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HSF5112 BD

EnviroSafe

Clear Biodegradable Heat Sealable Polypropylene Film

Multiplastics (Europe) Limited are pleased to announce our new Biodegradable Polypropylene film for applications including HFFS, VFFS, Overwrapping, Print/Lamination and Side-weld applications.

Our polypropylene film (HSF5112B) will decompose into a waxy like substance breaking down into CO2, water, and biomass in outdoor terrestrial environments (including landfill) within a maximum of two years or sooner (subject to conditions).

Using additives from Polymateria in the extrusion process enables the chain-breakdown of the base material whilst maintaining recyclability and product performance.

Tested and certified to the British Standard Institution BSI PAS 9017:2020 which specifies biodegradability of PP and PE.

On-pack claims for biodegradability under the Type II environmental labelling framework, underpinned by ISO 14021 standard.

Here is a short video, to help understanding how the technology works
https://youtu.be/V0zSlr-czKs

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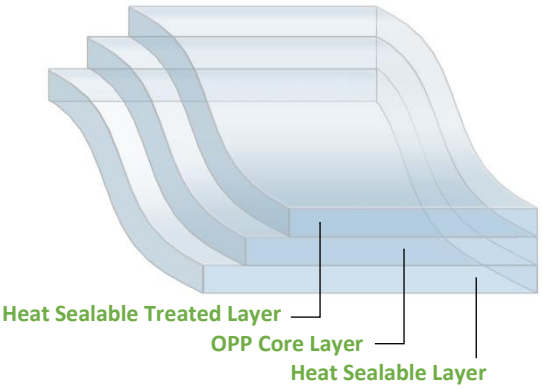
HSF5112 BD is a biodegradable heat sealable, bi-axially orientated gloss clear film. Heat sealable on both sides with one-side corona treated layer. A co-extruded product giving hot tack, free seal type for large size and weight packages.

Features

- Two side heat sealable
- One side corona treated
- Exceptional clarity
- High gloss and stiffness
- Excellent printability
- High seal strength
- Exceptional machinability on a variety of machines
- non-UV and non-water based printing
- Contains NO post-consumer recycled material
- Complies with FDA and EU regulations for direct food contact
- **PA 9017:2020, ASTM D6474 and ASTM D5988 Certified**
- **Independently tested and verified by ISO 17025**
- **Biodegradable in open-air terrestrial environment**



Typical Applications

- Suitable for printing, single ply or laminate applications
- Suitable for direct food contact, food and confectionary packaging:
  Horizontal & Vertical form fill and seal, Over wrap, Lap and fin seal applications

Primary Markets

Snacks • Sandwich Wraps • Morning Goods • Frozen Foods • Fruit & Vegetable
Confectionery • Box Overwrap • Spices • Pet Food • Film Bags • Print & Lamination

Gauges Available

- 15, 20, 25, 30, 35 and 40 micron

Environmental Features

5
PP

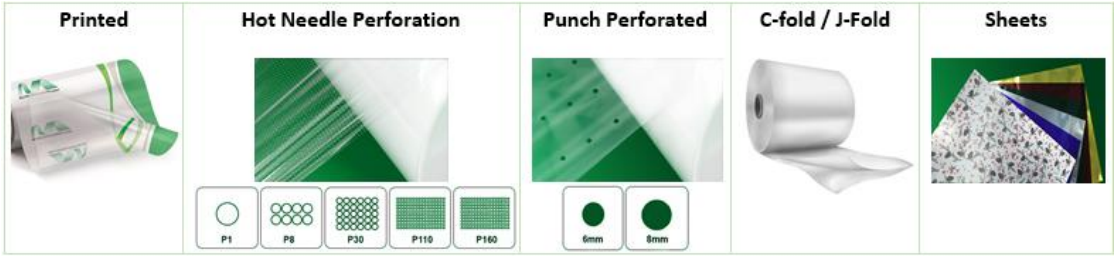
Petroleum Based

Environmental Features	Status
Recyclable	Yes - check with local authorities
Biodegradable	Yes
Home Compostable	No
Industrial Compostable	No

General Information

- Handling and Product Health and Safety details available on request
- Recommended storage in dry conditions between 30 °C and 5 °C
- Best used within 6 months of manufacture
- We recommend you let the film acclimatise in the production environment for 24 hours prior to use

Also available as:



