Date: 26 March 2026
Report: 19880/003

Test Report:

- **Compositional Analysis:**
  - Elemental Content: Determination of Prodegradant Catalysts
- **Accelerated Ageing Studies:**
  - Polymer Oxidation During Accelerated Ageing:
    - Thermal Stability
    - Thermal Degradation, Following Initial UV Exposure

Test Reference: **19880 Gilpa Impresores SAS**

Product Tested: **LDPE Bread Bag**

Prepared for: **Gilpa Impresores SAS**

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TEST REPORT

1.0 AIMS

- To determine the polymer composition of the LDPE Bread Bag sample by infrared (IR) spectroscopy.
- To evaluate the presence of prodegradant catalysts in the LDPE Bread Bag sample by determination of the prodegradant catalyst metal cations by X-ray fluorescence (XRF) spectroscopy.
- To evaluate the stability and degradation behaviour of the LDPE Bread Bag sample by means of accelerated laboratory ageing techniques, while monitoring extent of polymer oxidation by infrared (IR) spectroscopy as a function of time.

2.0 SAMPLE DETAILS

Samples Provided by: Gilpa Impresores SAS
On Behalf of: Bimbo Group
Product Type: LDPE Bread Bag
Date Received: 18/02/2026

Table 1: Sample Details

SEPTL Sample ID	Client Reference	Polymer Type	Prodegradant Additive
19880/12241	1	LDPE	1% d2w 93390/I

Table 1 is based solely on information provided by the client.

3.0 RESULTS & CONCLUSIONS

3.1 Compositional Analysis

3.1.1 Determination of Prodegradant Catalysts

The presence of prodegradant catalysts in each sample is confirmed by determination of the prodegradant catalyst metal cations by energy-dispersive X-ray fluorescence (XRF) spectroscopy.

The prodegradant catalyst content result, as determined by X-ray fluorescence (XRF) spectroscopy, is given in Table 2.

Table 2: Determination of Prodegradant Catalyst

Sample ID	Spectrum Ref.	Prodegradant Content
19880/12241	212014/5912	Prodegradant Present, Less Than Effective Concentration*

**A metal cation associated with prodegradant catalysts which is not a component of 93390 was also detected.*

3.2 Accelerated Ageing

3.2.1 Thermal Stability

The real-time stability of polymer products stored at ambient temperatures and protected from extended exposure to sunlight is evaluated over shorter period of time in the laboratory by monitoring stability and degradation during thermal ageing at elevated temperatures according to ASTM D5510.

Polymer stability and degradation is evaluated by determination of polymer oxidation by infrared spectroscopy in accordance with ISO 10640. The increase in magnitude of features of the infra-red spectra corresponding to the carbonyl products of polymer oxidation, is recorded as carbonyl optical density. The period of accelerated thermal ageing where no significant increase in carbonyl optical density (Table 5) is observed is considered to be representative of the real-time period of product stability in storage conditions.

Sample 19880/12241 demonstrated an initial period of stability followed by a significant increase in carbonyl optical density (Table 3/Figure 1). This result is consistent with the sample having undergone significant degradation.

