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UV Weathering of AURA[®] 139 Fluorescent Films

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Job No: B2302

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1 **Introduction**

Lakeside Films Ltd. is the authorized distributor and agent for Aura Optical Systems, L. P. (USA) in the UK. Aura Optical Systems develops and manufactures a range of high quality reflective & fluorescent films for use within the traffic and safety industries. Lakeside Films required independent testing of their products in accordance with specification ECE Regulation No. 70 Dated 19th February 2009 Uniform Provisions Concerning *The Approval of Rear Marking Plates For Heavy and Long Vehicles*. This report details the work conducted independently by Materials Technology Ltd.

2 **Specifications**

The products supplied were tested to the following specifications:

ECE Regulation No. 70 (Addendum 69), Dated 19th February 2009 - Uniform Provisions Concerning The Approval of Rear Marking Plates For Heavy and Long Vehicles. – Annex8, Resistance to External Agents

And

BS EN ISO 105-B02: 1999: Tests For Colourfastness – Colourfastness to artificial light: Xenon arc fading lamp test – Exposure condition Normal

Note: ECE Regulation No.70 still refers to BS EN ISO 105-B02: 1978. This standard is now superseded by the 1999 edition which has been utilised for this testing.

3 **Sample Information**

Lakeside Films Ltd. supplied 3 different film samples. The samples are detailed in table 1 below.

Table 1: Sample Details

Sample Ref:	Product Name	Product Code	Description
S1103-1 S1	AURA [®] 139 Fluorescent Red Film	0139-15	2 samples of Fluorescent red film attached to white plastic backing material. Each sample measuring 75mm x 150mm
S1103-1 S2	AURA [®] 139 Fluorescent Red Film	0139-15	2 samples of Fluorescent red film attached to white plastic backing material. Each sample measuring 75mm x 150mm
S1103-1 S3	AURA [®] 139 Fluorescent Red Film	0139-15	2 samples of Fluorescent red film attached to white plastic backing material. Each sample measuring 75mm x 150mm

All samples were in good condition in the as received state.

4 Methodology

Testing was conducted in accordance with ECE Regulation No. 70 which specifies the Xenon arc artificial weathering test in accordance with BS EN ISO 105-B02: 1999. An initial calibration run was conducted using the procedure and humidity control fabric specified in this standard to establish the correct “effective humidity”. The actual humidity and temperature was varied to give a light fastness of 5 on the humidity control fabric. Once established, these conditions were then used for the remainder of the testing. The specific conditions used are detailed in table 2 below. The test equipment was a Q-Sun Xenon arc Xe3HS machine.

Table 2: Test Conditions

Condition	Function	Irradiance	Black Standard Temperature	Air Temperature	Actual Humidity	Duration
Normal (Temperate Zone) clause 6.1.a	UV	0.36W/m ² (=42W/m ² over 300-400nm)	50°C	40°C	40%	Continuous

Irradiance was continually monitored during the testing via a solar eye control. One sample of each material detailed in table 1 was exposed to the above conditions. The remaining sample was kept in a cool dark location to act as a unexposed comparator. The samples were randomly arranged on the test bed and were rotated at routine intervals.

Blue wool samples ranging from number 4 to 7 were exposed at the same time as the film samples. Part of the blue wool samples were covered with an aluminium plate to act as the unexposed comparator. Whilst the specification only requires a number 5 blue wool reference, inclusion of additional control specimens insures continued accuracy of the test conditions.

The end point of the test was determined when the number 5 wool had faded to a greyscale no4. This was found to be a total exposure time of 43 hours. In addition to this testing colour measurements were made. Prior to and after the test colour check measurements were made using a Hunterlab Colourflex spectrophotometer, using the Yxy colour space system as specified in the standard. A visual check was also made on each sample to look for evidence of cracking etc.

All samples, including the blue wool references, were examined at routine intervals in order to monitor their degree of fade versus the greyscale calibration samples. On completion of the testing the samples were photographed.

5 Results

The results of the colour measurements are summarised in table 3 below. Photographs of the samples following exposure are also shown below.

The results in table 3 show colour measurements in the Yxy coordinate system. Y represents the % luminosity where x and y represent the chromacity coordinates. The samples showed a slight visible reduction in brightness (luminosity) as indicated by the reduction in Y values. There was no evidence of cracking, blistering or chalking of the surfaces. All samples met the chromacity requirements of the specification and the luminosity requirements both before and after exposure.