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Typical Properties

Properties		Test	Units	20mu	25mu	30mu	35mu	40mu
Grammage			g/m^2	18.20	22.75	27.30	31.85	36.40
Yield			m^2/kg	54.95	43.96	36.63	31.40	27.48
OTR		ASTM E96	cc / m^2 / day 23oC & 0 RH	2140	1468	1290	1150	962
WVTR		ASTM D1434	gr / m^2 / day	6.5	5.75	5.0	4.5	4.00
Heat seal range			°C	105-140				
Tensile strength	MD CD	ASTM D882	kg/mm^2	15 28				
Breaking Elongation	MD CD	ASTM D882	%	170 50				
Coefficient of friction		ASTM D1894	film to film	0.25				
Surface tension		ASTM D1894	dynes / cm	38				
Gloss		ASTM D2457	% at 45°C	85				
Haze		ASTM D1003	%	2.5				
Barrier	WV	ASTM F1249	$g/m^2/24h$	7.0	5.5	4.5	4.0	3.0
	OTR	ASTM D3985	$cc/m^2/24h$	2140	1468	1290	1150	962

Abiotic Degradation			
Carbonyl Index (CI)	PAS 9017	-	> 1.0
Reduction in Weight Avg Molecular Weight (Mw)	PAS 9017	Da	99
Higher Weight Avg Molecular Weight (Mz)	PAS 9017	Da	20,000
Number Avg Molecular Weight (Mn)	PAS 9017	Da	4000
Soil Biodegradation Testing	PAS 9017	%	99
Degradation Period	PAS 9017	Years	2

As all applications are subject to those conditions prevailing within specific applications, we recommend that a test be carried out to your satisfaction prior to full production.

The information and data contained in this document are given in good faith and supersede those given in any previous version. No liability, warranty or guarantee of final product performance is created by this document. No freedom from any patent is granted or to be inferred. This document does not constitute as a sales specification.

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This is to certify that **HSF5112 BD** fully complies with British Standard Institute (BSI) process PA 9017:2020, ASTM D6474 and ASTM D5988.

Biodegradability results show that by fully meeting these degradability criteria, the residue from the degradation has the ability to be broken up into metabolic products (CO_2, water and biomass) under the biological action of bacteria and fungi living in soil. The results show that it takes the bacteria and Fungi less than a year for the film to achieve over 90% biodegradation.

Furthermore, the fact that reaching over 90% biodegradation occurred at a steady rate demonstrates two important points in relation to microplastics and the toxicity of the degraded material:

1. The ensuing steady rate of biodegradation confirms that the preceding degradation process **did not leave any microplastics behind**. Otherwise, the bacteria and fungi wouldn't be able to absorb the degraded material due to the large size of the polymer chains embedded in such microplastics, as opposed to the ultra-small size oligomeric material generated.
2. The degraded material did not leave any toxic residue behind. As it is reflected by the steady conversion of the organic carbon, the bacteria and fungi were able to healthily feed on the degraded material and break down the carbon into metabolic products such as CO_2 at over 90% rate. The degradability behaviour indicates that the film has the ability to fully biodegrade within a reasonably timescale should they inadvertently leak out of the recycling loop, get littered on land in the natural environment or get disposed of aboveground in open air landfill disposal environment.
3. This film is 100% recyclable and or does not interfere with the recycling process.

For the latest version of this document, please select the link below or scan the QR Code:	
HSF5112BD SCAN ME	Specification Sheet
	Declaration of Compliance
	BRCGS Certificate
	ISO9001 Certificate
	Updated: May 2022

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impact solutions
independent plastic experts

PAS 9017 Test Specification Report

Job Number	*IMP4194-LR*
Date	*24th November 2020*
Customer:	Multiplastics (Europe) Limited
Customers Material Reference	*BOPP*
Impact's Identification Number	*MT/GM/4691*
Material Type:	*Polypropylene*
Material Composition	*Sample D: 5-layered non-heat sealable BOPP containing PMv2.4 at 2wt% (5LBOPP_03)*
Weathering methodology	*QUV: 1hr UV – 23 hrs dark, 60 ± 2 °C, Irradiance: 0.80 ± 0.02 W/m² UVA at 340 nm, 14 days.*

Evaluation	PAS 9017 Specification	Test Result
		Material D
Polyolefin Product Category	*Annex B*	PP + Biodegradable Additive
Carbonyl Index	*>1*	1.04
Number Average Molecular Weight (Mn)	*<5,000 Da*	3,533 Da
Higher Weight Average Molecular Weight (Mz)	*<30,000 Da*	17,400 Da
% Loss of Weight Average Molecular Weight (Mw)	*>90%*	99%
Seedling Emergence and Seedling Growth Test [1]	*OECD 208*	**Valid**
Daphnia magna Reproduction Test[1]	*OECD 211*	**Valid**
Earthworm Reproduction Test[1]	*OECD 222*	**Valid**
Soil Biodegradation Testing[2]	*>90%*	**99%**

[1]Results are in accordance with the eco-toxicity requirements of OECD 208, 222, and 211 standards and were carried out at the Research Centre for Toxic Compounds in the Environment (RECETOX) which can be found in the Ecotoxicity Statement provided and in line with the requirements specifies in PAS9017.
[2]Results are in accordance with the requirements in PAS9017 and were carried out at PolyBioAid, in line with ISO 17556, to which the test sample achieved 99 % biodegradation in 336 days. The data can be found in "PolyBioAid report SerpBio-PP-001"

The results show that the BOPP material containing PLMv2.4 formulation fully meets the requirements of PAS9017:2020.

