



Solar Simulator

Solar Simulator Finland Ltd.

Test Report

Public

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Ref.no.: StarckeSecuritiesLabeltr131107HS.pdf

Uranus **Comparative UV Radiation Analysis**

Customer:

Starcke Oy Securities
Ari-Veli Starcke
Suokkaantie 17
32800 Kokemäki

Research Contract:

4.10.2007

Target:

10 pcs, of self-adhesive label with Starcke security hologram and thermal transfer printing.



Test time:

The start of the Test: 5th of October, 2007
The end of the Test: 6th of November, 2007
Total test hours: 764 hours

Purpose of the test:

To test the long term UV-stability of self-adhesive label, especially the colour stability.

Test method:

Continuous high intensity UV-radiation
Intensity of UV-radiation: 110 W/m²
Black plate temperature: +40°C
Sample temperature: +32°C
Total test time: 764 hours



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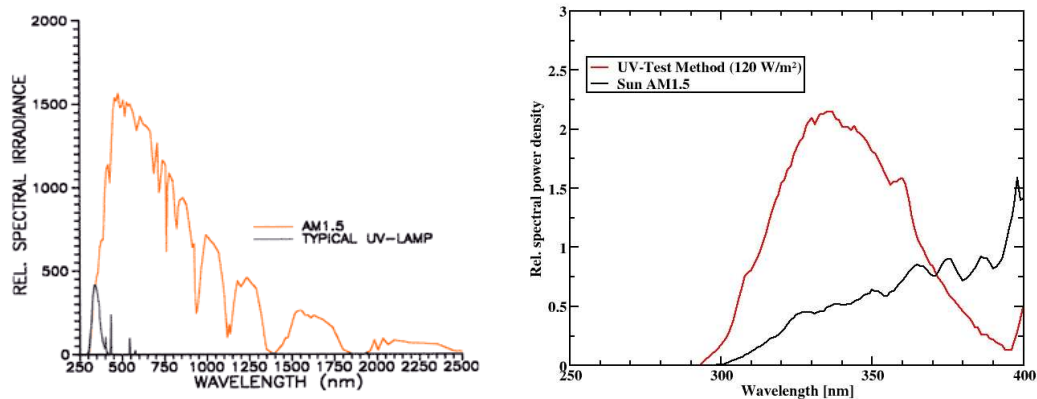
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Validation of test method:

Solar UV-radiation is a remarkable cause for the degradation of colours and degeneration of materials.



The figure on the left shows the solar AM1.5 spectrum and a spectrum of the UV-lamp which represents the solar UV-radiation. On the right there is the 120 W/m² of UV-radiation in this test compared to the 60 W/m² of UV-radiation in solar radiation.

The effects of the visual and infrared radiations to the samples are untested.

Actions done:

The test cycle was continuous UV-radiation. The mean intensity of UV-radiation was 110 ± 15 W/m². The mean black plate temperature was $40 \pm 2^\circ\text{C}$.

Five of each samples were directly attached onto a plywood board. Five of each samples were on their cover paper. All samples were situated horizontally to the radiation source.



The intensity of UV-radiation, black plate temperature, air temperature and relative humidity in the test chamber during one 24 hours cycle are in the next figure (next page). The air temperature in the test chamber is about 8°C lower than the black plate temperature.



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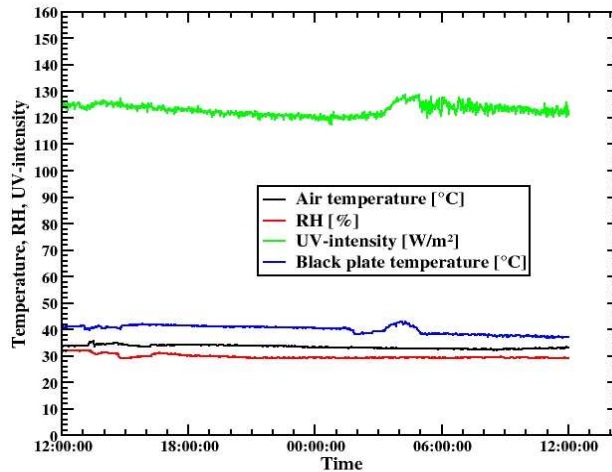
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Analysis:

Radiation correspondence

The mean UV radiation energy in Southern Finland during one year is 54 kWh/m² onto a horizontal surface and 47 kWh/m² onto a south facing vertical surface. Thus at this test the total UV-energy of 84 kWh/m² corresponds to 1.5 years of UV-energy onto a horizontal surface in Southern Finland and 1.8 years of UV-energy onto a south facing vertical surface in Southern Finland.