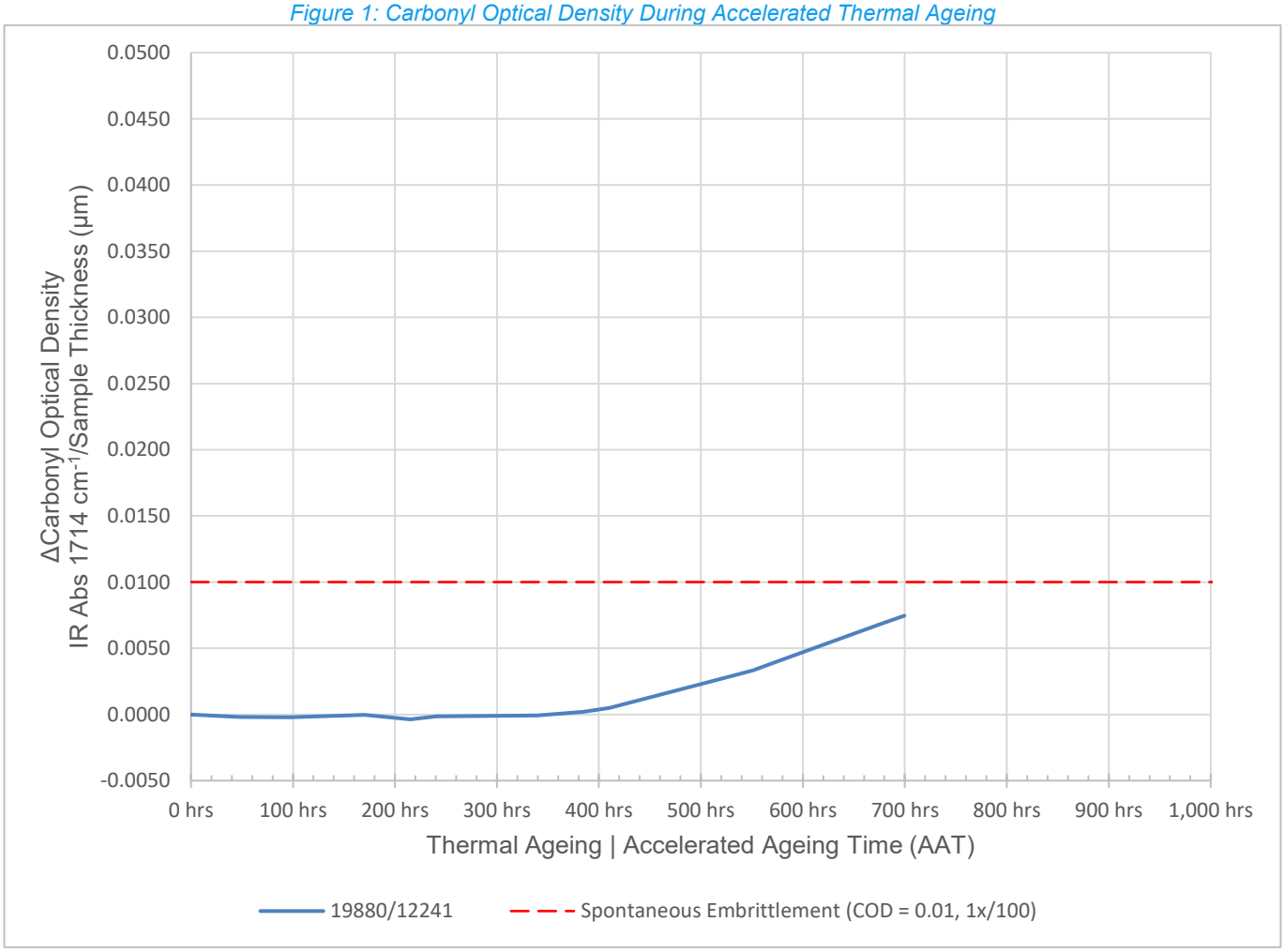
The initial period of stability confirms that the test sample is initially stable to some thermal ageing. This is consistent with the product having a limited useable fit for purpose shelf–life in storage conditions away from prolonged exposure to UV light and at an average temperature not exceeding 30°C.

Based on these results a product life of 7.5 months is estimated for this product, provided storage at an average ambient temperature which does not exceed 30°C in indoor storage conditions and is protected from extended sunlight exposure.

Table 3: Carbonyl Optical Density During Accelerated Thermal Ageing

Accelerated Ageing Time (AAT)	ΔCarbonyl Optical Density (IR Abs 1714 cm^{-1}/Thickness)
	19880/12241
0 hrs	0.0000
48 hrs	-0.0002
97 hrs	-0.0002
170 hrs	0.0000
215 hrs	-0.0004
241 hrs	-0.0002
339 hrs	-0.0001
384 hrs	0.0002
410 hrs	0.0005
506 hrs	0.0024
551 hrs	0.0033
577 hrs	0.0041
676 hrs	0.0068
700 hrs	0.0075

Figure 1: Carbonyl Optical Density During Accelerated Thermal Ageing



3.2.2 Thermal Degradation, Following Initial UV Exposure

Polymer degradation in dark conditions, following initial exposure to sunlight is evaluated in a shorter period of time in the laboratory by monitoring degradation during accelerated fluorescent UV ageing in accordance with ASTM D5208 followed by thermal ageing at elevated temperatures according to ASTM D5510.

Polymer degradation is evaluated by determination of polymer oxidation by infrared spectroscopy in accordance with ISO 10640. The increase in magnitude of features of the infra-red spectra corresponding to the carbonyl products of polymer oxidation, is recorded as carbonyl optical density. An increase in carbonyl optical density of 0.0100 corresponds to a >95% reduction in mechanical properties and is therefore considered indicative of advanced degradation as such to bring about spontaneous embrittlement (Table 5). The rate of degradation is evaluated and compared by monitoring carbonyl optical density as a function of ageing time.

3.2.2.1 48 hours Initial UV Exposure

The sample was initially exposed to constant fluorescent UV ageing for a period of 48 hours. The sample was then exposed to accelerated thermal ageing in dark conditions.

Sample 19880/12241 demonstrated a significant increase in carbonyl optical density (Table 4/Figure 2). This result is consistent with this sample having undergone significant degradation.