Test Report Author
Dr Fabio Pontecchiani

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1. Introduction

A 5-layered non-heat sealable BOPP material was manufactured by on the 10/02/2020 to evaluate its performance to biodegrade under open-air terrestrial conditions as per the specified criteria of PAS 9017.

Impact Solution conducted the testing in line with GLP and its quality system is covered by ISO 17025 in line with the specifications stated in PAS 9017:2020. The results are presented herein.

2. Materials

Table 1 identifies the product, the description and the corresponding Polymateria masterbatch incorporated at 2 weight percentage (wt%):

Table 1 Samples as received.

Material Identity	Material Description	Polymateria's MB	MT/GM/
D	BOPP_GPG_10022020_160	PLMv2.4	4691

3. Sample Preparation

The materials arrived at Impact Solutions on the 2nd of March 2020 in the form of plaques.

The sample plaques were mounted onto the UV specimen holders and placed into the Weatherometer trays for conditioning. The UV weathering parameters followed were in accordance with ASTM D4329 / ISO 4892-3. More precisely the following parameters were set:

- Model: Q-Lab Chamber – QUV
- 1 hr UV light- 23 hrs dark
- Uninsulated black panel temperature: 60 ± 2 °C.
- Condensation OFF.
- Irradiance: 0.80 ± 0.02 W/m^2 at UVA 340.
- Total test time of experiment: 336 hours

The samples were repositioned every 72 hours as shown in Figure 1 below:

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Figure 1 Sample repositioning in the QUV chamber.

Sample Frequency:

The sample frequency has been stated in hours which relate to the elapsed test time of the QUV apparatus. See table 2 below.

At each sample interval, one sample (2" by 4" holder) of each material needs to be removed from the QUV apparatus and placed in a bag, analysis is carried out where stated. The bags containing the samples should be labelled with the material ID and time interval removed ready to send to Polymateria.

Table 2 Testing frequency.

Frequency (time = hours)	D
0	IR & GPC
72	IR
168	IR
240	IR
336	IR & GPC

4. Sample Analysis

4.1. FTIR

A Thermo Nicolet IS10 FTIR, equipped with an Attenuated Total Reflectance (ATR) attachment was used for the infrared analysis of the specimens.

Attenuated Total Reflection (ATR) is a sampling technique used in conjunction with infrared spectroscopy which enables samples to be examined directly in the solid or liquid state without further preparation. Specimens were tested without any previous preparation

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straight after conditioning. The FTIR is annually calibrated, serviced and maintained by Thermo fisher engineers.
In total three specimens per material per conditioning time were tested under the FTIR. The FTIR testing parameters used were the following:

- Wavenumber range: 550 cm^{-1} to 4000 cm^{-1}
- Scanning resolution: 4 cm^{-1}
- Number of scans: 32 scans
- Number of background scans: 32 scans, before every sample.

From the spectra collected in FTIR tests, the carbonyl peaks were identified and the carbonyl index, CI was calculated as follows:

$$CI = \frac{Peak\ area\ of\ the\ carbonyl\ peak\ around\ 1714cm^{-1}}{Peak\ area\ of\ the\ CH_2\ scissoring\ peak\ around\ 1470cm^{-1}}$$

When calculating the carbonyl index the following peak regions were used (Also shown in Figure 2):

- For the carbonyl peak = 1650 cm^{-1} to 1850 cm^{-1}
- For the CH_2 peak = 1420 cm^{-1} to 1500 cm^{-1}

