Symphony environmental

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Advanced Poly-Packaging Inc.

A company registered in Ohio, USA
under registration number 77-152-1796

is an authorised User of

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Controlled-life Plastic Technology

Signed on behalf of
Symphony Environmental Ltd

..... *Director*

..... *Company Secretary*

Certificate Number
0911027

Date of issue
23rd November 2009

ISO 9001-2008 | Oxo-biodegradable Plastic Association | Market of London Stock Exchange | Society of Plastics Engineers (US) | Green Apple Award | ASTM Standards Worldwide | Society of the Chemical Industry (UK) | Millennium Award

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TEST REPORT No: Advanced Poly-Packaging, Inc. (1481)

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1.0 AIMS

To compare the oxo degradable response of polyethylene film samples containing a prodegradant additive with respect to a non degradable control sample by means of an accelerated UV ageing test.

2.0 CONCLUSIONS

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

The sample containing d_2w reached a carbonyl optical density value of 0.0108 and 0.0083 after 440 hours UV ageing; the control sample without additive demonstrated an increase in carbonyl optical density of only 0.0054.

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

3.0 SAMPLE DESCRIPTION

Supplier name:	Advanced Poly-Packaging, Inc.
Polymer type:	PE
Samples provided:	A) 70µm Clear film with d_2w oxo-biodegradable additive
	B) 73µm White film with d_2w oxo-biodegradable additive
	C) 71µm Control Clear film without additive
Additive system:	93283

4.0 TEST PROTOCOL

The method involves subjecting the substrate to accelerated UV ageing in an ARTACC Bandol Wheel apparatus 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.

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 are indicative of the rate of degradation.

The carbonyl optical density method has the added advantage in that it allows direct correlation with the mechanical properties of the samples. An optical density of 0.001 is typically 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: 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.

5.0 TEST METHODOLOGY

5.1 Accelerated UV Ageing-Bandol Wheel

Samples of product were exposed to accelerated UV ageing within an ARTACC Bandol Wheel H400 accelerated weathering apparatus (SEVAR sarl.). The samples were placed in a specially designed holder and mounted in a circular sample rack in which traces a circular path around a 400W air cooled low pressure mercury discharge lamp (Borosilicate filter). The lamp provides an irradiance of 105 W/m^2 at wavelengths between 290 and 400nm.

The period of each cycle was 4 hours with 84% of the time exposed to dry, light conditions and 16% exposed to wet, dark conditions (water immersion of sample).Test temperature as measured by a black body thermocouple was 60°C. Samples of the additive and control materials were withdrawn every 40 hours and their carbonyl optical density determined by FTIR spectroscopy.

5.2 Carbonyl Optical Density Measurement

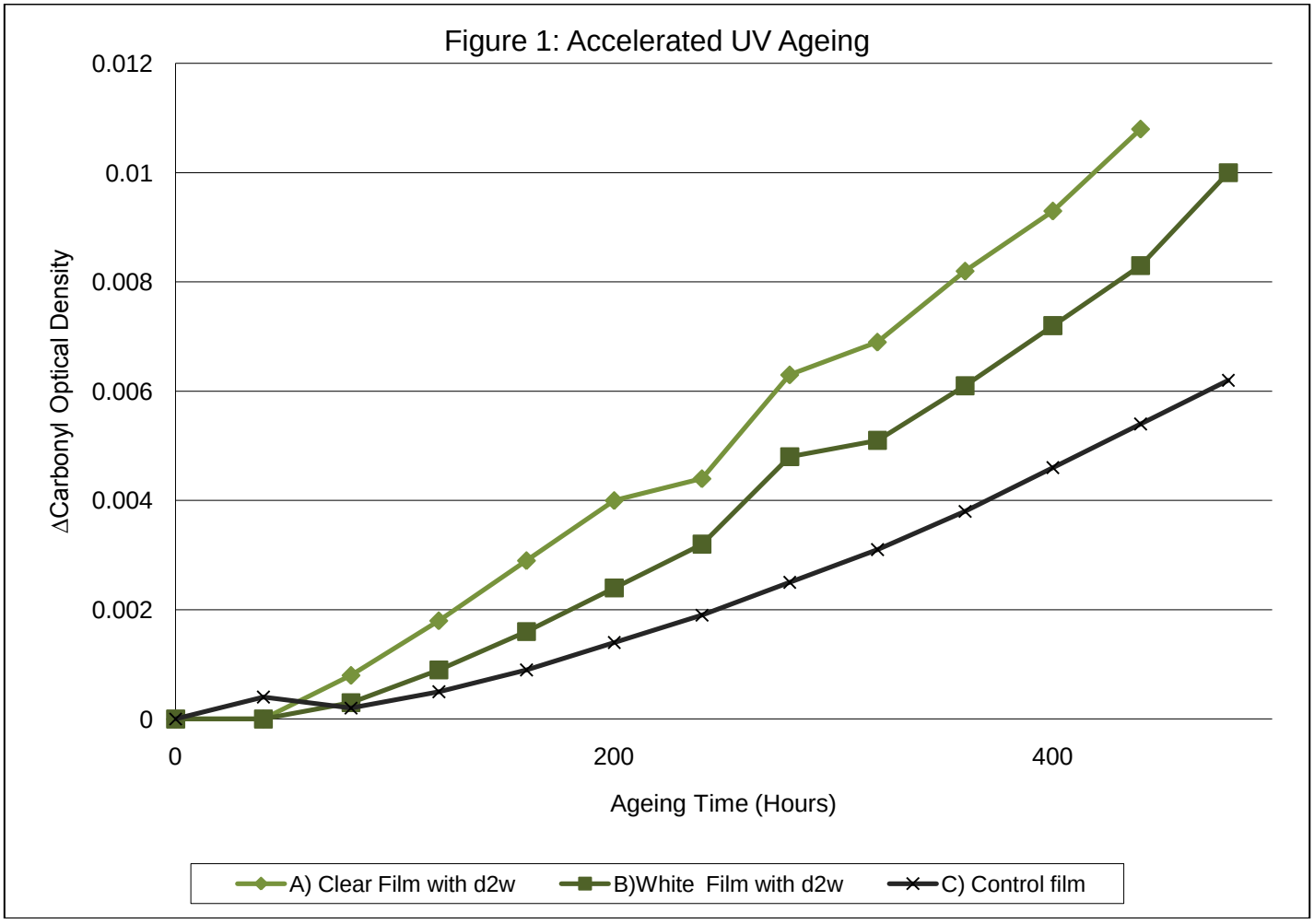
The carbonyl optical density ($\Delta 1713cm^{-1}$) of the samples was determined by FT-IR spectroscopy in transmission mode using a Thermo Electron Nicolett FTIR instrument.