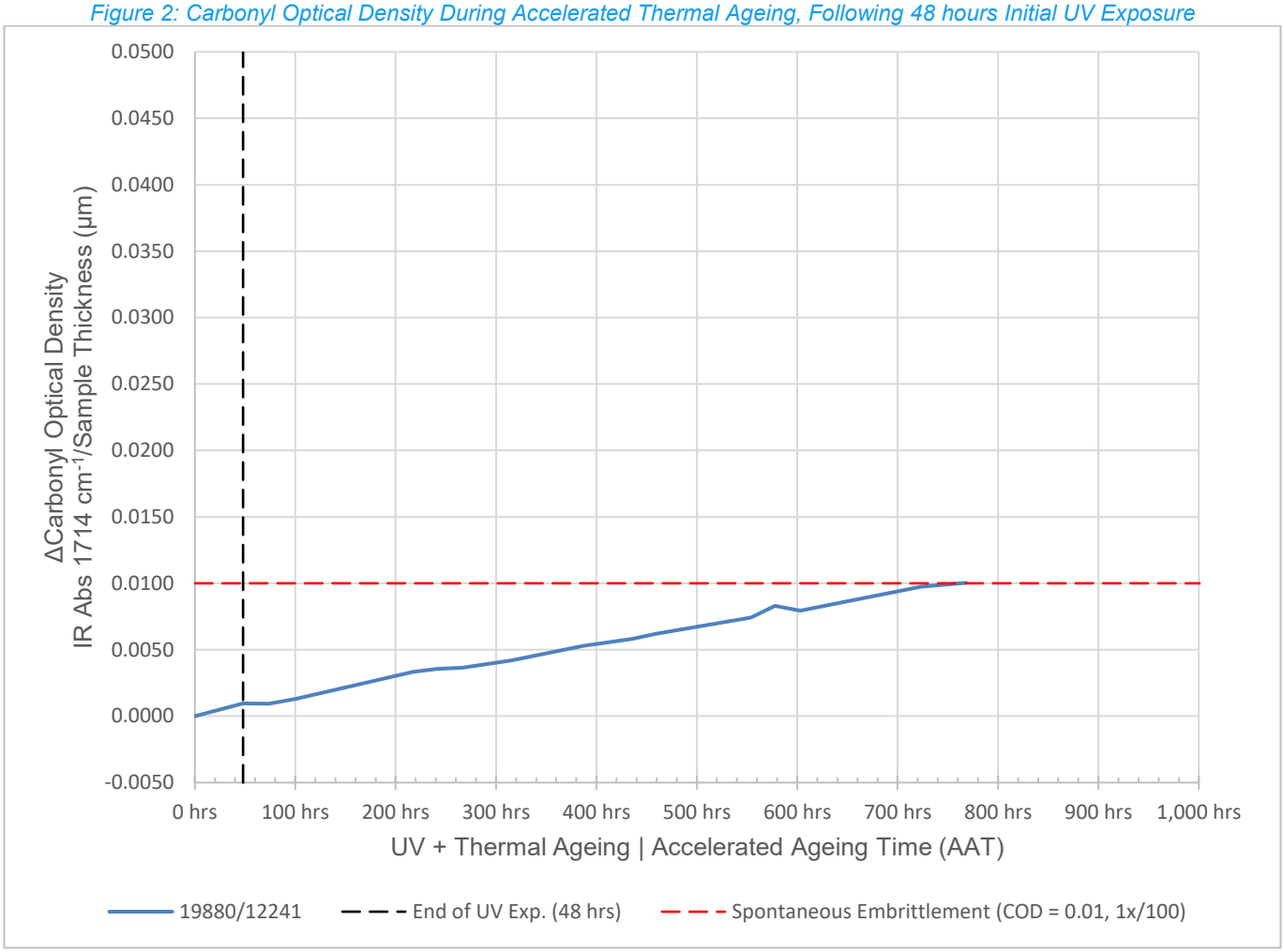
A carbonyl optical density value of ≥0.0100 is consistent with oxidation and molecular weight reduction of the polymer film sufficient to bring about a substantial reduction in mechanical properties (Table 5), this together with an observation of spontaneous embrittlement of the sample is sufficient to confirm an absolute elongation at break of 5% or less, according to ASTM D3826.

The observation of degradation in the sample which contains the prodegradant additive is consistent with the prodegradant catalyst promoting degradation of the product in dark conditions, following initial exposure to sunlight in the environment as litter.