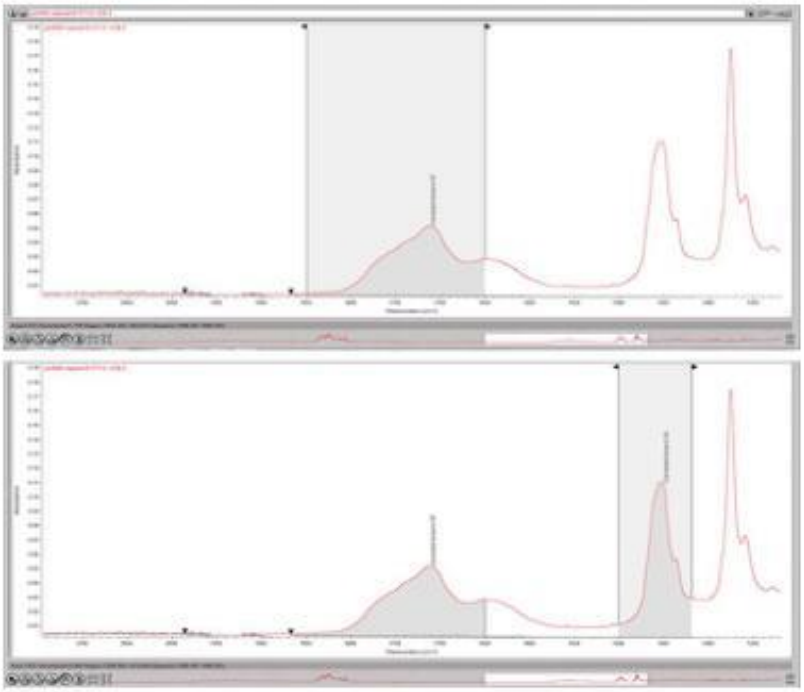

Figure 2 The method used to obtain the Carbonyl index.

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4.2. Gel permeation chromatography

A single solution of each sample was prepared by adding 10 mL of solvent to 20 mg of sample. The sample solutions were heated and shaken at 160 °C for 4 hours, or until dissolved. The vials were placed in an autosampler where injection of part of the contents of each vial was carried out automatically. All masses, volumes, times and temperatures in this section are only approximate.

- Instrument: Agilent Technologies PL GPC220,
- Columns: Agilent Technologies PLgel Olexis guard plus 3 x Olexis, 30 cm, 13 µm,
  Solvent: 1, 2, 4 -trichlorobenzene with anti-oxidant,
- Flow-rate: 1.0 mL/minute (nominal),
- Temperature: 160°C (nominal),
- Detector: refractive index with differential pressure and light scattering.

Data capture and subsequent data handling was carried out using Agilent Technologies 'Cirrus' software.

The chromatography for the reported results was carried out on the 1st of April 2020.

The GPC system used for this work was calibrated using a series of Agilent/Polymer Laboratories EasiVial PS-H polystyrene calibrants with known molecular weights but a mathematical correction, making use of Mark-Houwink parameters has been applied to express the results as for linear polyethylene or polypropylene homopolymer (the Mark Houwink parameters used are identified in Table 3 below).

Table 3 Mark-Houwink parameters.

	Polystyrene (calibrants)	Polypropylene Homopolymer (samples)
Alpha	0.655	0.725
K x 10^{-5} dL/g	19	19

The samples appeared to be completely soluble. There were no apparent problems with either the filtration or the chromatography of any of the solutions.

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5. Results

Table 4 below presents the carbonyl indexes from the FTIR analysis carried out on the samples at regular time intervals.

The full results from the FTIR tests are shown in the Appendix below.

Table 4 Average Carbonyl Index Results for the polymer materials.

MT/GM/	Material	Description	CI, T0	CI, T72	CI, T168	CI, T240	CI, T336
4691	**D**	**BOPP 03**	**0.26**	**0.29**	**0.49**	**0.90**	**1.04**
		STDVA	0.06	0.02	0.06	0.07	0.06

Furthermore, Table 5 below presents the molecular weight results for the sample before UV weathering and after 336 hours.

Table 5 Molecular weight test results (average in g mol^{-1}) from GPC analysis of the PLM materials (the full GPC table of results at page 8 of the Appendix).

MT/GM/	Material	Description	Mw, No conditioning	Mw, 336h UV weathering	Mn, No conditioning	Mn, 336h UV weathering	Mz, No conditioning	Mz, 336h UV weathering	Mw/Mn (PD)	Mw/Mn (PD) after weathering	%Mw loss
4691	**D**	**BOPP 03**	**323,833**	**8,767**	**71,233**	**3,533**	**812,833**	**17,400**	**5**	**2**	**97**
		STDVA	8,871	153	1,697	115	31,146	1,015			

