*

5.3.1 *Ultraviolet Radiometer*—Unless otherwise specified, use a total UV radiometer that measures ultraviolet radiation from 295 to 385 mm. Operate the radiometer in accordance with Practice G183. Narrow band radiometers (for example, with 20 nm bandpass) can also be used if agreed upon by all interested parties. Operate narrow band radiometers in accordance with Practice G183.

NOTE 5—The use of narrow band filter UV radiometers having selective spectral sensitivity may not be sensitive to all variations of solar-ultraviolet radiation. Monitoring at a narrow band (for example, 20 nm) may not relate to the total photodegradation of the plastic material, which is a result of a complex interaction of many factors, including sensitivity across a broad wavelength region.

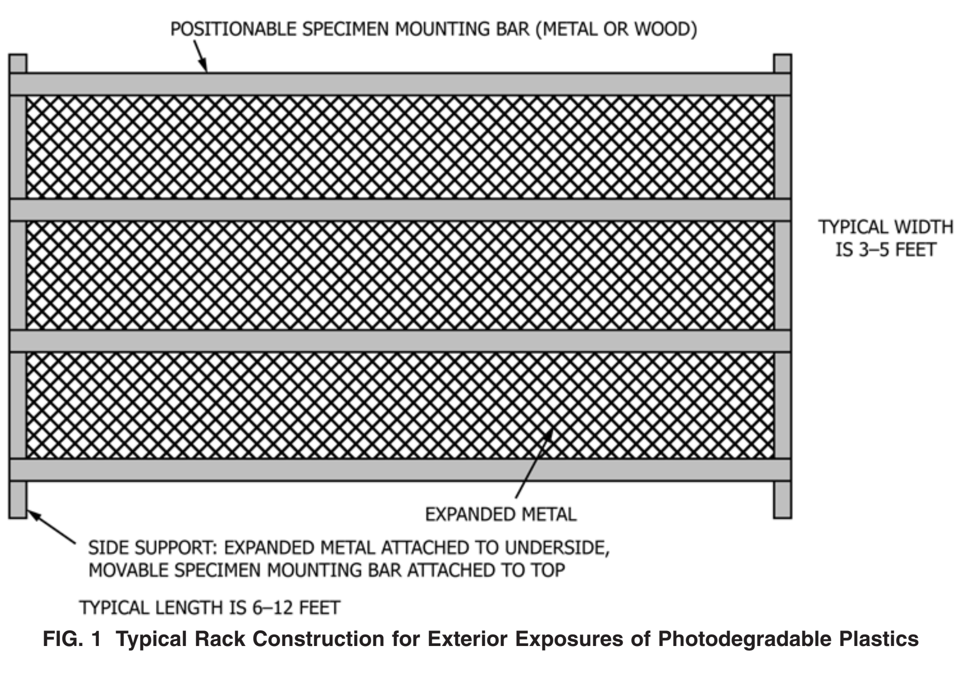

FIG. 1 Typical Rack Construction for Exterior Exposures of Photodegradable Plastics