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Plastics – Biodegradation of polyolefins in an open-air terrestrial environment – Specification

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Foreword

The development of this PAS was facilitated by BSI Standards Limited and it was published under licence from The British Standards Institution. It came into effect on 31 October 2020.

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- Fera Science Ltd
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The PAS process enables a specification to be rapidly developed in order to fulfil an immediate need in industry. A PAS can be considered for further development as a British Standard or constitute part of the UK input into the development of a European or International Standard.

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Use of this document

It has been assumed in the preparation of this PAS that the execution of its provisions will be entrusted to qualified and experienced people, for whose use it has been produced.

Presentational conventions

The provisions of this PAS are presented in roman (i.e. upright) type. Its requirements are expressed in sentences in which the principal auxiliary verb is “shall”.

Commentary, explanation and general informative material is presented in italic type and does not constitute a normative element.

Where words have alternative spellings, the preferred spelling of the Shorter Oxford English Dictionary is used (e.g. “organization” rather than “organisation”).

Contractual and legal considerations

This Publicly Available Specification does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a Publicly Available Specification cannot confer immunity from legal obligations.

0 Introduction

The use of plastics and particularly polyolefin-based plastics has significantly increased over the past decades in many applications.[1] Driven by low costs and strong supply chains, polyolefins have become the material of choice for many product applications. The result of this widespread use has meant that the end-of-life scenarios of these materials has come under ever-increased scrutiny. There are four major end-of-life scenarios of plastic materials. [2]

a) landfill;
b) incineration/waste-to-energy;
c) mechanical recycling; and
d) litter or leakage into the natural environment.

Whilst well-known standards and/or industry-accepted protocols exist for determining the applicability or performance of a plastic material in scenarios a), b) and c), previous standards in scenario d) have identified guidelines, but have not specified outcomes. In addition, they have sought to pre-determine the type of degradation process, rather than producing numerical criteria associated with the performance of the material under the stated test conditions.

NOTE 1 *Similarly to standards within scenarios a), b) and c) for end-of-life of plastic materials, which do not overlap with each other when evaluating a plastic material, this PAS does not overlap with standards relating to landfill, incineration or recycling of plastics. This PAS provides data on the material only related to the end–of-life scenario as stated in scenario d): littering or leakage into the natural environment.*

Within all plastic materials, polyolefin-based plastics are the most littered category (approx. 50% of total). [2] More specifically, 75% of all fugitive plastic is land based.[3][4] It is widely accepted that fugitive plastic on land goes through a process of weathering, normally resulting in the generation of microplastics, followed by limited soil biodegradation depending upon the environmental conditions.[3]

NOTE 2 *A definition of microplastics can be found in Annex G.*

The problem is that polyolefins are hydrocarbon-based materials that are resistant to environmental stimuli and inert to biological attack. Due to the ever-growing problem of plastic pollution and the need to innovate within current polyolefin-based packaging, additive-based solutions are being proposed as biodegradable innovations within polyolefinic materials. Although these additive-based innovations have been known for some time, previous standardization efforts have covered only specific aspects of polyolefin use, such as durability (via weathering testing), degradation or loss of physical properties due to aging over time or biodegradation under selected conditions. The primary objective of this PAS is to provide a standard specification that provides numerical data on the biodegradability of a given polyolefin containing a specific biodegradable additive under open-air terrestrial conditions. The PAS is specifically designed to simulate the overarching process of biodegradability in an unmanaged environment, as in the case of littering or unmanaged disposal. It does not provide data on how a polyolefinic material would perform under managed biodegradable end-of-life scenarios such as industrial or home composting, anaerobic digestion, or organic recycling.

