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DRAFT

Jamaican Standard

Specification

for

Oxo-biodegradable plastic

Draft Jamaican Standard

BUREAU OF STANDARDS JAMAICA

Comment period: 14 February to 15 April 2021

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Jamaican Standards establish requirements in relation to commodities, processes and practices, but do not purport to include all the necessary provisions of a contract.

The attention of those using this standard specification is called to the necessity of complying with any relevant legislation.

Amendments

No.	Date of Issue	Remarks	Entered by and date

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Foreword

This standard provides specification for the PASS/FAIL criteria and test methods applicable to Oxo-biodegradable finished product articles, that may leak into the environment after escaping the collection schemes, made from plastic films (polyolefins) based on (polyethylene, polypropylene and all their copolymers and combinations) with film thickness ≤ 300 microns.

This standard is voluntary.

Committee representation

Related Documents

This standard makes reference to the following:

a) ASTM D6954-2018 Standard Guide for Exposing and testing plastics that degrade in the environment by a combination of oxidation and biodegradation.

b) OPA Standard Specifications for: Accelerated stability & abiotic degradation testing of Oxo-Biodegradable polyethylene and polypropylene film products designed to degrade upon exposure to the environment as litter.

c) UAES 5009/2009 Standard & Specification for Oxo-biodegradation of plastic bags and other disposable plastic objects.

d) SASO 2879/2016 Degradable plastic products.

e) Swedish Standard SPCR 141 Polymeric waste degradable by abiotic and subsequent biological degradation – Requirements and test methods.

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Introduction

Oxo-biodegradable carbon-chain polymers degrades by an oxidation pathway. This is initiated abiotically and the chemical species that are formed have been shown to subsequently biodegrade rapidly, with the formation of cell biomass, water and carbon dioxide. The biodegradation mechanisms of pure oxo-biodegradable hydrocarbon polymers are very similar to those involved in the biodegradation of naturally occurring materials, in particular, lignocellulose in the form of: straw, twigs and sawdust etc.

The chemical formulation inside oxo-biodegradable plastic catalyses the cleavage of the long macromolecular chains and converts it into a material which is no longer a plastic but can be bio-assimilated by microorganisms such as; bacteria and fungi found in the environment. It therefore, simulates the way nature disposes of wastes, such as, leaves and straws, but much more quickly.

Biodegradation in the environment is not the same thing as composting. Composting is an artificial process operated according to a much shorter timescale than the processes of nature.

Specification Standards (such as ASTM D-6400 and EN13432) designed for compostable plastics is not appropriate for (except for their biodegradation and eco-toxicity test methods) plastics which are designed to degrade and biodegrade if it gets into the environment.

The rate of peroxidation, is a breakdown via the chemical reaction with atmospheric molecular oxygen in plastics that is accelerated by transition metal compounds, notably based on iron, cobalt, and manganese compounds, and retardation of antioxidants. The particular combination of metal ions and antioxidants determines the shelf life and the rate and extent of the abiotic phase that leads to the formation of low molar-mass and short chain biodegradable chemical species.

Please note: that the rate for the bioconversion of nature's lignocellulosic wastes (typical of these are straw and lignin) may require up to 10 years to mineralize completely, in comparison to, oxo-biodegradable plastics, the time frame for abiotic degradation and bio-assimilation established in this specification are much shorter.

The environment in Jamaica presents certain characteristics particularly to the region. For example, an abundance of sunlight (a strong UV source) and high ambient temperatures - especially during the summer months, as well as, relatively high ambient humidity and night condensation makes this environment extremely favourable to the actions and performances of the oxo-biodegradable technology. The Standard focuses on the oxo-degradative effects through thermal and ultraviolet degradation under atmospheric conditions, followed by the aerobic biodegradation of degraded materials, with no eco-toxicity to the environment.

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Draft Jamaican Standard Specification for Oxo-biodegradable plastic

1 Scope

This standard specification provides the PASS/FAIL criteria and test methods applicable to Oxo-biodegradable finished product articles, that may leak into the environment after escaping the collection schemes, made from plastic films (polyolefins) based on (polyethylene, polypropylene and all their copolymers and combinations) with film thickness ≤ 300 microns.

