Work Package 4: supplementary report – results of collaborative work

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1. ANTARES optical observation: protection common research

NUMBER OF PARTNER	COUNTRY	NUMBER OF OBJECTS	NUMBER OF SAMPLES
P3-P4	**ITALY**		**48**

1.1 Information on tested protecting treatments carried out on mock up samples within the companies/research centres and on-site based on the selected sculptures (output wp2 and wp3). Describe your experimental setup, including details on sample preparation, instruments and experimental conditions used. Take into account to name the objectnumber and sample identification.

This work was performed by ANTARES.

The aim of the work were

- to optically evaluate the appearance of samples surfaces before/after protecting treatments and prior/after ageing. This work is a part of the collaborative research aims to study the effectiveness of three coatings applied to low-medium resistance colours in which other 5 partners are involved

Materials

Table 1 Product list with acronyms and information provided by manufacturers/dealers

Support	Paint layers	Protectives
Concrete	Montana Colors MTN 94 RV 245 / Cyan **C**[1]	ACPU-Clear lacquer silky gloss **SC**[2]
	Montana Colors MTN 94 RV 241 / Madrid Red **R**[3]	Multisurface acrylic lacquer **MO**[4]
	Montana Colors MTN 94 RV 2004 / Orange **O**[5]	
	Montana Colors MTN 94 RV 323 / Violet Mandala **V**[6]	Anti-Stain **AN**[7]

48 concrete mock up samples were prepared by University of Vigo and sent to Antares for the observation (**Table 2**)**).**

The samples were divided in 3 sets:

- 1 set of 16 samples of dimension 8x8x2h cm addressed for solar ageing
- 1 set of 16 samples of dimension 3x3x2h cm for UV radiation ageing
- 1 set of 16 samples of dimension 3x3x2h cm as references

Each set was realized as follow:

- 4 samples was painted with each selected spray colors
  - 1 sample with the same color were unprotected
  - 3 samples with the same color were coated with each protective products

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[1] MTN 94 – Cyan – RV 245: Alkyd and solvent based spray paint containing Phtalocyanine pigments (PW6, PB15, PG7, PY42)

[2] Acrylic–polyuretane waterbased coating, code 50.201, supplied by Schmincke

[3] MTN 94 – Madrid Red – RV 241: Alkyd and solvent based spray paint containing Naphtol pigments (PW6, and PR170)

[4] Acrylic waterbased varnish, supplied by Montana Colors

[5] MTN 94 – Orange – RV 2004: Alkyd and solvent based spray paint containing Azo pigments (PW6, PY74, PO34)

[6] MTN 94 – Mandala Violet – RV 323: Alkyd and solvent based spray paint containing Quinacridone pigments (PW6, PR122, PV23

[7] Anti-stain-sacrificial anti-graffiti coating distributed by An.T.A.Res: aqueous emulsion of waxes and organic fluoropolymers.

Table 2 List of the mock up samples of the collaborative research

ID SAMPLE	COLOR	PROTECTIVE LAYER
REFERENCES		
RF-C	CYAN	No protective layer
RF-C-SC		Schmincke's protection
RF-C-MO		MONTANA's protection
RF-C-AN		ANTARES's protection
RF-R	RED	No protective layer
RF-R-SC		Schmincke's protection
RF-R-MO		MONTANA's protection
RF-R-AN		ANTARES's protection
RF-O	ORANGE	No protective layer
RF-O-SC		Schmincke's protection
RF-O-MO		MONTANA's protection
RF-O-AN		ANTARES's protection
RF-V	VIOLET	No protective layer
RF-V-SC		Schmincke's protection
RF-V-MO		MONTANA's protection
RF-V-AN		ANTARES's protection

SAMPLES FOR ARTIFICIAL SOLAR TEST		
S-C	CYAN	No protective layer
S-C-SC		Schmincke's protection
S-C-MO		MONTANA's protection
S-C-AN		ANTARES's protection
S-R	RED	No protective layer
S-R-SC		Schmincke's protection
S-R-MO		MONTANA's protection
S-R-AN		ANTARES's protection
S-O	ORANGE	No protective layer
S-O-SC		Schmincke's protection
S-O-MO		MONTANA's protection
S-O-AN		ANTARES's protection
S-V	VIOLET	No protective layer
S-V-SC		Schmincke's protection
S-V-MO		MONTANA's protection
S-V-AN		ANTARES's protection

SAMPLES FOR QUV TEST		
UV-C	CYAN	No protective layer
UV-C-SC		Schmincke's protection
UV-C-MO		MONTANA's protection
UV-C-AN		ANTARES's protection
UV-R	RED	No protective layer
UV-R-SC		Schmincke's protection
UV-R-MO		MONTANA's protection
UV-R-AN		ANTARES's protection
UV-O	ORANGE	No protective layer
UV-O-SC		Schmincke's protection
UV-O-MO		MONTANA's protection
UV-O-AN		ANTARES's protection
UV-V	VIOLET	No protective layer
UV-V-SC		Schmincke's protection
UV-V-MO		MONTANA's protection
UV-V-AN		ANTARES's protection

Instrumentation

The documentation of samples was carried out by using digital camera Nikon - D3100 under Visible (two vtlamp6 by Velleman, 6500 K), Tiffen color separation guide and gray scale (small) and UV light (portable Wood's lamp - model 31200). Optical observations and photos of all sample surfaces (at least two points for each sample) were performed with LFZNT stereomicroscope (Optech) equipped with Digital camera ISDV5003 and led ring light. Different magnifications were taken into account and the photos on the same points before/after aging were collected with the same setting.

1.2 What are the results from the application of different types of coatings on the ad hoc samples? (table) how did you get the results?

Table 1 – appendix summarized the optical results (see also **Tables 2-7 and Figures 1-4 – appendix)**.

In order to compare the changes between coated, uncoated and aged samples, the evaluation of each surface was focused on the following points:

- Colour
- Clarity
- Sheen
- Morphology
- Fluorescence response (only macro)

Appearance of the paint layers of the reference samples:

- look like typical industrial paints (homogeneity, extra-fine particles, good coverage etc) with rare impurities
- cover the uneven concrete support without completely leveling out it
- are characterized by a widespread microporosity, due to the spray paint technique, both deep, reaching the support, and closed and superficial. In the latter cases, a more matt and sometimes cracked underneath paint layer has been observed into the pores. The dimension, the distribution and the shape of the pores are different, even in samples of the same colour. In general the pores are circular with an average diameter of 40-60 µm, with a small amount of big pores up to 150-300 µm. Bubbles are also present on the cyan an violet samples.
- In general, they consist of overlapping layers, with void spaces between them.
- In general, they appear slightly gloss, especially where a milky and glossy material fill some pores likely due to the accumulation of the biding medium.

Appearance of the treated surfaces compared to the reference ones at h0:

Although we have not compared the same specimens before and after coating application, we can affirm all the coatings have changed the surface appearance:

- ACPU-Clear lacquer film seems to be the thickest and more leveling one, as shown by "micro-island areas" with a very thick film; followed by the Multisurface acrylic lacquer. Anti-Stain forms the thinnest film that doesn't completely cover the paint layer in all areas.
- Multisurface acrylic lacquer seems to modify more the gloss point of the surfaces: it forms a transparent and very gloss film; followed by ACPU-Clear lacquer and Anti-Stain, that show a milky and glossy film.
- Anti-Stain film seems to better respect the original surface appearance.
- Macroscopically, the coatings do not seem to impart a colour, nevertheless slight yellowish accumulations of coatings have been noticed observing the surfaces under stereomicroscope; in particular these areas were evident along the pores' edges and on the lighter paint layers, as the violet and cyan ones.

Observing the surfaces by using a Wood lamp, all the coating has a characteristic fluorescent colour useful to observe their distribution:

- Multisurface acrylic lacquer seems to have a stronger whitish fluorescence colour, ACPU-Clear lacquer and Anti-Stain have a weaker white-yellowish fluorescence colour.
- Despite the uneven support, Multisurface acrylic lacquer seems to form the more homogeneous film, followed by ACPU-Clear lacquer and Anti-stain (that was applied two times, wet on wet, because of the low absorbency of the paint layers).

Appearance of the aged and not treated surfaces compared to the reference ones:

All the paint layers have changed their surface appearance.

- The samples appear less gloss, probably due to a loss of binding medium, especially on the red colour.
- The orange layer was the most changed by ageing: total and superficial fading (more visible after the solar ageing) and whitish spots in the closed porosities were present. Heterogeneous fading of the red paint layer has occurred only under solar ageing and a slightly change of its hue has been noted after UV ageing. The violet and cyan layers seem to have not changed their colour, despite they appear slightly bluer or less yellowish, probably due to a loss of binding medium.
- The surfaces appear more porous and an irregular enlargement (cobweb type) of the pores has been observed; the surfaces seem thinner and appear more arid. The fragile areas characterized by overlapping layers are more present in the blue and violet paints and less evident in the red one. The broken bubbles after aging are clearly visible especially in the cyan and violet colours.
- The orange and secondly red surfaces have shown a different fluorescence response than h0. However, no sample has a characteristic fluorescence colours.