Table 4: Carbonyl Optical Density During Accelerated Thermal Ageing, Following 48 hours Initial UV Exposure

Accelerated Ageing Time (AAT)	Exposure	ΔCarbonyl Optical Density (IR Abs 1714 cm^{-1}/Thickness)
		19880/12241
0 hrs	UV	0.0000
48 hrs		0.0009
74 hrs	Thermal	0.0009
100 hrs		0.0013
217 hrs		0.0033
241 hrs		0.0036
267 hrs		0.0037
315 hrs		0.0042
387 hrs		0.0053
411 hrs		0.0055
436 hrs		0.0058
460 hrs		0.0062
554 hrs		0.0074
578 hrs		0.0083
603 hrs		0.0079
724 hrs		0.0097
768 hrs		0.0100

Figure 2: Carbonyl Optical Density During Accelerated Thermal Ageing, Following 48 hours Initial UV Exposure



4.0 TEST METHODOLOGY

4.1 FT-IR Spectroscopy

4.1.1 Polymer Oxidation

For determination of polymer oxidation, the infrared (IR) spectra are recorded by transmission, in accordance with ISO 10640 using a Thermo Scientific Nicolet iS10 Fourier transform infrared (FT-IR) Spectrometer fitted with a transmission accessory. Spectra are collected across the range 650 to 4,000 cm^{-1}, ≥16 scans, with a resolution of 4 cm^{-1}.

4.1.1.1 Carbonyl Optical Density Calculation

The extent of oxidation is reported as the carbonyl optical density, a function of the net increase in infrared carbonyl (C=O) absorbance at 1714 cm^{-1} during ageing, per unit of the path length (sample thickness in µm):

Equation 1: $$Carbonyl\ Optical\ Density = \frac{IR\ Abs_{1714\ cm^{-1}}}{Thickness\ (\mu m)}$$

4.1.1.1.1 Extent of Oxidation, Interpretation of Carbonyl Optical Density

The carbonyl optical density value may be interpreted to indicate the approximate extent of degradation of polyolefin films, according to Table 5.

Table 5: Carbonyl Optical Density, Indicated Extent of Degradation

Carbonyl Optical Density	Extent of Degradation
0.000	No significant degradation
0.001	~50% reduction in mechanical properties (EaB)
0.010	Spontaneous Embrittlement, ~>95% reduction in mechanical properties (EaB)
≥0.030	Significant Biodegradability

4.2 XRF Spectroscopy

The XRF spectrum of each unaged sample is recorded using a Bruker S2 Puma Series 2 benchtop spectrometer in air over 120 s live time, using an Ag X-ray anode and graphene window detector, with a 40.00 kV voltage, automatic current settings (300 kcps), and a 500.0 µm aluminium filter. Film samples were prepared in 38 mm diameter HDPE XRF sample cups and the total thickness made up to ~200 µm with 36 mm discs cut from the bulk material using a James Heal 230/10 sample cutter.

4.2.1 Determination of Prodegradant Catalyst

The concentration of prodegradant catalyst metal cations is quantified by correlation with a calibration of validated reference samples.

4.3 Accelerated Ageing Exposure

4.3.1 Sample Preparation/Holders

35 x 90 mm film samples were cut using a scalpel and secured in a sample holder with four exposure windows.

4.3.2 Thickness Determination

The thickness of the sample material is determined before ageing using a digital electronic micrometer, in not less than four random locations across the test sample and the average value recorded.

4.3.3 Accelerated Thermal Ageing

Thermal ageing of the samples was carried out in a Memmert UFE 600 fan assisted oven at a temperature of 70ºC in accordance with ASTM D5510 Procedure B: Forced Ventilation Oven.

4.3.3.1 Thermal Stability Real Time Exposure Prediction

The real-time period (RT) at ambient temperature (T_{RT}) represented by accelerated ageing time (AAT) at elevated accelerated ageing temperature (T_{AA}) is predicted in accordance with ASTM F1980 using the relationship outlined in Equation 2.

The calculation is performed using an anticipated average storage exposure temperature (T_{RT}) of 30°C and a conservative ageing factor (Q_{10}) of 2.

Equation 2: $$AAT = \frac{RT}{Q_{10}^{[(T_{AA}-T_{RT})/10]}}$$

4.3.4 Accelerated Fluorescent UV Ageing

Samples were exposed to ultraviolet radiation in accordance with ASTM D5208 in a Q Panel QUV/se test apparatus fitted with UVA 340 lamps, set to a black panel temperature of 50ºC and irradiance of 0.78 W/m^2/nm @ 340 nm.

5.0 REPORT HISTORY

Date	Report Ref.	Author	Comments
Previous Version			
23/02/2026	19880/001	YB	Prodegradant content report
19/03/2026	19880/002	YB	Added accelerated ageing data
Current Version – this report supersedes all previous versions			
26/03/2026	19880/003	YB	Updated accelerated ageing data

6.0 REPORT AUTHORISATION

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Date: 2026.03.26 10:44:18 Z