It essentially covers, but not limited to, flexible packaging and film applications, shopping bags and semi-rigid plastic packaging for food, magazine wraps, garbage bags, bin-liners for household use, cling film, shrink film, soil remediation plastic nets, as well as, agricultural/horticultural applications (e.g. banana bags, mulch film, etc.) and other articles normally used over short periods and subsequently accidental discarding, inclusive of, materials used directly in outdoor environment conditions (e.g. mulch, soil remediation, etc.).

2 Normative references

The following referenced documents are indispensable for the application 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.

ASTM D2765-16, *Standard Test Methods for Determination of Gel Content and Swell Ratio of Cross- linked Ethylene Plastics*

ASTM D3826-16, *Standard Practice for Determining Degradation End Point in Degradable Polyethylene and Polypropylene Using a Tensile Test*

ASTM D4001-16, *Standard Test Method for Determination of Weight - Average Molecular Weight of Polymers by Light Scattering*

ASTM D5208-16, *Standard Practice for Fluorescent Ultraviolet (UV) Exposure of Photodegradable Plastics*

ASTM D5338-15, *Standard Test Method for Determining Aerobic Biodegradation of Plastic Materials Under Controlled Composting Conditions*

ASTM D5988-16, *Standard Test Method for Determining Aerobic Biodegradation of Plastic Materials in Soil*

ASTM D6954-04(2018), *Standard Guide for Exposing and Testing Plastics that Degrade in the Environment by a Combination of Oxidation and Biodegradation*

ASTM D6988-16, *Standard Guide for Determination of Thickness of Plastic Film Test Specimens*

ASTM D882-14, *Standard Test Method for Tensile Properties of Thin Plastic Sheeting*

BS 8472:2011, *Methods for the assessment of the oxo-biodegradation of plastics and of the phyto-toxicity of the residues in controlled laboratory conditions*

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EN 13432:2000, *Packaging - Requirements for packaging recoverable through composting and biodegradation — Test scheme and evaluation criteria for the final acceptance of packaging*

EU Regulation No.10/2011 (as amended)

ISO 15351:2006, *Plastics — Guide for vocabulary in the field of degradable and biodegradable polymers and plastic items*

ISO 17556:2014, *Plastics – Determination of the ultimate aerobic biodegradability of plastic materials in soil by measuring the oxygen demand in a respirometer or the amount of carbon dioxide evolved*.

ISO 472:2017, *Plastics- Vocabulary*

OECD GUIDELINE 208, *Terrestrial Plant Test: 208: Seedling Emergence and Seedling Growth Test*

SPCR 141, *Polymeric waste compostable in small scale (home) composts – Requirements and test methods*

UAE.S 5009/2009, *Standard & Specification for Oxo-biodegradation of Plastic bags and other disposable Plastic objects*

3 Terms and definitions

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

3.1
abiotic degradation
degradation without influence/action from microorganisms, e.g. hydrolysis and/ or oxidation accelerated by heat and/or UV light.

3.2
biodegradable
degradation of a polymeric item due to cell-mediated phenomena (by the action of naturally occurring microorganisms).

3.3
degradable plastic
plastic designed to undergo a significant change in its chemical structure under specific environmental conditions, resulting in a loss in some properties that may vary as measured by standard test methods appropriate to the plastic and the application in a period of time that determines its classification.

3.4
environmental degradation
abiotic or biotic degradation processes or both that occurs in a given environment and includes photodegradation, thermal oxidation, hydrolysis, and biodegradation. Living organisms effect biotic degradation processes, while abiotic degradation processes are non- biological in nature.

3.5
oxidatively degradable plastic
degradable plastic in which the degradation results from oxidation.

3.6
oxo-biodegradation
degradation resulting from oxidative and cell-mediated phenomena, either simultaneously or successively.

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3.7
shelf -life
storage time under specified conditions during which a material may be expected to retain its essential properties for example; mechanical, optical, physical, and chemical properties.

4 Materials and use

Materials made with Oxo-biodegradable plastics are intended to show relatively rapid deterioration (as compared with normal plastics of the same type) of chemical, physical, and mechanical properties when exposed to light, heat, and air after fulfilling their intended purpose. The purpose of the addition of pro-degradant additives to plastic polymers is to induce property changes associated with conditions that might be experienced; when the material is discarded in landfills or as litter, including the effects of sunlight, moisture, heat, and microorganisms.

For the environment, it is necessary to ensure that the particle size of the degraded plastic object is not only invisible to mitigate unsightly litter, but also to ensure that the final residue is biodegradable and does not add to soil eco-toxicity.

