Symphony Environmental Ltd
6 Elstree Gate, Elstree Way
Borehamwood
Hertfordshire WD6 1JD
England

+44 (0)20 8207 5900 Telephone
+44 (0)20 8207 7632 Facsimile
www.d2w.net
info@d2w.net

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Registered in England Number 2967867 - Address as above.
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1.0 AIMS

To compare the oxo-degradable response of a polyethylene film sample containing d_2w prodegradant additive with respect to a non degradable control sample by means of successive accelerated UV and thermal ageing.

2.0 CONCLUSIONS

The results of the successive accelerated UV and thermal ageing test demonstrate that the film sample containing the d_2w prodegradant additive has degraded to a greater extent than the control sample.

The film sample containing the additive demonstrates a larger change in carbonyl optical density measurement than the respective control film sample at the conclusion of the test (Figure 1). This result is consistent with the film sample containing the prodegradant additive being in a more advanced state of degradation.

The sample containing d_2w reached a carbonyl optical density value of 0.0151 after 240 hours ageing (48 hours UV ageing directly followed by 192 hours thermal ageing) indicating that it has reached an extent of embrittlement equivalent to an elongation at break (EaB) reduction of >95% where as the control sample without additive showed no significant increase in carbonyl optical density.

This result is consistent with inclusion of d_2w promoting degradation in the film sample.

This conclusion is confirmed by observation: at the end of the ageing tests the oxo-biodegradable film sample show signs of breakdown whilst the control sample remains largely intact.

3.0 SAMPLE DESCRIPTION

Supplier name:	
Polymer type:	Polyethylene
Samples provided:	A) White film with d_2w oxo-biodegradable additive
	B) White control film without additive
Additive system:	d_2w
Thickness:	13 µm

4.0 TEST PROTOCOL

The method involves subjecting the substrate to 48 hours accelerated UV pre-ageing before accelerated thermal ageing and monitoring degradation as function of ageing time via changes in the carbonyl optical density ($\Delta 1713 cm^{-1}$) as determined by FT-IR (Fourier Transform Infra Red) spectroscopy.

5.0 TEST METHODOLOGY

5.1 Accelerated Fluorescent UV Ageing

Samples were placed in a sample holder, in which the film is sandwiched between two metal plates (35 x 90 mm) with four exposure windows, and exposed to ultraviolet radiation in a Q Panel QUV/se test apparatus fitted with UVA 340 lamps, in general accordance with ASTM D5208. A white panel temperature of 50°C was used in conjunction with a humid environment. The irradiance of the lamps was 0.78 $W/m^2/nm$. Samples of the additive and control materials were withdrawn every 48 hours and their carbonyl optical density determined by FT-IR spectroscopy.

5.2 Accelerated Thermal Ageing

Thermal ageing of the samples was carried out in a Memmert UFE 600 fan assisted oven at a temperature of 70°C in general accordance with ASTM D5510 Procedure B (withdrawn 2010): Forced Ventilation Oven. Samples of the additive and control materials were withdrawn every 96 hours and their carbonyl optical density determined by FT-IR spectroscopy.

5.3 Carbonyl Optical Density Measurement

The carbonyl optical density ($\Delta 1713\ cm^{-1}$) of the samples was determined by FT-IR spectroscopy in transmission mode using a Thermo Electron Nicolett FT-IR instrument.

The optical density is defined by the magnitude of the carbonyl peak at 1713 cm^{-1} divided by the sample thickness. Four optical density measurements were taken at each time point and an average determined.

Measuring changes in carbonyl optical density is a useful technique for monitoring the rate of degradation of the sample. Carbonyl species (aldehydes, ketones, carboxylic acids etc.) are reaction by-products of the oxidative degradation process and as such their accumulation is indicative of ongoing degradation.

The carbonyl optical density method allows direct correlation with the mechanical properties of the samples. An optical density of 0.001 is considered equivalent to an Elongation at Break (EaB) reduction of 50% in the sample, whilst a value of 0.01 equates to an EaB value of a 5%.

ASTM D5510 (withdrawn 2010): Standard practice for heat ageing of oxidatively degradable plastics, defines degradation in terms of an embrittlement endpoint at which the sample has achieved an elongation at break value of 5%. It thus follows that when a sample achieves a carbonyl optical density of 0.01 it is similarly embrittled.

5.4 XRF Spectroscopy

The anticipated presence of the prodegradant additive in each sample was confirmed by energy-dispersive X-ray florescence (ED-XRF) spectroscopy using a Bruker S2 Ranger A20-X10 bench top spectrometer against reference samples produced by Symphony.