Appendix – FTIR and GPC results

Time (hours)	Sample ID	1			2			3			Average CI	Standard deviation
		C=O (1650 cm-1)	C=H (1430 cm-1)	CI	C=O (1650 cm-1)	C=H (1430 cm-1)	CI	C=O (1650 cm-1)	C=H (1430 cm-1)	CI		
MATERIAL D												
0	4691-0	0.47	2.41	**0.20**	0.58	2.13	**0.27**	0.66	2.06	**0.32**	**0.26**	0.06
72	4691-1	0.61	2.27	**0.27**	0.62	2.22	**0.28**	0.7	2.25	**0.31**	**0.29**	0.02
168	4691-2	1.36	2.46	**0.55**	0.93	1.97	**0.47**	0.96	2.2	**0.44**	**0.49**	0.06
240	4691-3	2.3	2.8	**0.82**	2.75	2.88	**0.95**	2.84	3.04	**0.93**	**0.90**	0.07
336	4691-4	1.97	1.88	**1.05**	2.14	1.96	**1.09**	2.89	2.95	**0.98**	**1.04**	0.06

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GPC full table of Results:

		D
	Run	BOPP 03
Mw, No conditioning	1	320,900
	2	333,800
	3	316,800
	average	**323,833**
	stdva	8,871
Mw, 336h UV weathering	1	8,800
	2	8,900
	3	8,600
	average	**8,767**
	stdva	153
Mn, No conditioning	1	68,900
	2	71,300
	3	73,500
	average	**71,233**
	stdva	1,697
Mn, 336h UV weathering	1	3,600
	2	3,400
	3	3,600
	average	**3,533**
	stdva	115
Mz, No Conditioning	1	824,200
	2	836,700
	3	777,600
	average	**812,833**
	stdva	31,146
Mz, 336h UV weathering	1	16,500
	2	18,500
	3	17,200
	average	**17,400**
	stdva	1,015

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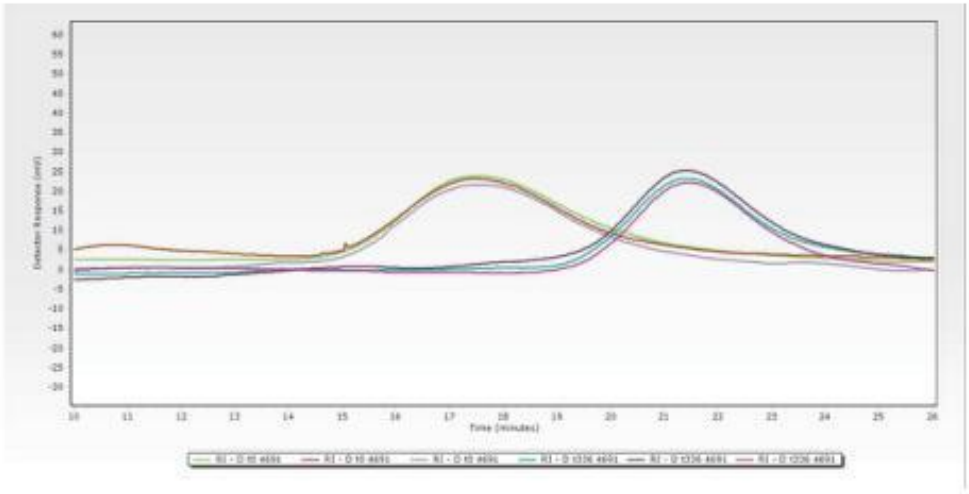
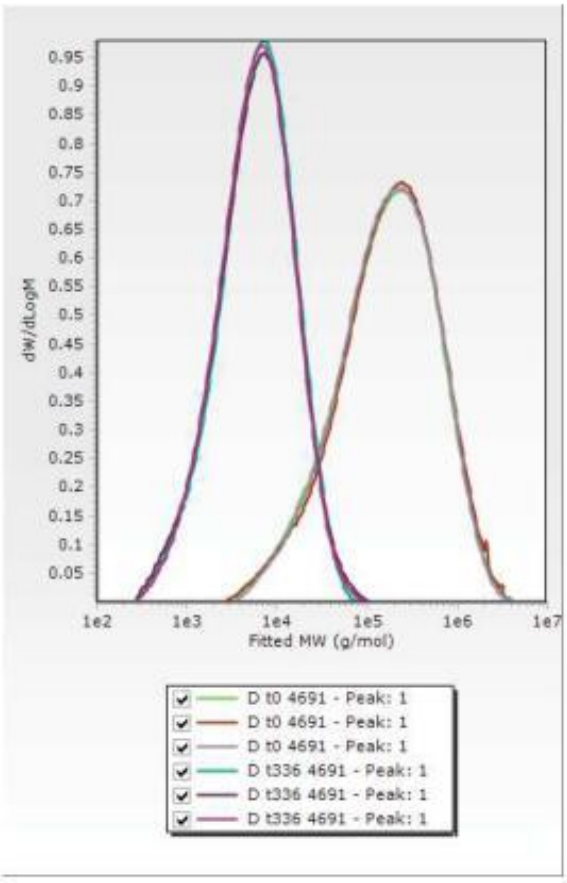
Chromatograms and molecular weight distributions

Material D





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PolyBioAid
Website: http://serpbio.fr

Annonce 1140 du JO en date du 08/04/17 sous le N° 20170014
RNA W561 007 538
N° Siret : 829 286 772 00019
N° Siren : 829 286 772 – Code APE : 9499Z

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Confidential! Not to be released without appropriate authorisation!