5 Requirements

For food packaging applications, all components, polymers, and additives shall conform to the relevant standards for plastics in contact with food. The Oxo-biodegradable additive suppliers should provide complete information of their additives to the relevant authority. A completed study of degradation, biodegradation, eco-toxicity, food contact compliance developed and issued by independent third -party laboratories, certified as per ISO 17025 and not older than 3 years. Additionally, all included components such as; polymers, additives, fillers, pigments, stabilizers, pro-oxidants, etc. shall be declared under confidential conditions. The components constituting a minimum of 0.1%, which are officially classified as environmentally hazardous according to the Globally Harmonized System (GHS) should not be using these formulations. The products shall be suitable for their purpose, meeting its standard requirements when in contact with food and fulfilling its functional demands.

5.1 Shelf- life

The film finished products must withstand a controlled in-house shelf-life of no less than 12 months indoor storage conditions to ensure the shelf-life will be met. For different shelf-life requested by customers/applicants, different time frame is required to be considered. The additive suppliers will adjust the composition of the supplied additives to ensure the shelf life requested by specific applicants is met.

All articles meant for use by consumers, and certified to be oxo-biodegradable, shall carry a "**use by date"**, so as to forewarn the consumer about the useful shelf- life after which the article is liable to start degrading.

5.2 Residual materials (heavy metals)

The residual materials from the abiotic degradation tests shall not create harmful or persistent residues. The heavy metal content shall be determined directly on test materials before the abiotic degradation in order to, verify that their concentration is within the acceptable limits as follows in Table 1.

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6 Abiotic degradation (Tier 1)

6.1 Requirements

Table 1 — Acceptable maximum concentration of heavy metals in Oxo-biodegradable plastic

Element	mg/kg of dry substance	Element	mg/kg of dry substance
Zn	150	Cr	50
Cu	50	Mo	1
Ni	25	Se	0.75
Cd	0.5	As	5
Pb	50	F	100
Hg	0.5	Co	38

This test shall be undertaken to predict the behaviour of polymer materials in the form of film or semi-rigid when subjected to light and/or temperature stresses likely to occur in the environment.

The extent of degradation shall be evaluated by measuring the loss in mechanical properties, decrease in molecular weight accumulation of carbonyl groups in the film composition (the carbonyl groups represent the accumulation of degradation products in the tested materials) and determination of gel content after the samples are exposed to ultraviolet radiation in a Fluorescent UV apparatus (accelerated weathering) and/or in thermal ageing ovens (accelerating ageing) and shall be given the following requirements:

a) Elongation at break ≤5% of the original value (≥95% reduction).

b) Decrease in molecular weight to <5,000 Daltons (Da).

c) Content of Gel Fraction <5%.

NOTE Dalton (Da) or, sometimes, universal mass unit (u), is a unit of mass used to express atomic and molecular masses. It is the approximate mass of hydrogen. Values of 1 u = $1.660538782(83) \times 10^{-24}$ g

6.2 Test procedure

6.2.1 Expose sample to ultraviolet radiation in a QUV Fluorescent UV Panel test apparatus fitted with Black Panels at a temperature of 50ºC, which should be used in conjunction under a humid environment.

6.2.2 The abiotic degradation test shall proceed to end within a maximum of four weeks exposure in the QUV apparatus (equivalent to a calculated time of 24 months in the intended anticipated disposal conditions above), the oxo-biodegradable film should be fully embrittled, showing advanced signs of degradation.

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6.2.3 The irradiance of the lamps should be set at 0.82 W/m^2/nm. Samples of the additive and control materials must be withdrawn every 48 hours and tested for a percent elongation at break and their carbonyl indices determined by using the Fourier Transform Infrared (FTIR) Spectroscopy in Transmission Scan Mode).

6.2.4 The Carbon Optical Density should be expressed as: **ΔIR Abs** *C=O*, **17**14/**Thickness** (μ**m**).

NOTE: Carbonyl species (aldehydes, ketones, carboxylic acids, etc.) are reaction by-products of the oxidative degradation process of polyolefins and as such, their accumulation are indicative of the rate of the polymer degradation.

6.2.5 Polyolefins should generally be reduced to the embrittled state of 5% elongation or less when the Carbonyl Optical Density is greater than approximately 0.01 depending on the type, grade, pigmentation and thickness of the product under consideration.