Appearance of the aged treated surfaces compared to the not aged treated/untreated surfaces:

All the paint layers have changed their appearance compared to not aged samples. ACPU-

Clearlaquer

- The surfaces appear totally coated maintaining their glossy appearance.
- Fading of the orange surfaces has been observed, especially after the solar ageing which has also induced chromatic alteration (yellowing) of the coating or/and the paint film (it is not clear). Solar aging has caused cracks and lacunas: macroscopically visible on red and cyan layers and only visible under the microscope on orange and violet ones. These cracks have not been highlighted on aged untreated samples. Only after solar aging, milky white areas due to accumulation of coating have been observed on the violet and orange samples. Whitish and opaque accumulations of coating have been noted on the red and cyan samples. After UV ageing, rare white pustules have been noted especially on orange and red paint layers.
- The paint layers seem thinner, smoother and reflect more the light.
- A slight increase of the pore diameters has been observed, but they maintain their circular shape, the breaking of the bubbles has been observed in particular on the cyan and on the violet, but in a lesser amount than the untreated.
- The white fluorescence colour has resulted very attenuated

Multisurface AL

- The surfaces appear totally coated maintaining their glossy appearance.
- Fading of the orange surfaces has been observed alike to the uncoated aged samples; ageing has also induced chromatic alteration of the coating: yellowing and whitening after solar and UV ageing, respectively. Red sample slightly faded only after solar ageing, and accumulations of milky and whitish coating have been noted after this ageing only on red and violet samples. Otherwise, whitening of the coating has been noted after UV ageing on all the four samples.
- White pustules have been noticed on the cyan layer and in a less amount on the other samples.
  Diameter ranges of the pustules caused by Solar ageing: on the cyan about 200-400 µm (also clustered), on the orange about 230-280 µm, on violet one about 100-240 µm and very few small pustules, about 80-100 µm, have been observed on red sample.
  Diameter ranges of the pustules strongly produced by UV ageing: on the cyan and red: 150-360 µm (on the red layer they also appear clustered), orange about 200-340 µm, rare pustules of about 100-200 µm have been also observed on violet layer.
- Solar ageing has caused micro-cracks only on the violet layer, where the coating whitened.
  No other morphological change has been observed.
- The paint layers seem slightly thinner and reflect more the light.
- The strong and white fluorescence colour of the coating is no longer visible, especially after solar ageing.

Anti-Stain

- The surfaces appear coated but slightly less gloss, especially for the red paint layer.
- Fading of the orange paint layer has been observed especially after solar ageing but in a less way than the other two coatings. On the same paint layer, the solar ageing has also slightly induced a chromatic alteration (yellowing) of (probably) the paint layer in some pores. In general, after ageing whitish spots of the paint layers have been observed alike to the uncoated aged samples. After UV ageing, a whitish patina and cracks of the paint layer have been noted on small areas of the cyan sample. Despite no significant colour change has been noted on the other paint layers, the cyan and violet seem less yellowish and bluer than the not aged samples.
- Important morphological change in all the samples has occurred, almost the same measured on the untreated and aged specimens: strong increase in the amount and dimension of micro porosity (cobweb type, except for the red sample after UV aging), broken bubbles, loss of accumulations and loss of coating films on the top of the pores.
- The paint layers seem thinner, lighter, flatter and reflect more the light.
- The white-yellowish fluorescence colour due to the coating is now very weak, almost no longer visible

1.3 Which of the applied protection treatments were most effective? (in terms of surface changes and of inner properties of the coatings themselves) (best protection and best aesthetic appearance,… test winner) what was your criteria for the evaluation?

None of the protective products tested on the four different paint layers has resulted optimal: all the coatings have changed the appearance of the not treated samples

Despite this, some conclusions can be made.

- ACPU-Clearlaquer: since it forms a very thick and leveling film, it is able to slow down in a significant way the morphological changes caused by ageing. Despite this feature, the coating appears glossier than original painting surfaces and it is not able to protect all the colours from fading. It also does not completely avoid the thinning of the paint layers underneath and sometimes it causes cracks and subsequently lacunas of the paint layers. Yellowing and whitening of the coating have been observed after ageing. It does not seem highly stable.

- Multisurface AL: it forms a thick and homogeneous film that protects the paint surfaces from morphological change due to aging, even if a slight thinning of the layers has been noticed. Despite this characteristic, the coating appears way glossier than the painting surfaces and it is not able to protect all the colours from fading. Yellowing and strong whitening of the coating have been also observed after ageing. It does not seem highly stable.

- Anti-Stain: despite it does not create a very thick and homogeneous film on the sample surfaces, it better respects their original appearance (gloss, morphology) than the other two coatings. Compared to the other coatings, it most mitigates the fading of the unstable painting layer due to ageing. Anti-stain coating has the drawback to not protect the surfaces from morphological changes: after ageing the coated surfaces are quite similar to the uncoated ones after ageing. It seems to be slightly more stable than the other two: no significant whitening/yellowing or chromatically alterated areas have been noted.

1.4 Comments or short conclusion

Data obtained from optical observation of reference and aged samples will be shared with the other partners and compared to other investigations (such as color measurements, chemical analyses) and other studies (developed within Capus and others) in order to define the most effective protection treatments and, at the same time, the requirements that a suitable coating for modern paints should have.

1.5 Appendix

Table 1 Optical observation of paint samples on cement prior and after ageing. The descriptions refer to the coatings when not expressly specified

Sample number	Product	Optical results 0h		Sample number	Optical results after solar ageing 1400h		Sample number	Optical results after UV ageing	
RF-C S-C UV-C		**Colour**	cyan with rare thiny red particles	S-C	**Colour**	paint layer seems more blue	UV-C	**Colour**	paint layer seems more blue
		Clarity	n.a.		**Clarity**	n.a.		**Clarity**	n.a.
		Gloss	slightly gloss		**Gloss**	slightly less gloss		**Gloss**	slightly less gloss
		Morphology	homogeneous, covering and fragile paint film, extrafine particles not visible, widespread circular microporosity, lot of bubbles, widespread overlapping layers with void spaces in between		**Morphology**	strong increase of amount and dimension of micropores that take on an irregular shape, presence of broken bubbles, surface seems flatter, multiple layers still visible		**Morphology**	strong increase of amount and dimenion of micropores that take on an irregular shape, presence of broken bubbles, surface seems flatter, multiple layers still visible
		Other	accumulation of transparent material along the pores' edges		**Other**	transparent material no longer visible along the pores' edges		**Other**	transparent material no longer visible along the pores' edges
		Fluorescence response	none		**Fluorescence response**	none		**Fluorescence response**	none
RF-R S-R UV-R		**Colour**	red	S-R	**Colour**	superficial and heterogeneous fading	UV-R	**Colour**	slight change of hue
		Clarity	n.a.		**Clarity**	n.a.		**Clarity**	n.a.
		Gloss	slightly gloss		**Gloss**	slightly less gloss		**Gloss**	heterogeneous loss of gloss (matt areas)
		Morphology	homogeneous, covering and compact paint film, extrafine particles not visible, widespread circular microporosity, very few bubbles, overlapping layers with void spaces in between only around jutting areas		**Morphology**	slight increase of amount and dimension of micropores that take on an irregular shape, presence of broken bubbles, surface seems flatter, multiple layers still visible		**Morphology**	slight increase of amount and dimension of micropores that take on an irregular shape, presence of broken bubbles, surface seems flatter, multiple layers still visible
		Other	matt areas inside the bigger and closed pores		**Other**	matt areas inside the bigger and closed pores still present		**Other**	matt areas inside the bigger and closed pores still present
		Fluorescence response	none		**Fluorescence response**	none		**Fluorescence response**	none
RF-O S-O UV-O		**Colour**	orange with rare thiny red particles	S-O	**Colour**	superficial, strong and homogeneous fading (ie. less in the inner layers)	UV-O	**Colour**	superficial, slight and homogeneous fading (ie. less in the inner layers)
		Clarity	n.a.		**Clarity**	n.a.		**Clarity**	n.a.
		Gloss	slightly gloss		**Gloss**	slightly less gloss		**Gloss**	slightly less gloss
		Morphology	homogeneous, covering and fragile paint film, extrafine particles not visible, widespread circular microporosity, few bubbles, widespread overlapping layers with void spaces in between		**Morphology**	strong increase of amount and dimension of micropores that take on an irregular shape, presence of broken bubbles, surface seems flatter, multiple layers still visible		**Morphology**	strong increase of amount and dimension of micropores that take on an irregular shape, presence of broken bubbles, surface seems flatter, multiple layers still visible
		Other	accumulation of transparent material along the pores' edges, accumulation of milky and gloss material inside the pores		**Other**	transparent material no longer visible along the pores' edges, whitish stains where milky and gloss material were present		**Other**	transparent material no longer visible along the pores' edges, whitish stains where milky and gloss material were present
		Fluorescence response	none		**Fluorescence response**	none		**Fluorescence response**	none
RF-V S-V UV-V		**Colour**	violet with rare tiny red particles	S-V	**Colour**	paint layer seems more blue	UV-V	**Colour**	paint layer seems more blue
		Clarity	n.a.		**Clarity**	n.a.		**Clarity**	n.a.
		Gloss	slightly gloss		**Gloss**	slightly less gloss		**Gloss**	slightly less gloss
		Morphology	homogeneous, covering and fragile paint film, extrafine particles not visible, widespread both circular and irregular microporosity, lot of bubbles, widespread overlapping layers with void spaces in between		**Morphology**	strong increase of amount and dimension of micropores that take on an irregular shape, presence of broken bubbles, surface seems flatter, multiple layers still visible		**Morphology**	strong increase of amount and dimension of micropores that take on an irregular shape, presence of broken bubbles, surface seems flatter, multiple layers still visible
		Other	accumulation of transparent material along the pores' edges		**Other**	transparent material no longer visible along the pores' edges		**Other**	transparent material no longer visible along the pores' edges
		Fluorescence response	none		**Fluorescence response**	none		**Fluorescence response**	none