PolyBioAid report SerpBio-PP-001

16th February 2020

Laboratory report: Determining ultimate aerobic biodegradation on soil of a weathered plastic material

Dr Christopher Wallis
Polymateria Ltd
Imperial Incubator White City-I-HUB
White City Campus
Imperial College
80, Wood Lane, White City
W12 OBZ – London
United Kingdom.-

Dear Dr Wallis,

Please find below the report regarding the respirometry test performed on soil at 28°C as per ISO 17556/ASTM 5988 test method to access the biodegradability on soil of a polypropylene (PP) bottle after Xenon Arc weathering.

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1. Purpose

Access the biodegradability on soil of a polypropylene bottle after Xenon Arc weathering. The percentage rate of biodegradation expressed in per cent is determined by calculating the amount of carbon dioxide evolved from the theoretical amount of carbon in the test material.

2. Sample identification

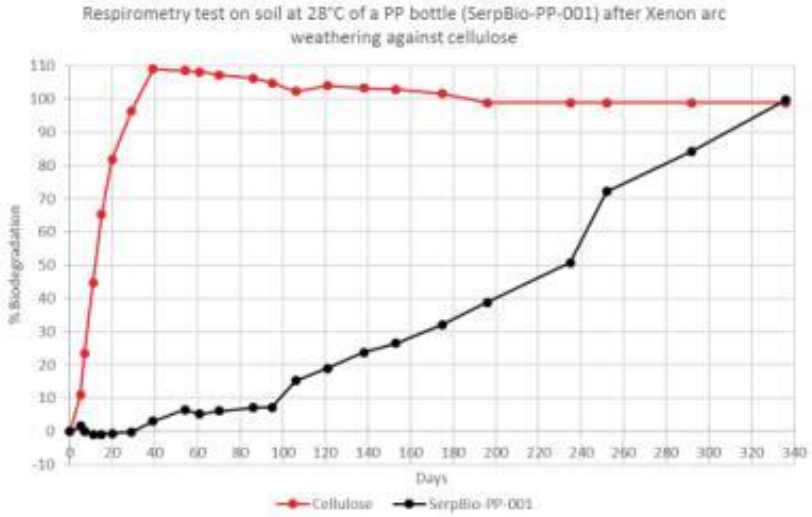
Sample	Description	Total Carbon % (dry weight)	Standard deviation
Cellulose	Cellulose (ashless filter paper)	41.12	0.02
SERPBIO-PP-001	PP bottle tested after Xenon arc weathering	78.79	0.88

3. Experimental

The test sample was placed on soil in a temperature-controlled chamber at 28°C. The carbon dioxide evolved was measured at regular intervals and calculated from gravimetric titrations.

4. Results of the respirometry test for sample "SerpBio-PP-001"

a. Biodegradation results reported as a mean of triplicates



Note: Slight synergistic effect of the cellulose (the cellulose favoured the biodegradation in the media compared to the blank) and « lag phase » of about 50 days observed for Serpbio-PP-001

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MULTIPLASTICS (EUROPE) LIMITED

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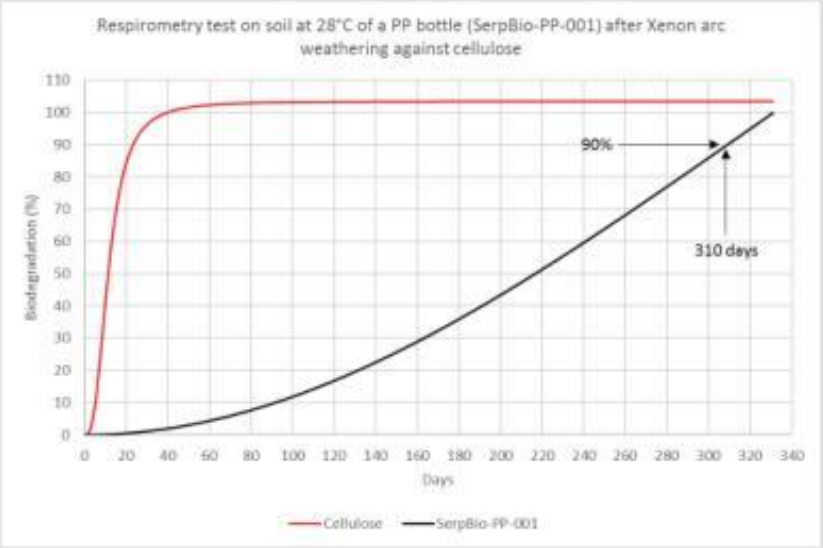
b. Biodegradation results fitted to the Hill equation

