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Define, classify, marking and degradability requirement of degradable plastic

降解塑料的定义、分类、标志和

降解性能要求

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Foreword

This Standard shall be under the jurisdiction of National Technical Committee on Plastic Products of Standardization Administration of China.

Main drafting organization of this Standard: Light Industry Institute of Plastics Processing Applications

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This Standard is issued for the first time.

Define, classify, marking and degradability requirement of degradable plastic

1 Scope

This Standard specifies terms and definitions, classification and marks, degradability requirements, and test methods of degradable plastic.

This Standard applies to the following degradable material:

- Natural and/or synthetic polymers, copolymers or their mixtures;
- Plastic material that contains additives such as plasticizers, pigments, or other compounds;
- Water-soluble polymers;
- Products processed by various types of degradable plastic materials.

2 Normative references

The provisions in following documents become the provisions of this Standard through reference in this Standard. For dated references, the subsequent amendments (excluding corrigendum) or revisions do not apply to this Standard, however, parties who reach an agreement based on this Standard are encouraged to study if the latest versions of these documents are applicable. For undated references, the latest edition of the referenced document applies.

GB/T 1040 Plastics - Determination of tensile properties

GB/T 1844.2 Plastic - Symbols and abbreviated - Part 2: Fillers and reinforcing materials (GB/T 1844.2-1995, neq ISO 1043-2:1987)

GB/T 1844.3 Plastics - Symbols and abbreviated terms - Part 3: Plasticizers (GB/T 1844.3-1995, neq ISO 1043-3:1987)

GB/T 7141 Plastics - Methods of heat aging

GB/T 13022 Plastics - Determination of tensile properties of films (GB/T 13022-1991, neq ISO 1184:1983)

GB/T 15596 Plastics - Determination of changes in color and variations in

properties after exposure to daylight under glass, natural weathering or laboratory light sources (GB/T 15596-1995, eqv ISO 4582:1980)

GB/T 17603 Method for outdoor exposure testing of photodegradable plastics

GB/T 19276.1 Determination of the ultimate aerobic biodegradability of plastic materials in an aqueous medium - Method by measuring the oxygen demand in a closed respirometer (GB/T 19276.1-2003, ISO 14851:1999, IDT)

GB/T 19276.2 Determination of the ultimate aerobic biodegradability of plastic materials in an aqueous medium - Method by analysis of evolved carbon dioxide (GB/T 19276.2-2003, ISO 14852:1999, IDT)

GB/T 19277 Determination of the ultimate aerobic biodegradability of plastic materials under controlled composting conditions - Method by analysis of evolved carbon dioxide (GB/T 19277-2003, ISO 14855:1999, IDT)

GB/T 19811 Determination of the degree of disintegration of plastic materials under defined composting conditions in a pilot-scale test (GB/T 19811-2005, ISO 16929:2002, IDT)

CJ/T 96 General detecting methods for the chemical characteristic of domestic refuse

CJ/T 97 Municipal domestic refuse - Determination of total chromium - Diphenyl carbazide color method

CJ/T 98 Municipal domestic refuse - Determination of mercury - Cold atomic absorption spectrophotometric method

CJ/T 99 Municipal domestic refuse - Determination of pH - Glass electrode method

CJ/T 100 Municipal domestic refuse - Determination of cadmium - Atomic absorption spectrophotometric method

CJ/T 101 Municipal domestic refuse - Determination of lead - Atomic absorption spectrophotometric method

CJ/T 102 Municipal domestic refuse - Determination of arsenic - Spectrophotometric method with silver diethyldithiocarbamate

CJ/T 103 Municipal domestic refuse - Determination of total nitrogen - Semi - Micro Kjeldahl method

CJ/T 104 Municipal domestic refuse - Determination of total phosphorus -

Ammonium metamolybdate spectrophotometric method

CJ/T 105 Municipal domestic refuse - Determination of total potassium - Flame spectrophotometric method

CJ/T 3059 Technical evaluating targets on municipal solid waste composting plant

ISO 3310-2:1999 Test sieves - Technical requirements and testing - Part 2: Test sieves of perforated metal plate