NOTE 3 *Biodegradability in unmanaged aquatic or marine environments is not considered in this PAS. These environments will be considered upon revision of this PAS depending upon available standards and evidence.*

To achieve the objective of this PAS, internationally accepted existing standards in relation to the three key stages of concern with respect to biodegradability in an open-air terrestrial environment will be referenced accordingly. These standards will be further augmented in line with written protocols to specify the conditions and timeframes used for the testing at each stage. The three stages represented are:

1) weathering of the polyolefinic material under specific conditions and timeframes, after which chemical analysis proves that the polyolefinic material has been transformed into a wax containing a specified carbonyl index;
2) an assessment of the eco-toxicity of the wax using three sentinel species to determine that the wax presents no hazardous or inhibiting effects; and

3) biodegradation of the wax under mesophilic conditions using exclusively soil as the medium for the test to reflect unmanaged disposal conditions.

NOTE 4 *An overview of the approach and pass-fail criteria can be found in Annex A.*

NOTE 5 *Specifying that the biodegradation testing achieves a degree of mineralization greater than 90% avoids the generation of microplastics.*

The PAS aims to standardize the effectiveness of technologies that impart biodegradability within polyolefins by providing data on the performance of the tested technology under the stated conditions. Only by meeting the requirements of the standardized testing in all stages of this PAS is a technology within a given polyolefinic material composition deemed to be compliant.

This PAS does not specify the origin of the raw materials used in the polyolefin composition. Claims around bio-based content are to be made in accordance with relevant standards. In addition, the PAS does not specify the use-life or durability aspects of the polyolefinic material under evaluation.

NOTE 6 *If an assessment of the bio-based content of a polyolefinic material is desired, further reading of BS EN 16640 and BS EN 16785-1 is recommended.*

NOTE 7 *Compatibility of innovative polyolefin packaging entering the market with current recycling streams is covered by the protocols of Plastics Recyclers Europe (PRE).*

The PAS is not intended for making claims of biodegradability, nor for product (self-) declaration. Compliance with the PAS would provide the numerical evidence to support claims about the performance of the technology within polyolefins in alignment with BS EN ISO 14021.

NOTE 8 *Attention is drawn to the legal requirements of the territory of use of the polyolefinic material.*

1 Scope

This PAS specifies requirements of polyolefinic materials enhanced with an additive technology that imparts biodegradability in an open-air terrestrial environment. This PAS specifies the standards to be used for evaluating the performance of the tested polyolefinic material at each stage, whilst within these protocols it specifies the conditions and maximum timeframes the testing is to be conducted in. Furthermore, it specifies the chemical analysis and the numerical limits required to meet compliance with the PAS at the end of each stage of testing.

Thus, this PAS covers:

a) polyolefin composition and additive technology under evaluation;

b) alignment of specific standardized protocols for testing at each stage, notably:

   1) weathering exposure of test polyolefinic materials for a defined period of time, including chemical analysis to yield quantifiable measurement of chemical transformation into a wax;

   2) eco-toxicity testing upon the wax to ensure no hazardous substances are present; and

   3) biodegradation testing under mesophilic on soil conditions.

c) standardized testing protocol to be used at each stage of evaluation as well as for chemical analyses;

d) reporting of the data at the end of each stage of testing and the specifications to indicate compliance with the PAS.

This PAS does not cover:

- managed biodegradable end-of-life scenarios such as industrial or home composting, landfill and anaerobic digestion;
- unmanaged aquatic environments of freshwater of marine habitats, including the damage that bioaccumulation of plastic pollution creates in these ecosystems;
- durability testing of the polyolefinic material prior to any chemical or biological transformation;
- the suitability or compatibility of the polyolefinic material to be mechanically, chemically or organically recycled;
- the life cycle assessment analysis of the polyolefinic material combined with the biodegradable additive technology;
- self-declared claims of biodegradability outside the framework of an appropriate standard such as BS EN ISO 14021; or
- the requirement of the use of independent third-party certification for claims of conformance to the PAS.

This PAS is intended to be used by plastic or plastic technology manufacturers looking to obtain data as to the performance of the biodegradability of an additive technology within a polyolefinic material in an open-air terrestrial environment. In addition, this PAS provides testing laboratories with a standardized protocol to evaluate polyolefinic materials for conformance to the PAS.

In addition, other standards agencies, national laboratories or academic research groups could use the test method described in this PAS as a universal baseline methodology of evaluating the biodegradability of new technological discoveries within polyolefins.