RF-C-SC S-C-SC SC UV-C-	ACPU-Clear lacquer silky gloss	**Colour**	colourless coating with yellowish accumulations	S-C-SC	**Colour**	paint layer seems more blue, the yellowish accumulations are less yellow, presence of rare whitish areas	UV-C-SC	**Colour**	paint layer seems more blue, the yellowish accumulations are less yellow, presence of rare whitish areas
		Clarity	slight milky		**Clarity**	slight milky, with rare opaque areas		**Clarity**	slight milky, with rare opaque areas
		Gloss	glossy		**Gloss**	glossy, reflect more the light		**Gloss**	glossy, reflect more the light
		Morphology	very thick and leveling		**Morphology**	slight increase of micropores' dimensions, presence of few broken bubbles and cracks with subsequent coating/paint layer lacunas, surface seems flatter and the coating appears smoother, multiple layers still visible		**Morphology**	slight increase of micropores' dimensions, presence of few broken bubbles, surface seems flatter and the coating appears smoother, multiple layers still visible
		Other			**Other**			**Other**	
		Fluorescence response	weak white-yellowish colour		**Fluorescence response**	weaker white-yellowish colour		**Fluorescence response**	weaker white-yellowish colour
RF-R-SC S-R-SC SC UV-R-		**Colour**	colourless coating	S-R-SC	**Colour**	paint layer slightly faded, rare whitish areas on coating	UV-R-SC	**Colour**	paint layer slightly changed its hue, rare whitish areas on coating
		Clarity	slight milky		**Clarity**	slight milky, with rare opaque areas		**Clarity**	slight milky, with rare opaque areas
		Gloss	glossy		**Gloss**	glossy, reflect more the light		**Gloss**	glossy, reflect more the light
		Morphology	very thick and leveling		**Morphology**	slight increase of micropores' dimensions, presence of cracks with subsequent coating/paint layer lacunas, surface seems flatter and the coating appears smoother, multiple layers still visible		**Morphology**	slight increase of micropores' dimensions, surface seems flatter and the coating appears smoother, presence of rare tiny white circular jutting accumulations, multiple layers still visible
		Other			**Other**			**Other**	
		Fluorescence response	weak white-yellowish colour		**Fluorescence response**	weaker white-yellowish colour, more light		**Fluorescence response**	weaker white-yellowish colour, more light
RF-O-SC S-O-SC UV-O- SC		**Colour**	colourless coating	S-O-SC	**Colour**	paint layer homogeneously faded, chromatic alteration of paint layer/coating (?) (yellowing), bleached areas on coating	UV-O-SC	**Colour**	paint layer homogeneously faded
		Clarity	slight milky		**Clarity**	slight milky, with opaque areas		**Clarity**	slight milky
		Gloss	glossy		**Gloss**	glossy, reflect more the light		**Gloss**	glossy, reflect more the light
		Morphology	very thick and leveling		**Morphology**	slight increase of micropores' dimensions, presence of tiny cracks with subsequent coating/paint layer lacunas, surface seems flatter and the coating appears smoother, multiple layers still visible		**Morphology**	slight increase of micropores' dimensions, surface seems flatter and the coating appears smoother, presence of rare tiny white circular jutting accumulations, multiple layers still visible
		Other			**Other**			**Other**	
		Fluorescence response	weak white-yellowish colour		**Fluorescence response**	weaker white-yellowish colour, more light, the bleached areas are more evident		**Fluorescence response**	weaker white-yellowish colour, but slightly more yellowish, more light
RF-V-SC S-V-SC UV-V- SC		**Colour**	colourless coating with yellowish accumulations	S-V-SC	**Colour**	paint layer seems more blue, the yellowish accumulations are less yellow, bleached areas on coating	UV-V-SC	**Colour**	paint layer seems more blue, the yellowish accumulations are less yellow, rare whitish areas on coating
		Clarity	slight milky		**Clarity**	slight milky, with opaque areas		**Clarity**	slight milky, with rare opaque areas
		Gloss	glossy		**Gloss**	glossy, reflect more the light		**Gloss**	glossy, reflect more the light
		Morphology	very thick and leveling		**Morphology**	slight increase of micropores' dimensions, presence of few broken bubbles and tiny cracks with subsequent coating/paint layer lacunas, surface seems flatter and the coating appears smoother, multiple layers still visible		**Morphology**	slight increase of micropores' dimensions, presence of few broken bubbles, surface seems flatter and the coating appears smoother, multiple layers still visible
		Other			**Other**			**Other**	
		Fluorescence response	weak white-yellowish colour		**Fluorescence response**	weaker white-yellowish colour, the bleached areas are more evident		**Fluorescence response**	weaker white-yellowish colour

RF-C-MO S-C-MO C-MO UV-	Multisurface acrylic lacquer	**Colour**	Colourless coating with yellowish accumulations	S-C-MO	**Colour**	Paint layer seems more blue, the yellowish accumulations are less yellow, presence of rare whitish areas	UV-C-MO	**Colour**	Paintlayerseemsmoreblue,theyellowishaccumulations are less yellow, widespread milky and whitened areas of coating
		Clarity	clear		**Clarity**	clear with rare opaque and milky areas		**Clarity**	milky and opaque
		Gloss	very glossy		**Gloss**	very glossy, reflect more the light		**Gloss**	very glossy, reflect more the light
		Morphology	thick and homogeneously spread		**Morphology**	surface seems flatter, presence of tiny white circular jutting accumulations, multiple layers still visible		**Morphology**	surfaceseemsflatter,strongpresenceoftinywhitecircular jutting accumulations, multiple layers still visible
		Other			**Other**			**Other**	
		Fluorescence response	strong white colour		**Fluorescence response**	the strong white colour is no longer visible, but the tiny white circular jutting accumulations are evident		**Fluorescence response**	the strong white colour is now weakened and the tiny white circular jutting accumulations are evident
RF-R-MO S-R-MO R-MO UV-		**Colour**	colourless coating	S-R-MO	**Colour**	Paint layer slightly faded, whitened areas of coating	UV-R-MO	**Colour**	Paint layer slightly changed its hue, milky and whitened areas of coating
		Clarity	clear		**Clarity**	clear with opaque and milky areas		**Clarity**	slight milky and opaque
		Gloss	very glossy		**Gloss**	very glossy, reflect more the light		**Gloss**	very glossy, reflect more the light
		Morphology	thick and homogeneously spread		**Morphology**	surface seems flatter, rare presence of tiny white circular jutting accumulations, multiple layers still visible		**Morphology**	surfaceseemsflatter,strongpresenceoftinywhitecircular jutting accumulations, multiple layers still visible
		Other			**Other**			**Other**	
		Fluorescence response	strong white colour		**Fluorescence response**	the strong white colour is no longer visible but the tiny white circular jutting accumulations are evident		**Fluorescence response**	the strong white colour is now weakened and the tiny white circular jutting accumulations are evident
RF-O-MO S-O-MO UV- O-MO		**Colour**	colourless coating	S-O-MO	**Colour**	Paint layer homogeneously faded, yellowish coating's accumulations	UV-O-MO	**Colour**	Paint layer homogeneously faded, widespread milky and whitened areas of coating
		Clarity	clear		**Clarity**	clear with opaque and milky areas		**Clarity**	milky and opaque
		Gloss	very glossy		**Gloss**	very glossy, reflect more the light		**Gloss**	very glossy, reflect more the light
		Morphology	thick and homogeneously spread		**Morphology**	surface seems flatter, presence of rare tiny white circular jutting accumulations, multiple layers still visible		**Morphology**	surfaceseemsflatter,strongpresenceoftinywhitecircular jutting accumulations, multiple layers still visible
		Other			**Other**			**Other**	
		Fluorescence response	strong white colour		**Fluorescence response**	the strong white colour is no longer visible but the tiny white circular jutting accumulations are evident		**Fluorescence response**	the strong white colour is now weakened and the tiny white circular jutting accumulations are evident
RF-V-MO S-V-MO UV- V-MO		**Colour**	colourless coating with yellowish accumulations	S-V-MO	**Colour**	Paint layer seems more blue, the yellowish accumulations are less yellow, whitened areas of coating	UV-V-MO	**Colour**	Paintlayerseemsmoreblue,theyellowishaccumulations are less yellow, rare whitish areas on coating
		Clarity	clear		**Clarity**	clear with opaque and milky areas		**Clarity**	clear with slightly opaque and milky areas
		Gloss	very glossy		**Gloss**	very glossy, reflect more the light.		**Gloss**	very glossy, reflect more the light.
		Morphology	thick and homogeneously spread		**Morphology**	cracks on the paint layer, surface seems flatter, presence of rare tiny white circular jutting accumulations, multiple layers still visible		**Morphology**	presence of few broken bubbles, surface seems flatter, presence of rare tiny white circular jutting accumulations, multiple layers still visible
		Other			**Other**			**Other**	
		Fluorescence response	strong white colour		**Fluorescence response**	the strong white colour is no longer visible		**Fluorescence response**	the strong white colour is now weakened and the tiny white circular jutting accumulations are evident