ISO 11465:1993 Soil quality - Determination of dry matter and water content on a mass basis - Gravimetric method

ISO 14853:2005 Plastics - Determination of the ultimate anaerobic biodegradation of plastic materials in an aqueous system - Method by measurement of biogas production

ISO 15985:2004 Plastics - Determination of the ultimate anaerobic biodegradation and disintegration under high-solids anaerobic-digestion conditions - Method by analysis of released biogas

ISO 17556:2003 Plastics - Determination of the ultimate aerobic biodegradability in soil by measuring the oxygen demand in a respirometer or the amount of carbon dioxide evolved

ASTM D5510:1994 (2001) Standard Practice for Heat Aging of Oxidatively Degradable Plastics

3 Terms and definitions

The following terms and definitions apply to this Standard.

3.1 Degradation

A process that it is affected by environmental conditions after a certain time and contains one or more steps, through which the structure is changed significantly and loss of properties (such as integrity, relative molecular mass, structural or mechanical strength).

Refer to **deterioration** (3.6).

3.2 Biodegradation

Degradation that is caused by biological activities, especially significant changes in material's chemical structure due to the action of enzymes. The material is gradually digested as nutrient source by microorganisms or some

standard test method); and it is completely biodegradable in the final use of compost. Compost shall comply with relevant quality standards, such as, low heavy metal content, no toxicity, no distinguishable residues.

3.11 Degradable plastic

The plastic that has a significant change in structure, loss of properties (such as integrity, molecular mass, structural or mechanical strength) and/or fracture under specified environmental conditions after a certain time. It shall use standard test method which can reflect property changes to test, and determine its category based on degradation mode and service cycle.

Refer to **Biodegradable plastic** (3.12), **Heat- and/ or oxide- degradable plastic** (3.13), **Photo-degradable plastic sheet** (3.14) and **Compostable plastic** (3.15).

3.12 Biodegradable plastic

The plastic that is degraded by microbial action in nature; and it can be eventually and completely degraded into carbon dioxide (CO₂), methane (CH₄), water (H₂O), mineralized salts with the elements, and new biomass, under soil and/or sand conditions, and/or under specific conditions such as composting or anaerobic digestion conditions, or in aqueous medium.

Refer to **Degradable plastic** (3.11).

3.13 Heat- and/ or oxide- degradable plastic

The plastic degraded by heat and/or oxidation.

Refer to **Degradable plastic** (3.11).

3.14 Photo-degradable plastic sheet

The plastic degraded by natural daylight effect.

Refer to **Degradable plastic** (3.11).

3.15 Compostable plastic

A plastic that can be degradable and disintegrated due to biological reaction process under composting conditions; and it shall be eventually and completely degraded into carbon dioxide (CO₂), methane (CH₄), water (H₂O), mineralized salts with the elements, and new biomass; and heavy metal content, toxicity tests, residual debris of the compost shall comply with the provisions of relevant standards.

Refer to **Degradable plastic** (3.11).

PLA-(GF25+MD15) or PLA-(GF+MD)40

Example 3: Polylactic acid that contains 20% mineral powders (MD) in mass fraction and 15% glass fiber (GF) in mass fraction shall be marked as:

PLA-(MD20+GF15) or PLA-(MD+GF)35

4.3.3.2 Products containing plasticizer

For products containing plasticizer, add hyphen behind polymer acronym. Then mark with "P" and bracketed plasticizer acronym stipulated in GB/T 1844.3.

Example: PCL containing dibutyl phthalate as plasticizer shall be marked as:

PCL-P(DBP)

4.3.3.3 Products containing degradation agent

For products containing degradation agent, add hyphen behind polymer acronym, then mark with "DPA".

Example: PLA that contains 15% mineral powders in mass fraction and 25% glass fiber in mass fraction, added with 5% photosensitizer in mass fraction shall be marked as:

PLA-(GF25+MD15)DPA5 or PLA-(GF+MD)40DPA5

4.4 Marks making

Marks shall be made by molding, printing, embossing, branding or other clear marking methods that cannot be erased.

