Report

about the

Artificial weathering with fluorescent UV lamps according to ISO 11507, method A for a coating on textile

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1. Problem, Materials and Exposition

For the examinations, the customer provided a textile specimen with the coating NANO4-PREMIUMTEXTILE. The objective is the assessment of the aging behavior according to ISO 11507, method A. Figure 1 shows a photograph of the textile specimen in the used specimen holders before the weathering started.

Figure 1: Photograph of the textile specimen mounted on the used specimen holders

2. Experimental Details

2.1 Artificial Weathering according to ISO 11507, Method A – Fluorescent UV lamps and Water [1]

INTRODUCTION

For many products, it is necessary to be weather-resistant mainly to UV radiation. However, under "weather-resistant" should be understood the fulfillment of the requirement profile of the products. For example, an aging effect can be existent, if products show optical changings like discolorations or loss of gloss. These effects are a clear fault for the customers. The term **aging** is defined in the standard DIN 50035 as 'the accumulation of irreversible chemical and physical reactions in a materials' [*„die Gesamtheit aller im Laufe der Zeit in einem Material irreversibel ablaufenden chemischen und physikalischen Vorgänge"]* [2].

During the use of technical products, a natural weathering as well as a weathering behind window glass over several years can be occur. Based on the dependency of the results on the weathering location, this means from the local climate, the season as well as the position on the earth, the artificial weathering has significant benefits for the assessment of the weatherability. Predictions, which are independent of the location, are possible by a constant and reproducible irradiance, temperature, and moisture as well as condensation or spray cycles.

The most important thing for the choice of a suitable test method is an adequate simulation of the solar radiation by the used radiation source. This is realized by **xenon-arc lamps** through the usage of proper filters, wherefore the xenon-arc lamps are preferred for the simulation of the global irradiance. The photochemical effective UV and short-wavelengths range is important for the aging of polymers. For such investigations, **fluorescent UV lamps** are used.

For the simulation of the UV radiation in the QUV/SPRAY (Co. Q-LAB CORPORATION, USA), fluorescent UV lamps according to ISO 11507 were used. The radiation emission in the UV range, this means below 400 nm, is minimum 80 % of the total emission. Typically, fluorescent UV lamps are used with a radiation content of less than 2 % below 300 nm and an emission peak at 340 nm (UV-A-340, Type II) [1]. The required spectral distribution is realized through a proper selection of the phosphor coating on the inner surface of the lamps and the used glass type. Figure 2 shows the irradiance of direct sunlight in comparison to the UV radiation of the used UV-A-340 lamp. The solar energy barrier (UV cut-off) is 295 nm and the radiation maximum is 340 nm.

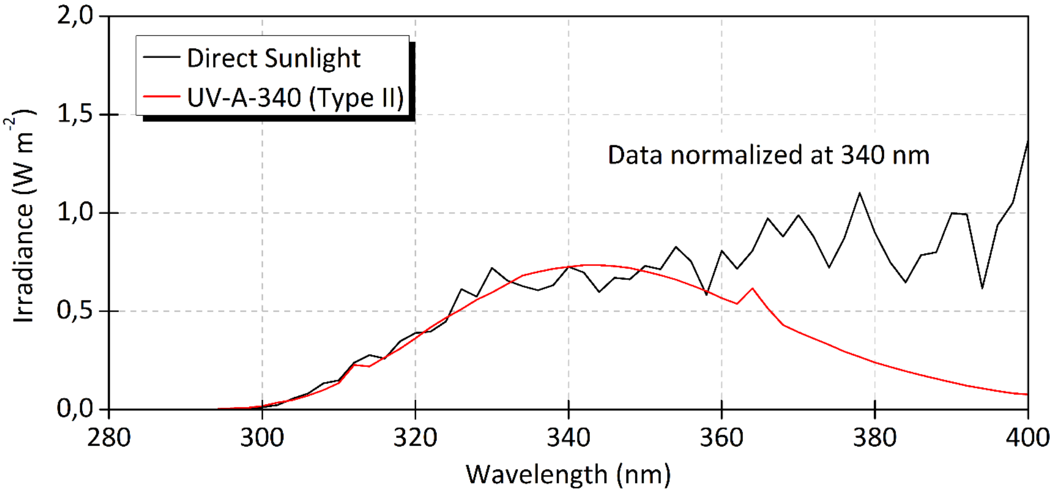

Figure 2: Comparison of the spectrum of the fluorescent UV lamp UV-A-340 (Type II) with direct sunlight [3]

EXPERIMENTAL DETAILS

By the method A – according to ISO 11507 – the specimens were exposed to UV radiation, temperature and condensation phase with distilled water to reproduce weathering effects, which can appear in reality and for the use of the products typical environments (UV radiation) in the material. The test condition are listed below and Figure 3 shows the used accelerated weathering tester QUV/SPRAY.