Hill sigmoid curve using the general equation $y = ax^b/(c^b + x^b)$		
Tested Sample	**Cellulose**	**SERPBIO-PP-001**
Coefficient a	103.411	395.020
Coefficient b	2.705	2.001
Coefficient c	11.495	569.233
R^2 (ddl = 68)	0.971	0.910
Theoretical asymptote (%)	103.411	395.020
Reference test material validation	70.00 % in 15 days, hence 168 days before the cut-off date	---
Ultimate biodegradability at day_{331} (%)	103.40[1]	99.78[2]
Relative biodegradation at day_{331} (%)	100.00	96.50
ISO 17556/D5988 compliance	YES	YES
Conclusion	**Test validated**	**Test validated**

[1]Slight synergistic effect (the cellulose favoured the biodegradation in the media compared to the blank)
[2]« lag phase » of about 50 days observed



Reviewed by,

Guy César PolyBioAid Chairman	

Membre du SERPBIO	Membre de BREIZPACK

Caisse d'Epargne de Bretagne – Compte PolyBioAid-**RIB - 14445-20200 - 08002646005 - 01**
Domiciliation CE Bretagne - BIC CEPAFRPP444 - **IBAN FR76 – 1444– 5202 – 0008 – 0026 - 4600 - 501**
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Ecotoxicity Statement

This statement confirms that plastic products biotransformed by Polymateria's additive technologies, specified hereunder, have met the criteria for:

- **Freshwater aquatic eco-toxicity, and**
- **Soil invertebrates eco-toxicity, and**
- **Plant eco-toxicity,**

and can thus be considered safe for contact in these environments.

The testing and reporting were conducted at RECETOX, a third-party laboratory ISO 17025: 2005 accredited for chemical trace analysis and conducting the research, development and utilization of environmental eco-toxicity testing.

Persons responsible for the eco-toxicological testing and reporting – Mgr. Jana Vašíčková, Ph.D. and Mgr. Dana Fojtová

Study dates: 8th June 2017 - 15th August 2017; 1st October 2018 - 1st December 2018 and 1st October 2019 – 13th December 2019.

Place of study - Research Centre for Toxic Compound in the Environment (RECETOX), Faculty of Science, Masaryk University, Brno, Czech Republic.

Biotransformed products used in these studies:

Product 1	Plastic film (PE) containing Masterbatch formulation No. 1 of Cycle+
Product 2	Plastic film (PE) containing Masterbatch formulation No. 1 of DegrAid
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Biotransformed products met criteria for:

- Acute toxicity:

OECD 202 (acute immobilisation)	OECD 207	OECD 236
Daphnia sp.	Earthworm *Eisenia andrei*	Zebra Fish Embryo *Danio rerio*

OECD 202: *Daphnia magna* sp., acute immobilisation test (freshwater aquatic eco-toxicity test). Products tested: 1–5.
OECD 207: Earthworm acute toxicity test. Products tested:1-3.
OECD 236: Fish Embryo Acute Toxicity (FET) Test. Product tested: 6 & 7.

- Chronic toxicity:

OECD 208	OECD 220 ISO EN 17512	OECD 222	OECD 211
Terrestrial plant	Enchytraeid	Earthworm *Eisenia andrei*	*Daphnia* sp.

OECD 208: Terrestrial plant test (*Sinapis alba* and *Lepidum sativum*): seedling emergence and growth test. Products tested: 4 & 5.
OECD 220: Enchytraeid reproduction test. Products tested: 4 & 5.
OECD 222: Earthworm reproduction test (*Eisenia fetida / Eisenia andrei*). Products tested: 1, 2 & 3.
ISO EN 17512: Soil quality: avoidance test for determining the quality of soils and effects of chemicals on behaviour. Part 1: test using Enchytraeids. Products tested: 4 & 5.
OECD 211: *Daphnia magna* sp. Reproduction Test (2012). Products tested: 6 & 7.

Conclusion: The trial concluded that a range of biotransformed plastic products (PP and PE) containing Polymateria's technologies (both Cycle+ and DegrAid) have met the criteria for the various ecotoxicity tests cited above and can thus be considered safe for contact in soil, plant and water environments.

Professor Luděk Bláha
RECETOX deputy director

In Brno, CZ, on 20th February 2019

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PolyBioAid
Website: http://serpbio.fr

Annonce 1140 du JO en date du 08/04/17 sous le N° 20170014
RNA W561 007 538
N° Siret : 829 286 772 00019
N° Siren : 829 286 772 – Code APE : 9499Z

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France

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Confidential! Not to be released without appropriate authorisation!