Anti-Stain

RF-C-AN S-C-AN UV-C-AN	**Colour**	colourless coating with slight yellowish accumulations	S-C-AN	**Colour**	colourless coating. Paint layer seems more blue, the yellowish accumulations appears less yellow	UV-C-AN	**Colour**	colorlesscoating.Paintlayerseemsmoreblue,theyellowish accumulationsappearlessyellow,rarewhitetiny areason coating
	Clarity	slight milky		**Clarity**	slight milky		**Clarity**	slight milky, with rare whitish and opaque areas
	Gloss	slightly glossy		**Gloss**	slightly glossy and reflect more the light.		**Gloss**	slightly less glossy, but reflects more the light.
	Morphology	very thin and not homogeneous		**Morphology**	strongincreaseofamountanddimensionof micropores that take on an irregular shape, presence of broken bubbles, surface seems flatter, multiple layers particularly visible		**Morphology**	strongincreaseofamountanddimensionofmicropores that take on an irregular shape, presence of broken bubbles and rare tiny cracks inside some pores, surface seems flatter, multiple layers particularly visible
	Other	pores covered by a thin film of coating		**Other**	coating no longer visible on the top of the pores		**Other**	coating no longer visible on the top of the pores
	Fluorescence response	weak white-yellowish colour		**Fluorescence response**	the weak white-yellowish colour is no longer visible		**Fluorescence response**	the weak white-yellowish colour is no longer visible
RF-R-AN S-R-AN UV-R-AN	**Colour**	colourless coating	S-R-AN	**Colour**	colourless coating	UV-R-AN	**Colour**	colourless coating
	Clarity	slight milky		**Clarity**	slight milky		**Clarity**	slight milky
	Gloss	slightly glossy		**Gloss**	slightlylessglossy,butreflectsmorethelight.		**Gloss**	slightly less glossy, but reflects more the light.
	Morphology	very thin and not homogeneous		**Morphology**	increase of amount and dimension of micropores that take on an irregular shape, presence of broken bubbles, surface seems flatter, multiple layers particularly visible		**Morphology**	increaseofamountanddimensionofmicroporesthattake on an irregular shape, presence of broken bubbles, surface seems flatter, multiple layers particularly visible
	Other	pores covered by a thin film of coating		**Other**	coating no longer visible on the top of the pores		**Other**	coating no longer visible on the top of the pores
	Fluorescence response	weak white-yellowish colour		**Fluorescence response**	the weak white-yellowish colour is no longer visible		**Fluorescence response**	the weak white-yellowish colour is no longer visible
RF-O-AN S-O-AN UV-O-AN	**Colour**	colourless coating	S-O-AN	**Colour**	colourless coating. Paint layer homogeneously faded, yellowish areas inside some pores	UV-O-AN	**Colour**	colourless coating. Paint layer slightly faded
	Clarity	slight milky		**Clarity**	slight milky		**Clarity**	slight milky
	Gloss	slightly glossy		**Gloss**	slightly glossy and reflect more the light.		**Gloss**	slightly less glossy, but reflects more the light.
	Morphology	very thin and not homogeneous		**Morphology**	strongincreaseofamountanddimensionof micropores that take on an irregular shape, presence of broken bubbles, surface seems flatter, multiple layers particularly visible		**Morphology**	strongincreaseofamountanddimensionofmicropores that take on an irregular shape, presence of broken bubbles, surface seems flatter, multiple layers particularly visible
	Other	pores covered by a thin film of coating		**Other**	coating no longer visible on the top of the pores, whitish stains particularly visible on paint layer where milky and glossy accumulations were present		**Other**	coating no longer visible on the top of the pores, whitish stains particularly visible on paint layer where milky and glossy accumulations were present
	Fluorescence response	weak white-yellowish colour		**Fluorescence response**	theweakwhite-yellowishcolouris nolonger visible		**Fluorescence response**	the weak white-yellowish colour is no longer visible
RF-V-AN S-V-AN UV-V-AN	**Colour**	colourless coating, with slight yellowish accumulations	S-V-AN	**Colour**	colourless coating, paint layer seems more blue, the yellowish accumulations appear less yellow	UV-V-AN	**Colour**	colourlesscoating,paintlayerseemsmoreblue,the yellowishaccumulations appear less yellow
	Clarity	slight milky		**Clarity**	slight milky		**Clarity**	slight milky
	Gloss	slightly glossy		**Gloss**	slightly glossy and reflect more the light.		**Gloss**	slightly less glossy, but reflects more the light.
	Morphology	very thin and not homogeneous		**Morphology**	strongincreaseofamountanddimensionof micropores that take on an irregular shape, presence of broken bubbles, surface seems flatter, multiple layers still visible		**Morphology**	strongincreaseofamountanddimensionofmicropores that take on an irregular shape, presence of broken bubbles, surface seems flatter, multiple layers still visible
	Other	pores covered by a thin film of coating		**Other**	coating no longer visible on the top of the pores		**Other**	coating no longer visible on the top of the pores
	Fluorescence response	weak white-yellowish colour		**Fluorescence response**	the weak white-yellowish colour is no longer visible		**Fluorescence response**	the weak white-yellowish colour is no longer visible

Table 2 Images under stereomicroscope of reference samples and samples with coatings before ageing.

Magnification 7x (on the left) and 45x (on the right)