5 Technical requirements of degradability properties

5.1 Biodegradable plastic

5.1.1 Single polymer

If the material is processed and made by single polymer, then the biodegradation rate shall be $\geq 60\%$; test method is shown in 6.1.

5.1.2 Mixture

If the material is mixture, then the organic constituents shall be $\geq 51\%$, and biodegradation rate shall be $\geq 60\%$. The biodegradation rate of organic constituent of which the constituents are $\geq 1\%$ in material shall be $\geq 60\%$. The test method is shown in 6.1.

accelerated aging box			Water-spray cycle: every spraying time is 18 min±0.5 min; time interval between two spraying is 102 min±0.5 min.
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6.3.2 Retention rate of tensile elongation at break

6.3.2.1 Tensile elongation at break

When sample thickness is less than 1 mm, conduct the test according to the provisions in GB/T 13022. Use type-I sample; take 5 samples. The test results shall be respectively represented by the arithmetic average of determination results. Tensile speed is (50±5) mm/min.

When sample thickness is greater than or equals to 1 mm, conduct the test according to the provisions in GB/T 1040. Use type-II samples; take 5 samples. The test results shall be respectively represented by the arithmetic average of determination results. For degradable plastic with vertical and horizontal directions, respectively take 5 samples at vertical and horizontal directions. The test result shall be respectively represented by the arithmetic average of determination results at vertical and horizontal directions. Tensile speed is (50±5) mm/min.

When sample is molded product, make sampling from the product. When sample is unmolded raw material such as resin, master batch or special material, use the product processed by plastic molding processing method or test spline. If product size is not suitable for direct sampling, it shall process and mold the raw material to be the sample stipulated in the Standard, or the sample size shall be negotiated and agreed by interested parties.

6.3.2.2 Retention rate of tensile elongation at break

Retention rate of tensile elongation at break shall be calculated according to equation (1):

$$L_t = \frac{L_0 - L'}{L_0} \times 100\% \quad \dots\dots\dots (1)$$

Where,

L_t - Retention rate of tensile elongation at break after degradation, %;

L_0 - Tensile elongation at break before degradation, %;

L' - Tensile elongation at break after degradation, %.

6.4.2 Retention rate of tensile elongation at break

When sample thickness is less than 1 mm, conduct the test based on the provisions in GB/T 13022. Use Type-I sample; take 5 samples. The test results shall be respectively represented by the arithmetic average of determination results. For sample with vertical and horizontal directions, respectively take 5 samples at vertical and horizontal directions. The test result shall be respectively represented by the arithmetic average of determination results at vertical and horizontal directions. Tensile speed is (50±5) mm/min.

When sample thickness is greater than or equals to 1 mm, conduct the test according to the provisions in GB/T 1040. Use Type-II sample; take 5 samples. The test results shall be respectively represented by the arithmetic average of determination results. For sample with vertical and horizontal directions, respectively take 5 samples at vertical and horizontal directions. The test result shall be respectively represented by the arithmetic average of determination results at vertical and horizontal directions. Tensile speed is (50±5) mm/min.

When sample is molded product, make sampling from the product. When sample is unmolded raw material such as resin, master batch or special material, use the product processed by plastic molding processing method or test spline. If product size is not suitable for direct sampling, it shall process and mold the raw material to be the sample stipulated in the Standard, or the sample size shall be negotiated and agreed by interested parties.

Retention rate of elongation at break shall be calculated according to equation (3):

$$L_t = \frac{L_0 - L'}{L_0} \times 100\% \quad \dots\dots\dots (3)$$

Where,

L_t - Retention rate of tensile elongation at break after degradation, %;

L_0 - Elongation at break before degradation, %;

L' - Elongation at break after degradation, %.

6.4.3 Mass decrease rate of weight average relative molecular mass

Weight average relative molecular mass before and after photo-degradation of sample by high temperature gel chromatograph, and relative molecular mass separation range limit of gel material for relative molecular mass test shall include relative molecular mass that is less than 5000.

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