Table 1: Test conditions according to ISO 11507, method A

Lamp type	UV-A-340 (Type II)
Irradiance E_λ	$0.76\ W \cdot m^{-2} \cdot nm^{-1}$
Black panel temperature	60°C ± 3°C
Black panel temperature during condensation	50°C ± 3°C
Method A:	
Dry phase	4 hours
Condensation	4 hours (UV lamps off)
Exposure time	3500 h

Figure 3: Accelerated weathering tester QUV/SPRAY and water treatment plant type ELIX 15

2.2 Determination the Contact Angle according to DIN 55620-1 and DIN 55620-2 [4, 5]

The determination of the contact angle θ according to DIN 55660-2 took place with distillated water as test liquid. The measurements were realized with the testing device DSA100 TROPFENANALYSE-SYSTEM (DROP ANALYSIS SYSTEM) of the company KRÜSS GmbH, Germany. For the determination of the contact angle θ, the angle to the baseline, which arise to the tangent on the drop contour at the three-phase point, was used. This can be seen schematically in Figure 4.

The determination of the contact angle θ was repeated every 500 h in the center of the specimens. The test conditions are shown in Table 2.

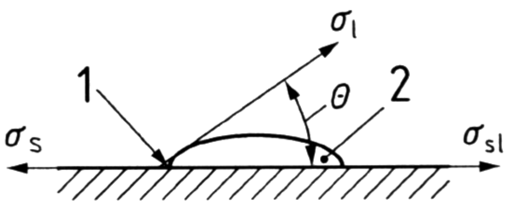

Figure 4: Schematic representation of the contact angle measurements; 1 – three-phase point, 2 – liquid, σ_l – surface energy of the liquid, σ_S – free surface of the solid state surface, σ_{Sl} – interface energy between solid state surface and liquid. θ – contact angle [4]

Table 2: Test conditions for the measurements of the contact angle

Test liquid:	distillated water
Drop capacity:	4 µl
Number of drops:	10
Manner of contact angle measurements:	static
Numerical method (measurement range):	
Young-Laplace equation	20° till 110° and 110° till 180°

3. Results

The contact angle was measured every 500 h within a period of 3500 h. A graphical representation of the result is shown in Figure 5 and a tabular listing can be found in appendix 1. The coating Nano4-PremiumTextile shows an increase in the contact angle from 131.0° to 142.8° after 3500 h weathering, which can be explained with a chemical post-crosslinking.

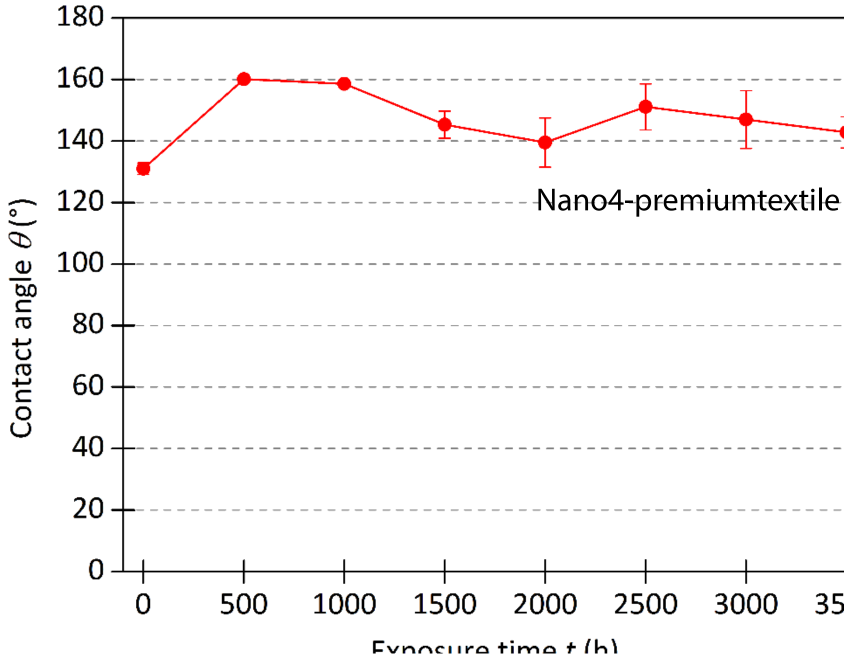

Figure 5: Representation of the contact angle in dependence on exposure time t for Nano4-PremiumTextile

4. Literature

[1] ISO 11507 (2007-05): Paints and varnishes – Exposure of coatings to artificial weathering – Exposure to fluorescent UV lamps and water

[2] DIN 50035 (2012-09): Terms and definitions used on ageing of materials – Polymeric materials

[3] Fowler, S.: Spectral power distribution data for UVA-340 and UVA-351 lamps used in the QUV, and Daylight-Q and Window-Q filters used in the Q-Sun. Q-Lab Corporation, Personal Communication September 6, 2011.

[4] DIN 55660-1 (2011-12): Paints and varnishes – Wettability – Part 1: Terminology and general principles

[5] DIN 55660-2 (2011-12): Paints and varnishes – Wettability – Part 2: Determination of the free surface energy of solid surfaces by measuring the contact angle

Mean value of the contact angle θ (°); Weathering with UV fluorescent lamps according to ISO 11507, method A

Material	Coating	Initial value	SD	500 h	SD	1000 h	SD	1500 h	SD	2000	SD	2500	SA	3000	SD	3500	SA
Textile	NANO4-PREMIUMTEXTILE	**131,0**	1,9	**160,1**	0,7	**158,6**	0,7	**145,3**	4,4	**139,5**	8,0	**151,1**	7,5	**147,0**	9,4	**142,8**	5,1