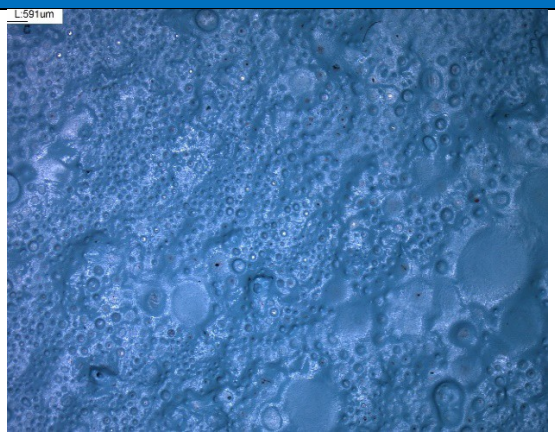
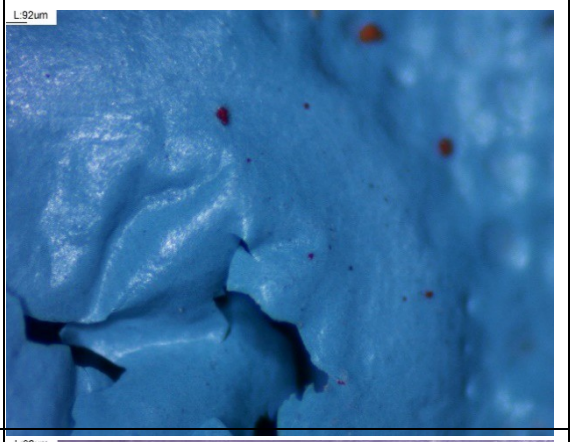
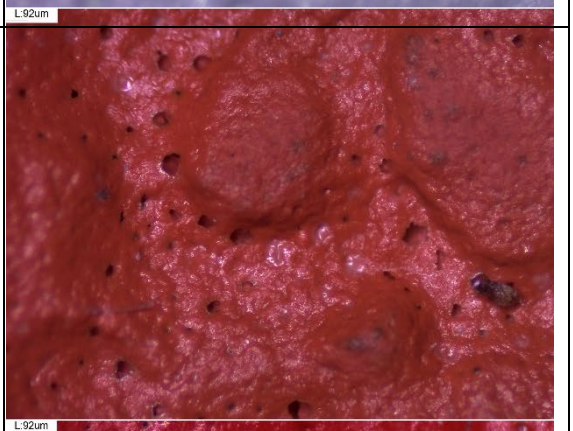
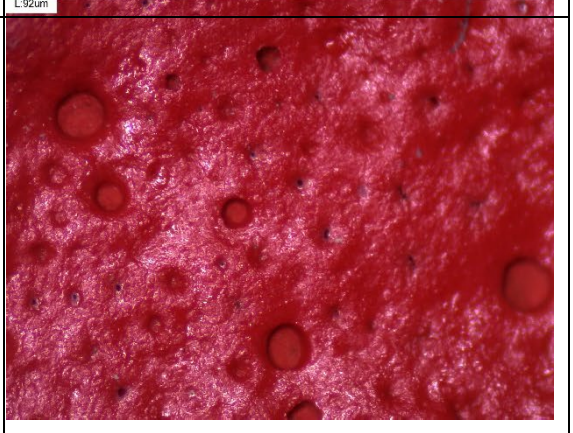
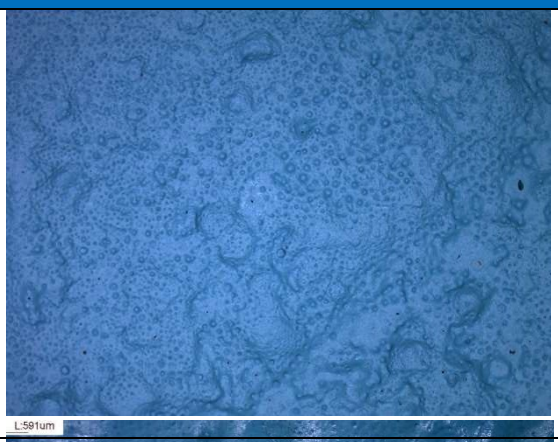
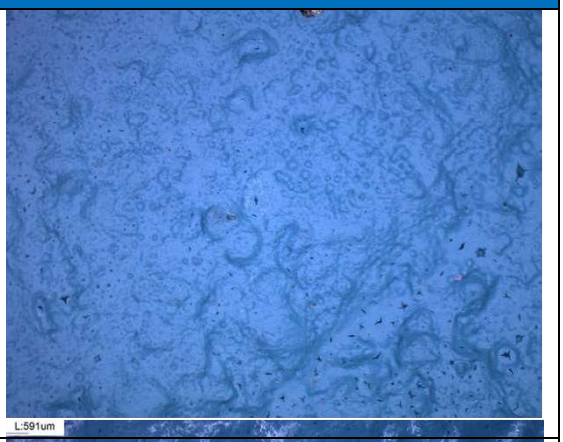
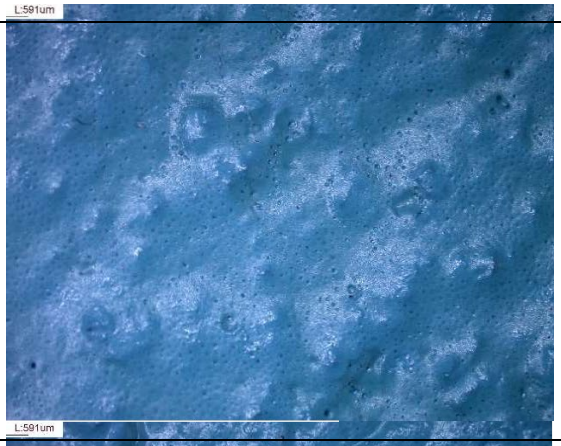
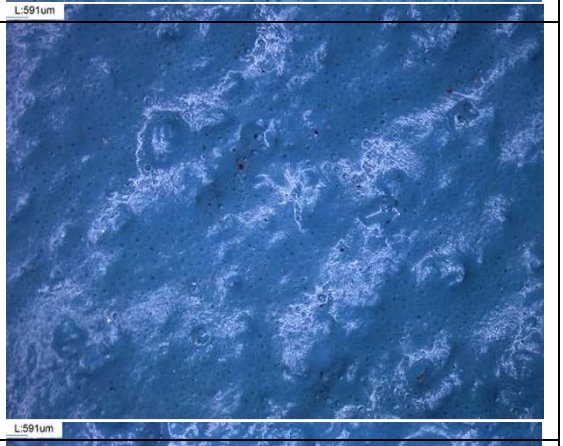
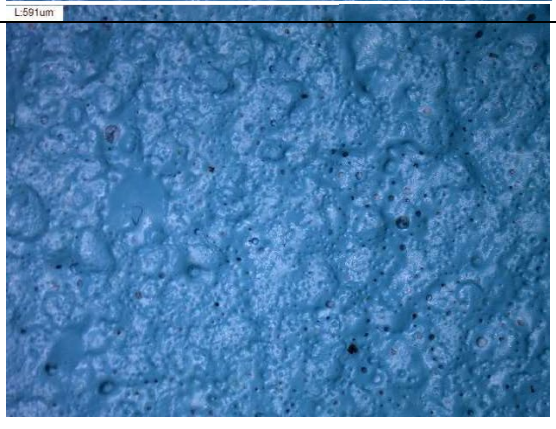
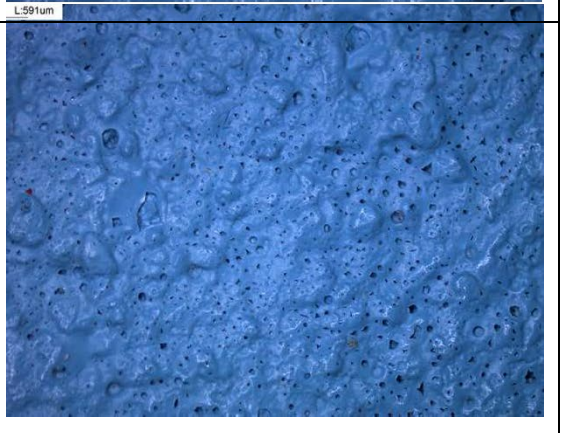
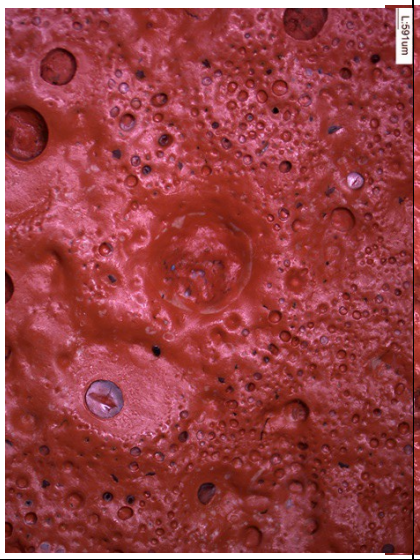
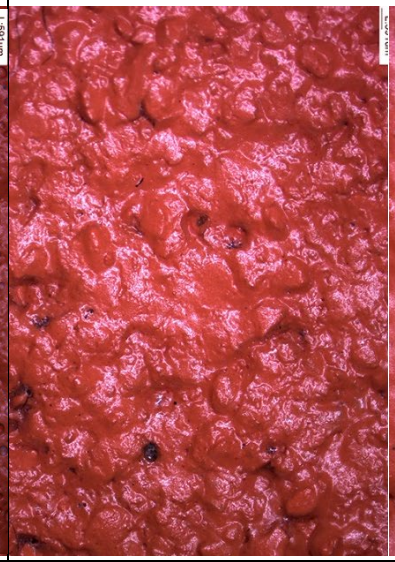
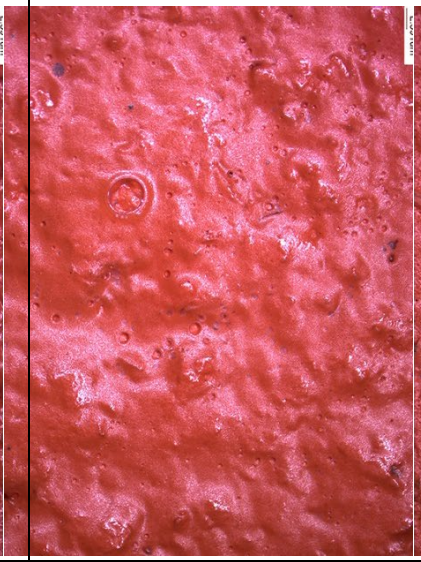
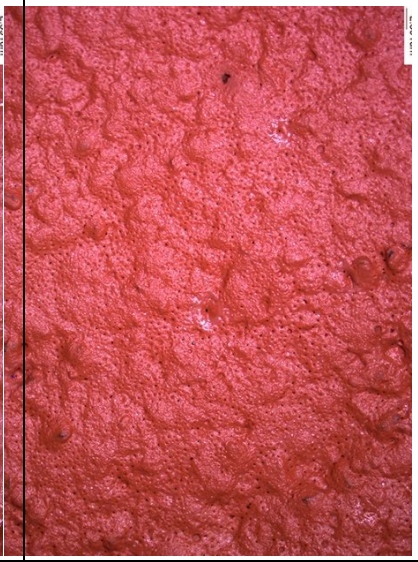
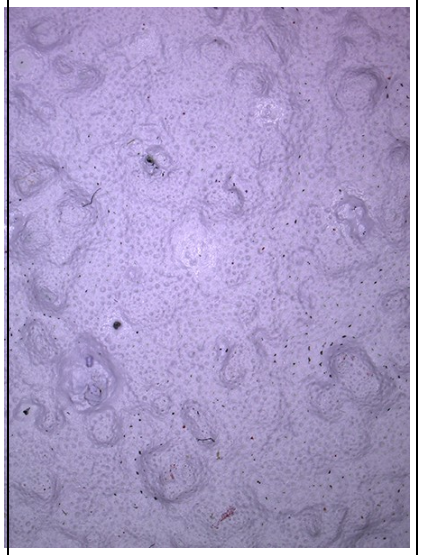
REFERENCE SAMPLES			
S-C		S-C	
RF-V		RF-V	
S-O		S-O	
S-R		S-R	