Table 3: Summary of colour measurements

	Pre Test			43 hrs UV exposure (Blue wool 5 faded to grey scale 4)			Comments
	Y	x	y	Y	x	y	
S1103-1 S1	36.10	0.6454	0.3417	32.0300	0.6388	0.3397	Slight reduction in brightness
	36.07	0.6452	0.3417	31.9600	0.6394	0.3397	
	35.97	0.6454	0.3416	31.8700	0.6395	0.3398	
Average	36.05	0.6453	0.3417	31.95	0.6392	0.3397	
			ΔE^*	-4.1000	-0.0061	-0.0020	
S1103-1 S2	36.74	0.6425	0.3421	32.47	0.6360	0.3394	Slight reduction in brightness
	37.05	0.6411	0.3421	32.74	0.6347	0.3392	
	36.72	0.6429	0.3421	32.41	0.6370	0.3396	
Average	36.84	0.6422	0.3421	32.54	0.6359	0.3394	
			ΔE^*	-4.3000	-0.0063	-0.0027	
S1103-1 S3	35.97	0.6450	0.3418	32.46	0.6341	0.3390	Slight reduction in brightness
	36.32	0.6442	0.3419	32.30	0.6341	0.3390	
	36.19	0.6442	0.3419	32.11	0.6364	0.3394	
Average	36.16	0.6445	0.3419	32.29	0.6349	0.3391	
			ΔE^*	-3.8700	-0.0096	-0.0028	

Note: ΔE^* measures change in reading

Table 4: Summary of Specification Limits versus Measurements

Specification							
Colour	Coord.	1	2	3	4	5	Luminance
Red	x	0.69	0.595	0.569	0.655	0.69	≥ 0.30
	y	0.31	0.315	0.341	0.345	0.31	

Sample		Chromacity		Luminance		Result
		Pre test	Post Test	Pre Test	Post Test	
		1	1	1	1	
S1	x	0.6453	0.6392	0.36	0.32	Pass
	y	0.3417	0.3397			
S2	x	0.6422	0.6359	0.37	0.33	Pass
	y	0.3421	0.3394			
S3	x	0.6445	0.6349	0.36	0.32	Pass
	y	0.3419	0.3391			