Colour coordinates

The L*a*b* colour coordinate values and Yellowness Index E313 of the white part of the samples were measured and they are figured. The reflected specular component from the samples is included in the L*a*b* values.

L*-coordinate indicates the lightness of the sample. The bigger the value the lighter the sample.
+a*-coordinate indicates the red direction and -a* indicates the green direction.
+b*-coordinate indicates the yellow direction and -b* indicates the blue direction.

Under ideal viewing conditions a DE value of 1 represents a just perceptible colour difference to the human eye. However the human eye sees differently colour differences in different colours. The differences in darker colours are more perceptible to the eye.

The colour coordinates and colour difference ΔE of the white part of the logos compared to the original colour are figured. The L*-coordinate is in its own figure and a*-, b*-, ΔE and Yellowness Index are in their own figure.



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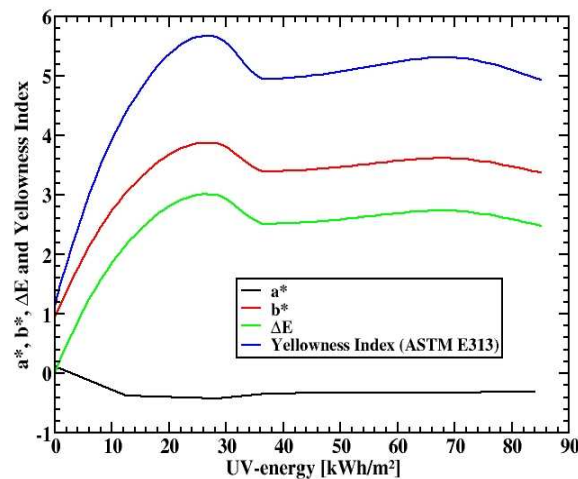
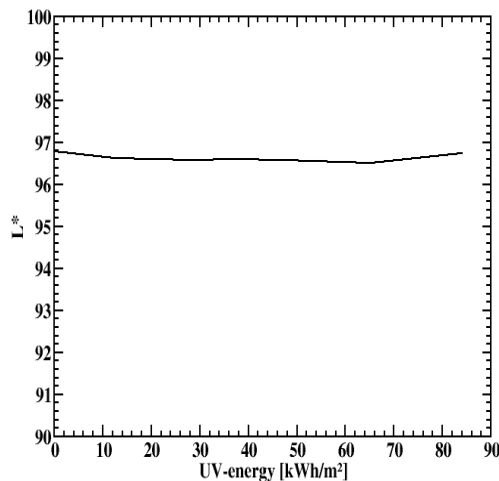
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The L^* -coordinate or the lightness of the white part of the logo did not change very much. And neither the a^* -coordinate changed very much during the test. The changes in the colour difference and Yellowness Index were mostly determined by the change in the b^* -coordinate to the yellow direction. The maximum colour difference and Yellowness Index values were reached after 30 kWh/m² of UV-energy after which the values remained nearly constant. The yellowness of the white part of the logo is not very remarkable. The amount of 30 kWh/m² of UV-energy corresponds to 6.7 months of UV-energy received onto a horizontal surface in Southern Finland.

The white part of the Starcke-logo was a little yellower than the original. At this stage also the highest row of the sample set was covered with an aluminium radiation shield.

In the Starcke-logo the bottom paper first changed to a very yellow tone but then during the test the yellow tone lightened. The hologram part of the Starcke-logo seem to have more red tone nearing the end of the test.

Below are pictures of the samples after 0, 114, 258, 430, 594 and 764 test hours.





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Conclusions:

The strain of the test onto the samples was UV-radiation.

Remarks:

Actions, operations and reporting are in accordance with IEC/ISO 17025 'General requirements for the competence of testing laboratories'.

Signatures:

Littoinen

Timo Oksa
8th of November, 2007