Table 3 Images under stereomicroscope of samples before and after solar ageing. Magnification 7x

	SAMPLES BEFORE SOLAR AGEING		SAMPLES AFTER SOLAR AGEING	
S-C				
S-C-SC				
S-C-MO				
S-C-AN				

S-O-AN	S-O-MO	S-O-SC	S-O
			
S-O-AN	**S-O-MO**	**S-O-SC**	**S-O**
			

S-V-AN	S-V-MO	S-V-SC	S-V
			
S-V-AN	**S-V-MO**	**S-V-SC**	**S-V**
			

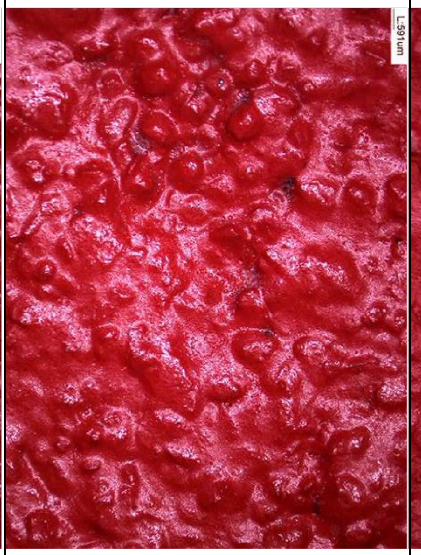
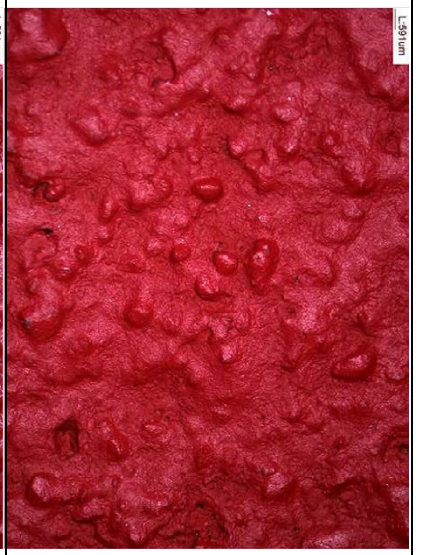
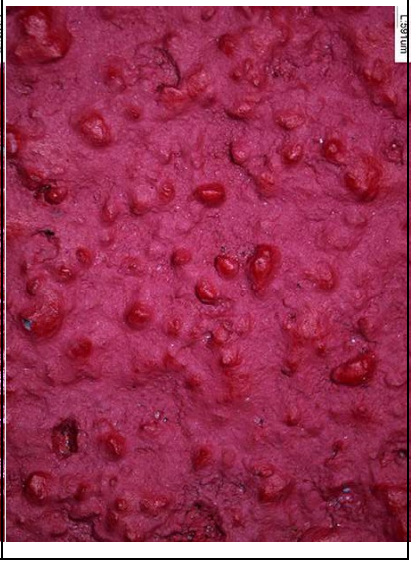
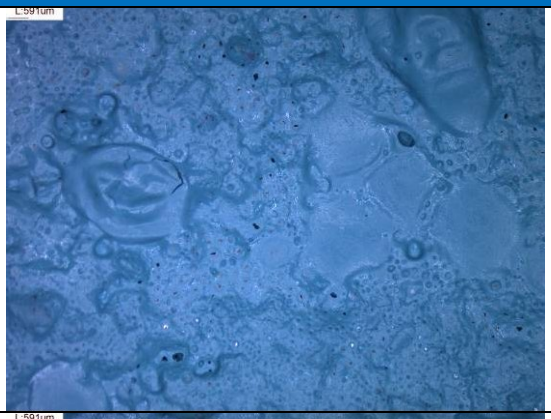
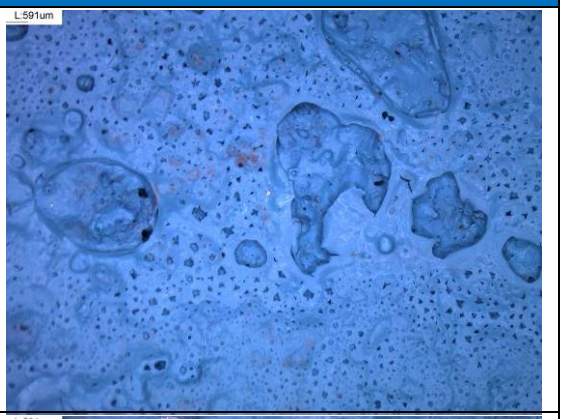
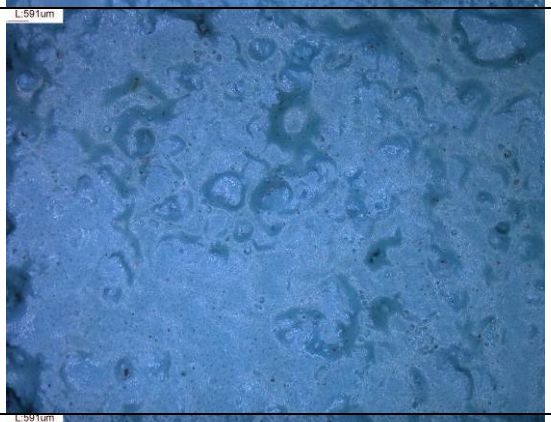
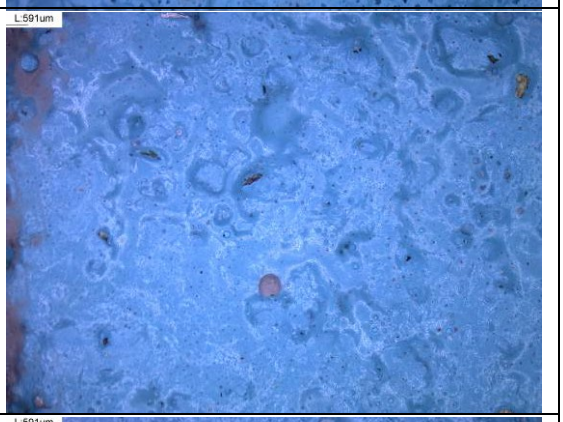
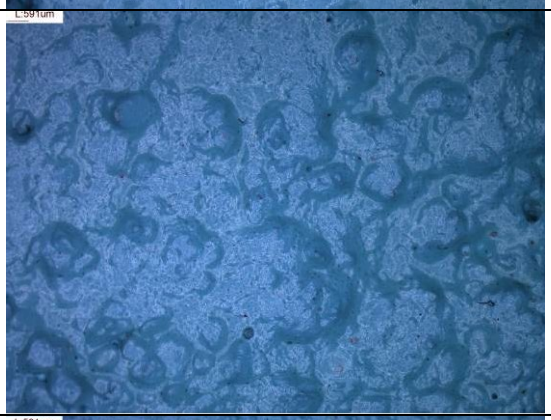
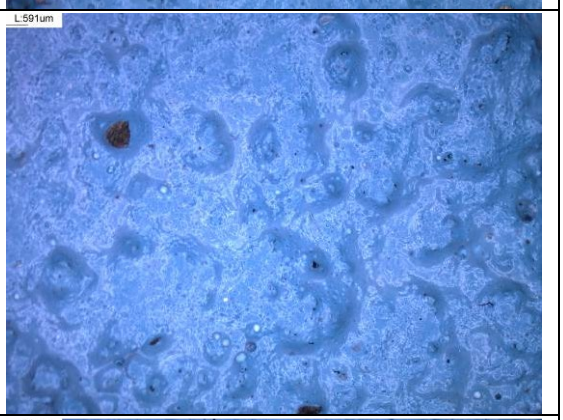