6.2.6 Thicker sections, stabilizer packages, and heavier pigmentations can give critical carbonyl indices far greater than the range given, but the actual critical carbonyl index should be readily determined empirically during the testing procedure (by relating it to the embrittled state).

6.2.7 Gel formation (Non-degradable fraction)

A sample of the residual material from the abiotic degradation test shall be dissolved in an appropriate non- reactive solvent, such as toluene, and the gel phase, if any, separated by filtration, dried, and the weight ratio of gel to the total sample established. This is regarded as the non-degradable fraction of the polymer and should be ≤ 5%.

7 Biotic degradation (Tier 2)

7.1 Requirements

For products consisting of homopolymers 60 % of the organic carbon must be converted to carbon dioxide during the time frame allowed by the test method, before ending the test. For products consisting of more than one polymer, 90 % of the organic carbon must be converted to carbon dioxide, before ending the test.

7.2 Test procedure

A portion of the residual material from the abiotic degradation test shall be tested for ultimate aerobic biodegradability under controlled aerobic conditions in a laboratory environment by analysis of evolved carbon dioxide (the carbon in the degraded plastic is consumed by microorganisms and CO_2 is generated).

8 Plant eco-toxicity test (Plant germination and growth) (Tier 3)

The eco-toxicity test and the determination of further biodegradation of the plastic materials in the soil, shall be conducted as per the following methods:

8.1 After biodegradation in the chosen environment, remove residual solids, and mix the contents of each replicate vessel carefully. Continue mixing until the contents are mixed thoroughly. The resulting homogeneous mixture should have uniform moisture content and appearance. Repeat the same procedure for positive reference and blank replicates.

8.2 The rest of the mixture shall be dried at a temperature of 20°C to 45°C until a dry solids content of 65 ±2 % is reached. The dry solids content shall be determined after drying.

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8.3 The dried mixtures can be stored for a maximum of four weeks at 4°C. The mixtures should be opened on a weekly basis to prevent slow accumulation of acids in the mixtures as a result of anaerobic conditions.

8.4 For the terrestrial toxicity tests and the determination of further biodegradation of the plastic materials in the soil, the final dried mixture at 65 % dry solids is used.

8.5 Plant germination

8.5.1 The potential effect of materials on plant germination may be assessed with the cress seed test. This step is especially valuable for screening processing additives used at 1% or less in the plastic.

8.5.2 Soils from the above soil biodegradation testing may be evaluated at the beginning and end of the test to establish the potential effect of microbial degradation products. In the cress test, soil is extracted with water and filtered. The supernatant is used for the germination test. Various dilutions of the supernatant are prepared, and aliquots are added to petri dishes lined with filter paper. Cress seeds are placed on the wet paper and left to germinate in the dark over four days period at room temperature.

8.5.3 The percentage of germinated seeds is determined after four days and compared to a water control. Soils containing test materials should not be significantly different from the blank soil at 95 %.

9 Test plan

See Figure 1 for test plan to be conducted for each sample.