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

6.0 RESULTS - Accelerated UV Ageing- Bandol Wheel

Table 1: Carbonyl optical density measurement during accelerated UV ageing- Bandol Wheel

Sample	Δ Carbonyl Optical Density												
	0 Hrs	40 Hrs	80 Hrs	120 Hrs	160 Hrs	200 Hrs	240 Hrs	280 Hrs	320 Hrs	360 Hrs	400 Hrs	440 Hrs	480 Hrs
A) Clear Film with d_2w	0.0000	0.0000	0.0008	0.0018	0.0029	0.0040	0.0044	0.0063	0.0069	0.0082	0.0093	0.0108	-
B)White Film with d_2w	0.0000	0.0000	0.0003	0.0009	0.0016	0.0024	0.0032	0.0048	0.0051	0.0061	0.0072	0.0083	0.0100
C) Control film	0.0000	0.0004	0.0002	0.0005	0.0009	0.0014	0.0019	0.0025	0.0031	0.0038	0.0046	0.0054	0.0062



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"The information presented in this report is based on the material actually tested. Performance of finished product made with d2w(R) additive depends on the conditions under which and length of time for which the additive is stored and on the method of manufacture of the finished product and the heat, light, stress and other conditions to which the finished product is exposed. Nothing in this report constitutes or implies a licence to use Symphony's intellectual property".

Making Plastic Smarter

Symphony environmental

d2w® controlled-life plastic technology

Controlled-life plastic technology

d_2w is the only oxo-biodegradable (controlled-life) plastic additive to be awarded an internationally recognised Eco-Label.

QUALIDADE-ABNT-AMBIENTAL PE-308

www.d2w.net

Controlled-Life plastic technology

A masterbatch which turns ordinary plastic at the end of its useful life, in the presence of oxygen, into a material with a different molecular structure. At the end of that process, it is no longer a plastic and has become a material which will biodegrade in the open environment in the same way as a leaf.

Stages of oxo-biodegradation with d_2w technology:

1. d_2w masterbatch is added at the manufacturing stage.
2. Film containing d_2w is extruded at the factory and is made into bags or packaging.
3. The product behaves like a conventional product during its intended service life.
4. After its service life, the bag or packaging may end up in the open environment.
5. The d_2w then takes effect and the product begins to degrade in the presence of oxygen.
6. The product eventually biodegrades to nothing more than carbon dioxide, water and biomass.

Added Value with d_2w

- Requires only 1% inclusion rate.
- Works with virgin and recycled plastic.
- Works with PE, PP and PS.
- No change to the manufacturing process.
- Does not lose any of its original properties during its useful life.
- Our customers receive full support from Symphony's Technical and Marketing teams.

Standards – The following standards are used for testing products containing d_2w

- British Standard 8472
- American ASTM D6954
- United Arab Emirates Standard 5009:2009
- French Accord T51-808

Protecting the environment with controlled-life plastic.

RECYCLED
Paper made from recycled material
FSC® C020119

Disclaimer: The information provided is general information. For specific applications, please consult our Technical Department. Supplies of d_2w are conditional upon regulatory approval for the purpose(s) concerned in the country or countries concerned.

ISO 9001 Quality Management FM37939
ISO 14001 Environmental Management EMS 567450

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