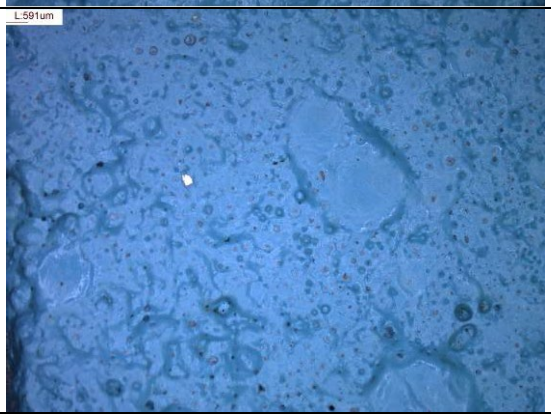
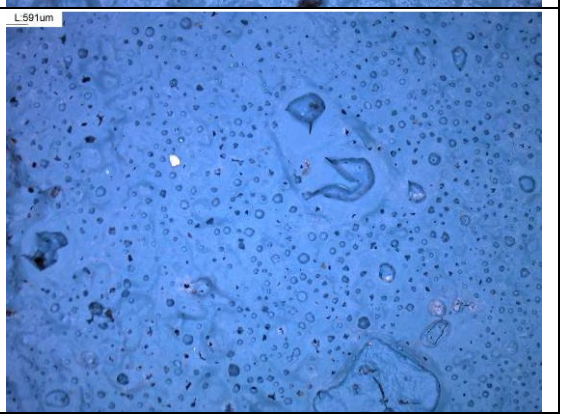
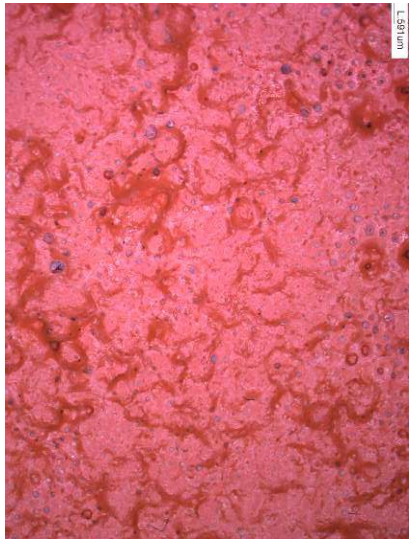
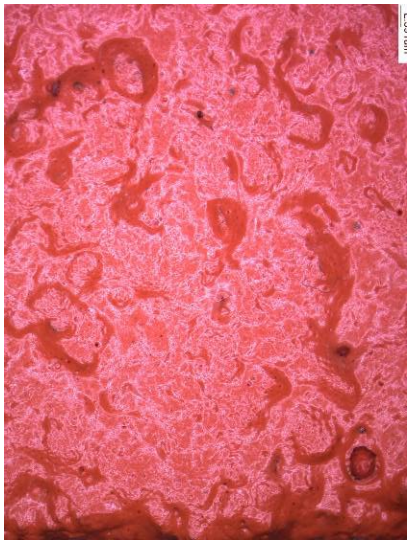
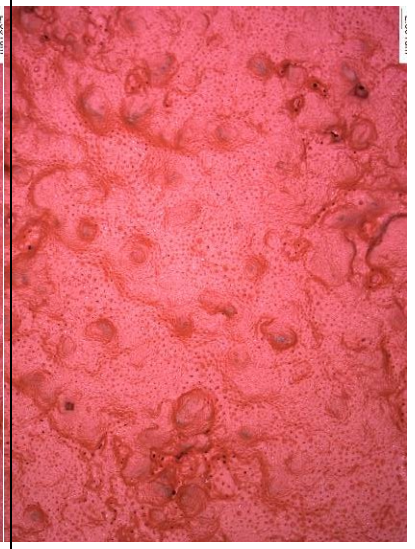
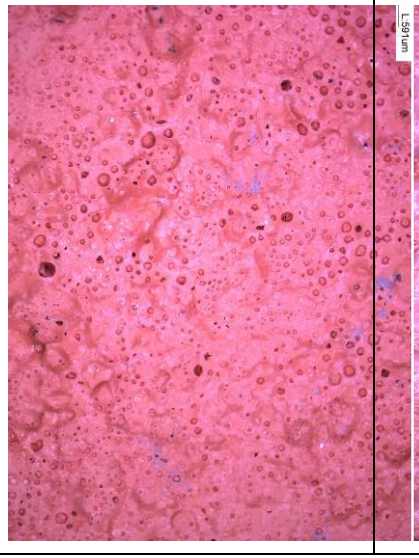
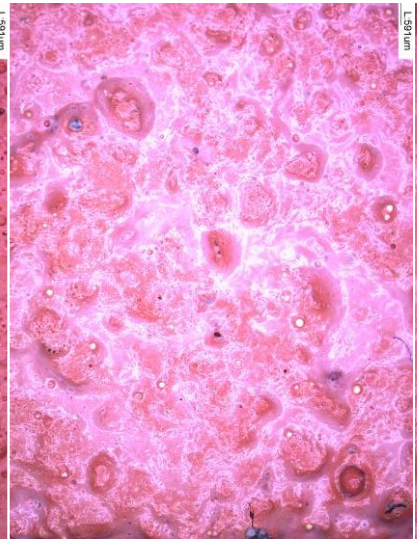
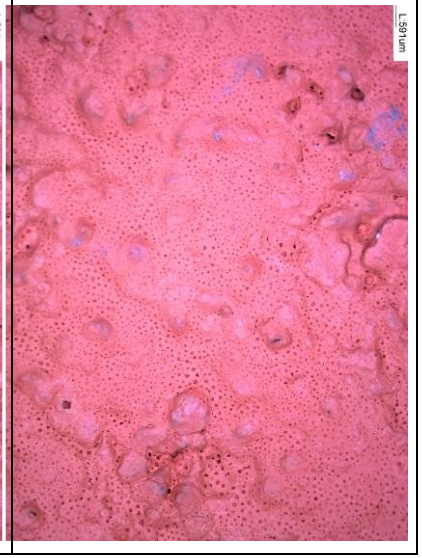
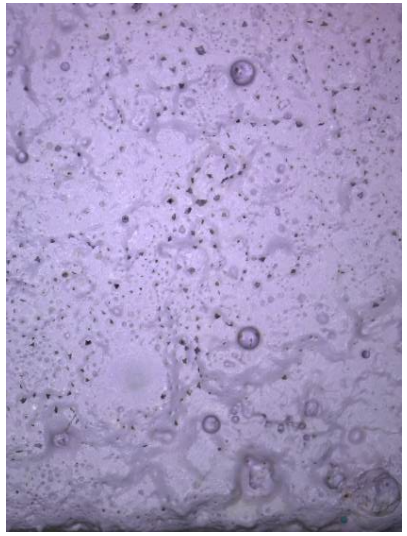
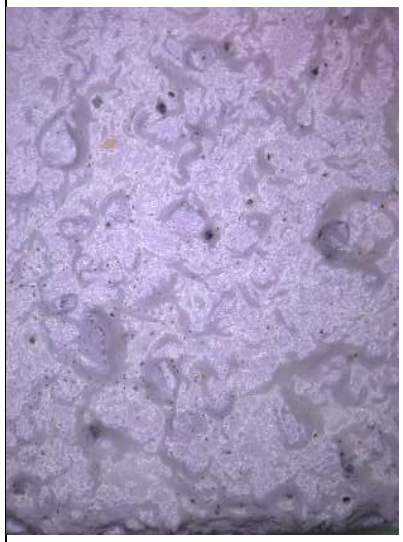
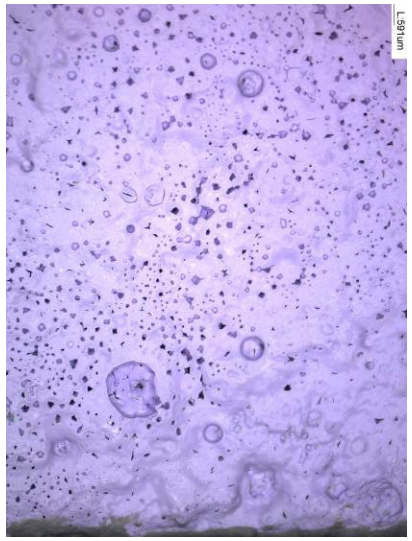
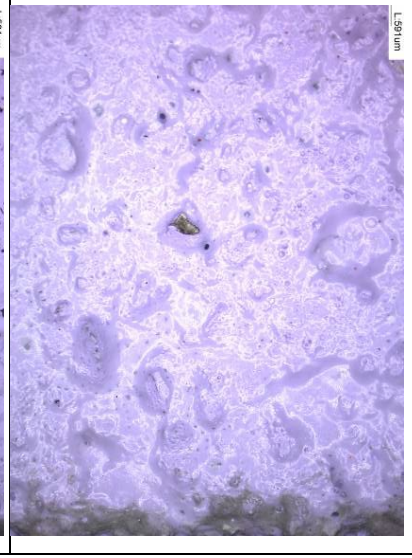
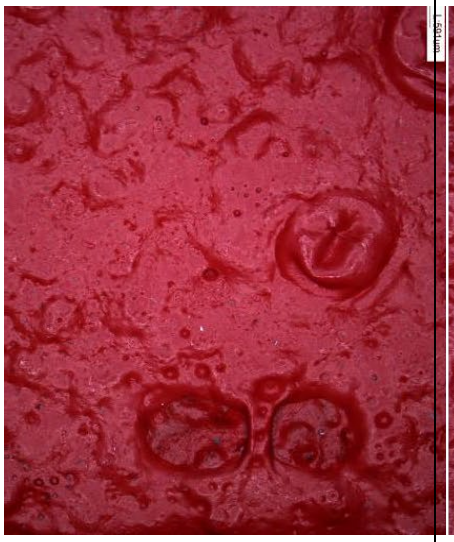
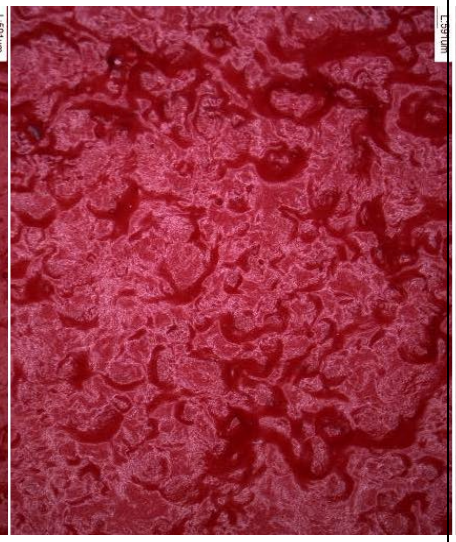
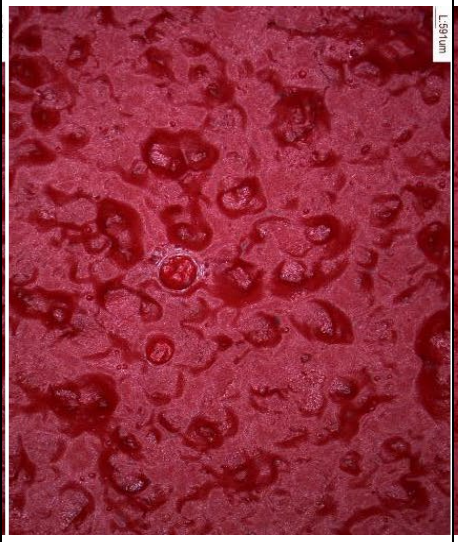
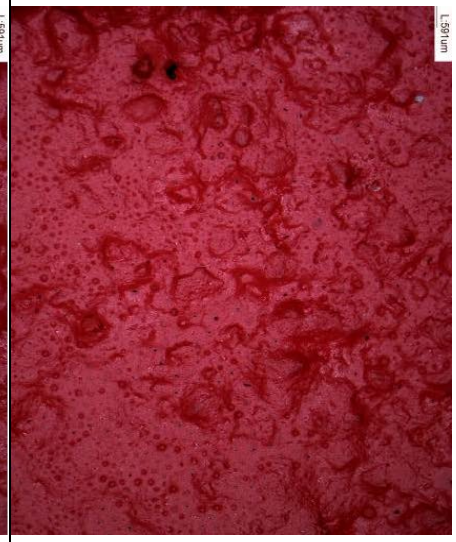
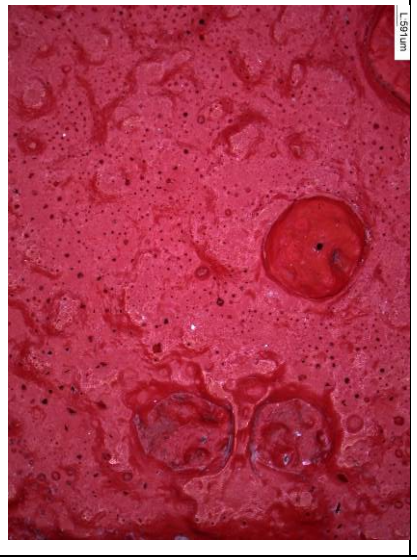
S-R-AN	S-R-MO	S-R-SC	S-R
			