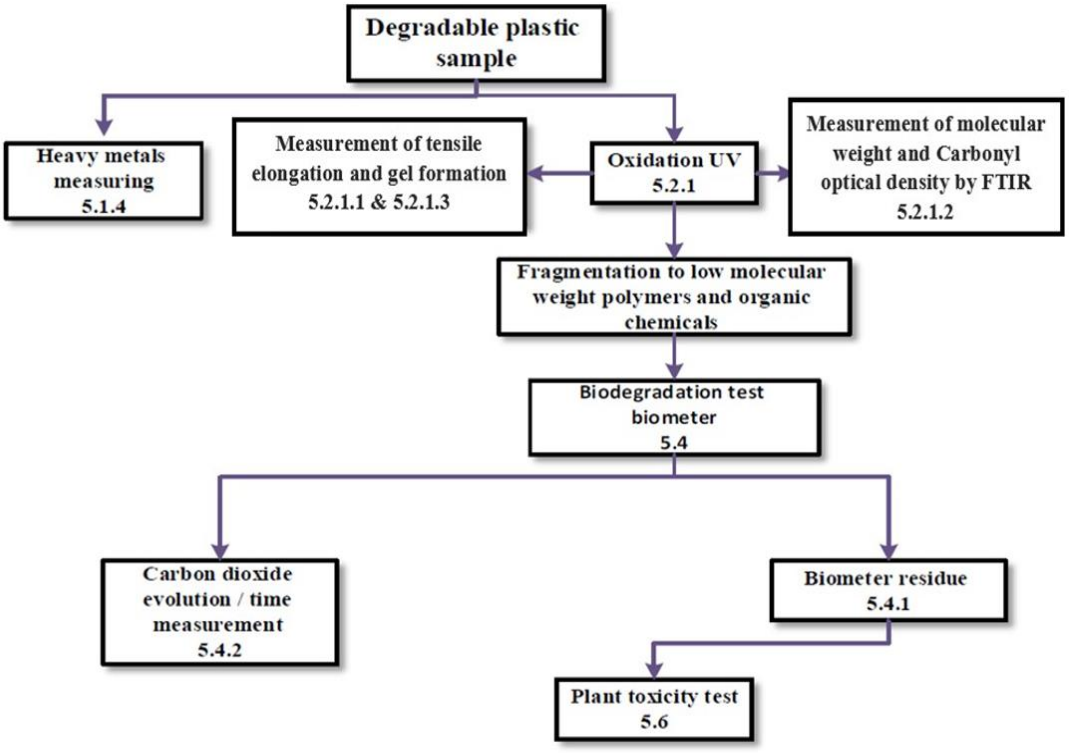

Figure (1)- Guide For Tests

10 Reporting

The report shall identify the following:

a) Product used must be clearly stated, with target of application.

b) Product specifications must be noted including the thickness.

c) Polymer type.

d) The required storage conditions for the plastic to maintain properties and not begin the degradation earlier than the stated shelf-life must be clearly indicated.

e) Anticipated service-life and storage-life.

f) The exposure conditions such as; temperature, time, moisture shall be reported.

g) The exposure conditions and time of exposure (kJ/m^2•nm at 340 nm) to radiation, if used, must be recorded.

h) Molecular weight, tensile elongation and percentage of gels of the samples before and after the indicated time for abiotic test exposures shall be reported.

11 Marking and labelling

Each piece of finished product shall be legibly and indelibly marked with the following information and on package for small pieces for which it may be difficult to print on it as follows:

a) Type of plastic material.

b) Name of the manufacturer and / or the trademark.

c) Country of origin (if different from Jamaica) and whether manufactured under license to a named brand/ manufacturer.

d) Date of production and batch number. Purpose and type of application.

e) The shelf-life period and storage conditions.

f) The degradable Logo on product.

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Standards Council

The Standards Council is the controlling body of the Bureau of Standards Jamaica and is responsible for the policy and general administration of the Bureau.

The Council is appointed by the Minister in the manner provided for in the Standards Act, 1969. Using its powers in the Standards Act, the Council appoints committees for specified purposes.

The Standards Act, 1969 sets out the duties of the Council and the steps to be followed for the formulation of a standard.

Preparation of standards documents

The following is an outline of the procedure which must be followed in the preparation of documents:

1. The preparation of standards documents is undertaken upon the Standard Council's authorisation. This may arise out of representation from national organisations or existing Bureau of Standards' Committees of Bureau staff. If the project is approved it is referred to the appropriate sectional committee or if none exists a new committee is formed, or the project is allotted to the Bureau's staff.

2. If necessary, when the final draft of a standard is ready, the Council authorises an approach to the Minister in order to obtain the formal concurrence of any other Minister who may be responsible for any area which the standard may affect.

3. The draft document is made available to the general public for comments. All interested parties, by means of a notice in the Press, are invited to comment. In addition, copies are forwarded to those known, interested in the subject.

4. The Committee considers all the comments received and recommends a final document to the Standards Council

5. The Standards Council recommends the document to the Minister for publication.

6. The Minister approves the recommendation of the Standards Council.

7. The declaration of the standard is gazetted and copies placed on sale.

8. On the recommendation of the Standards Council the Minister may declare a standard compulsory.

9. Amendments to and revisions of standards normally require the same procedure as is applied to the preparation of the original standard.

Overseas standards documents

The Bureau of Standards Jamaica maintains a reference library which includes the standards of many overseas standards organisations. These standards can be inspected upon request.

The Bureau can supply on demand copies of standards produced by some national standards bodies and is the agency for the sale of standards produced by the International Organization for Standardization (ISO) members.

Application to use the reference library and to purchase Jamaican and other standards documents should be addressed to:

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