Graph 1: Graph of Chromacity Specification Limits versus Measurements

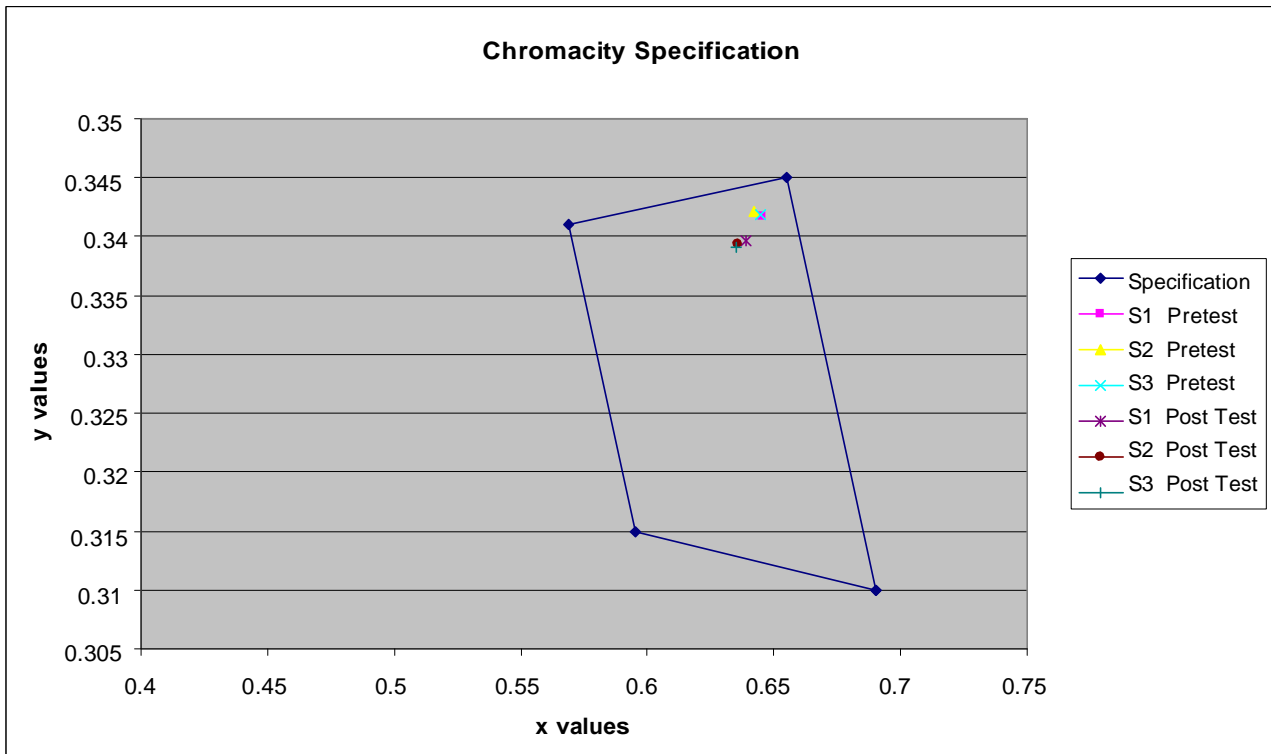


Photo 1: Blue wool reference swatches after exposure No 5 (bottom) grey scale reference 4 (above). Right hand side shows exposed region.



Photo 2: Sample S1 – Unexposed on left and exposed sample on right. 43 hours of UV exposure.



Photo 3: Sample S2 – Unexposed on left and exposed sample on right. 43 hours of UV exposure.

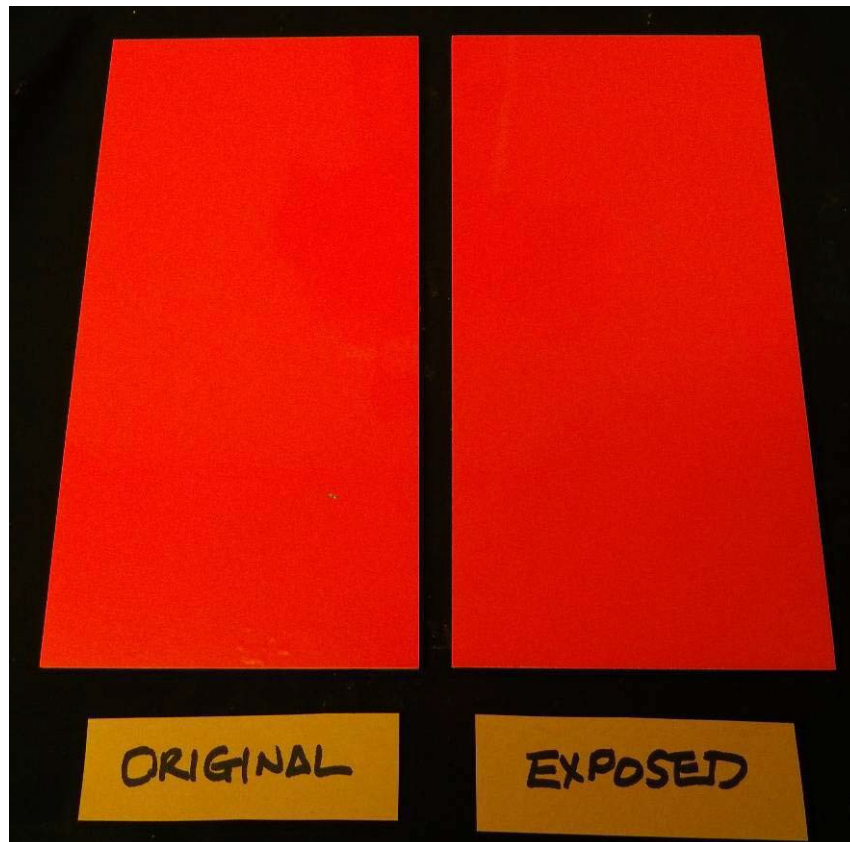


Photo 4: Sample S3 – Unexposed on left and exposed sample on right. 43 hours of UV exposure.

6 Discussion

All of the samples tested showed a slight visible reduction in brightness as measured by the luminosity figure Y. Note that this figure is expressed as % in table 3 whereas the specification limit is expressed as absolute value. All of the samples met the chromacity limits of the specification and this is shown by graph 1 with all data points falling within the blue curve. All of the samples also met the luminosity requirement prior to and after exposure.

7 Conclusions

A range of fluorescent films (Product Name: AURA[®] 139 Fluorescent Red Film Product Code: 0139-15) have been exposed to Xenon arc UV weathering in accordance with ECE regulation 70 until a blue wool no.5 had obtained a grey scale change of 4. This equated to an exposure duration of 43 hours under the specification conditions. From this work the following conclusion can be made:

1. All samples showed a slight reduction in luminosity after exposure.
2. All samples met the chromacity requirements before and after exposure.
3. All samples met the luminosity requirements before and after UV exposure.

A handwritten signature in black ink, reading "N. Kenworthy". The signature is written in a cursive style with a long horizontal stroke extending from the end of the name.

Prepared by:

Nicholas Kenworthy
Technical Director

End of Report