PolyBioAid report SerpBio-PP-001

16th February 2020

Laboratory report: Determining ultimate aerobic biodegradation on soil of a weathered plastic material

Dr Christopher Wallis
Polymateria Ltd
Imperial Incubator White City-I-HUB
White City Campus
Imperial College
80, Wood Lane, White City
W12 OBZ – London
United Kingdom.-

Dear Dr Wallis,

Please find below the report regarding the respirometry test performed on soil at 28°C as per ISO 17556/ASTM 5988 test method to access the biodegradability on soil of a polypropylene (PP) bottle after Xenon Arc weathering.

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1. Purpose

Access the biodegradability on soil of a polypropylene bottle after Xenon Arc weathering. The percentage rate of biodegradation expressed in per cent is determined by calculating the amount of carbon dioxide evolved from the theoretical amount of carbon in the test material.

2. Sample identification

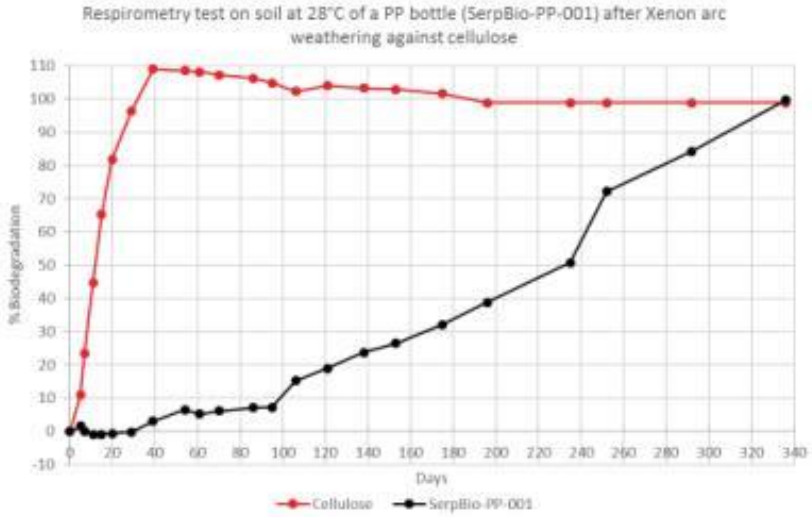
Sample	Description	Total Carbon % (dry weight)	Standard deviation
Cellulose	Cellulose (ashless filter paper)	41.12	0.02
SERPBIO-PP-001	PP bottle tested after Xenon arc weathering	78.79	0.88

3. Experimental

The test sample was placed on soil in a temperature-controlled chamber at 28°C. The carbon dioxide evolved was measured at regular intervals and calculated from gravimetric titrations.

4. Results of the respirometry test for sample "SerpBio-PP-001"

a. Biodegradation results reported as a mean of triplicates



Note: Slight synergistic effect of the cellulose (the cellulose favoured the biodegradation in the media compared to the blank) and « lag phase » of about 50 days observed for Serpbio-PP-001

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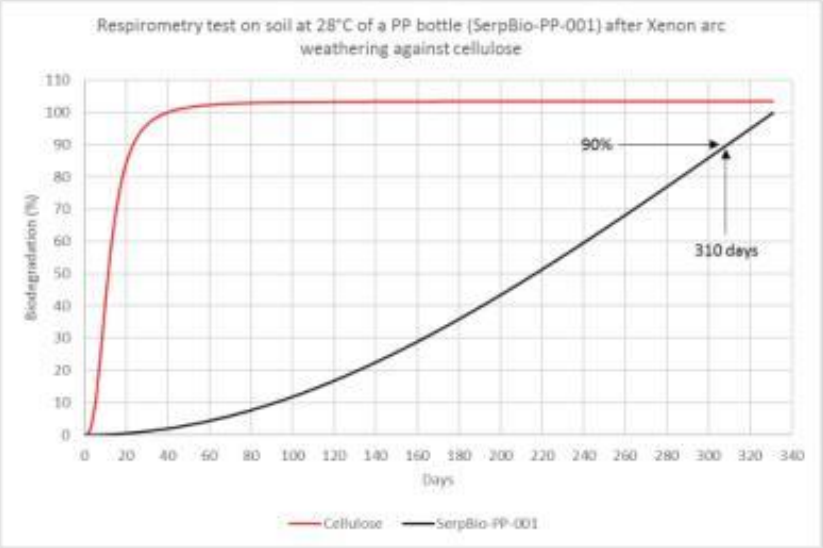

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