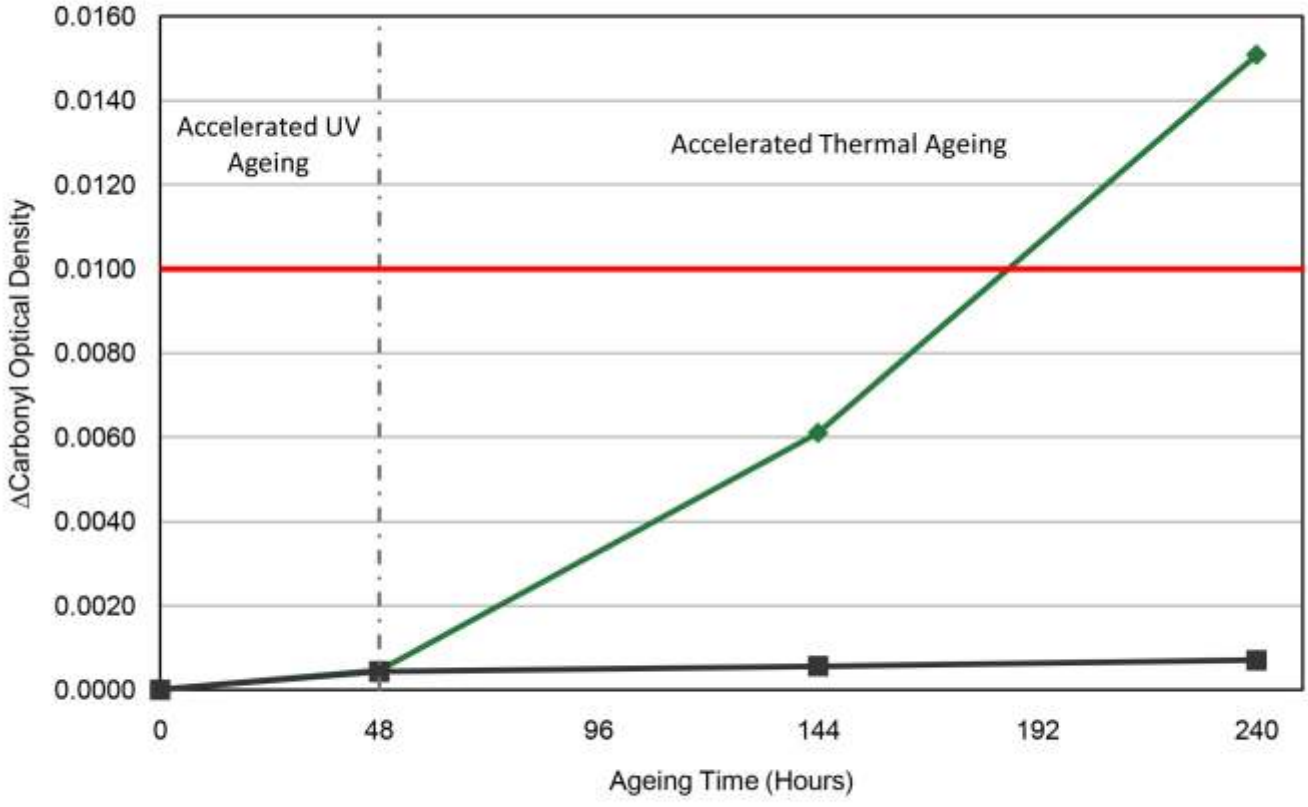
The XRF spectrum of each sample was determined in air over 120 s with 40.00 kV, 250 mA X-ray source and 500.0 µm aluminum filter. Samples of film were prepared in 38 mm HDPE XRF sample cups and the total thickness made up to ~200 µm with 36 µm discs cut from the sample using a James Heal 230/10 sample cutter.

6.0 RESULTS

Table 1: Carbonyl optical density measurement during accelerated UV and thermal ageing

Sample	Δ Carbonyl Optical Density			
	QUV Ageing		Thermal Ageing	
	0 Hrs	48 Hrs	144 Hrs	240 Hrs
A) Film with d_2w	0.0000	0.0005	0.0061	0.0151
B) Control Film	0.0000	0.0004	0.0006	0.0007

Figure 1: Sucessive Accelerated UV and Thermal Ageing



Author:	Primary review:	Secondary review:
Sophie Gray	Andrew Redfearn	Perry Higgs
Laboratory Technician	Technical Assistant	Technical Executive