S-R-AN	**S-R-MO**	**S-R-SC**	**S-R**
			

Table 4 Images under stereomicroscope of samples before and after UV ageing. Magnification 7x

	SAMPLES BEFORE UV AGEING		SAMPLES AFTER UV AGEING
UV-C		UV-C	
UV-C-SC		UV-C-SC	
UV-C-MO		UV-C-MO	
UV-C-AN		UV-C-AN	

UV-O-AN	UV-O-MO	UV-O-SC	UV-O
			
UV-O-AN	**UV-O-MO**	**UV-O-SC**	**UV-O**
			

UV-V-AN	UV-V-MO	UV-V-SC	UV-V
			
UV-V-AN	**UV-V-MO**	**UV-V-SC**	**UV-V**
			

UV-R- AN	UV-R- MO	UV-R- SC	UV-R
			
UV-R- AN	**UV-R- MO**	**UV-R -SC**	**UV-R**
			

Below the photos under UV light of the reference samples and the ones treated with the three selected coatings

Table 5 Uncoated and coated samples under UV light prior to ageing

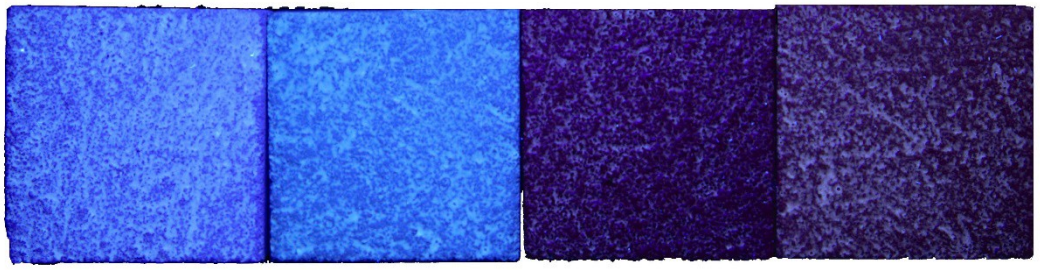
Reference samples (not protected)	
ACPU-clearlaquer (Schmincke)	
Multisurface Acrylic lacquer (Montana)	
Anti-Stain (An.T.A.Res)	

Table 6 Uncoated and coated samples under UV light after solar ageing

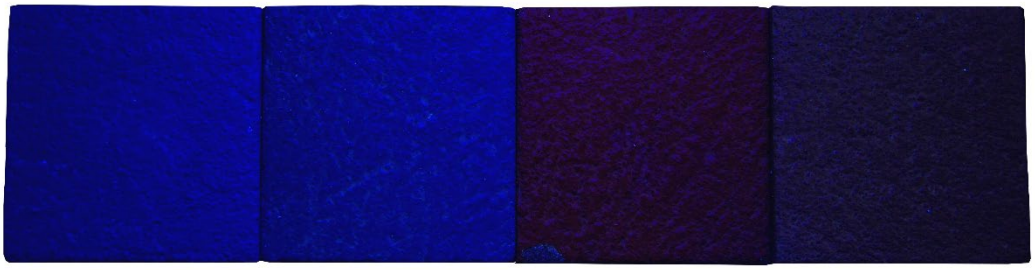
Reference samples (not protected)	
ACPU-clearlaquer (Schmincke)	
Multisurface Acrylic lacquer (Montana)	
Anti-Stain (An.T.A.Res)	

Table 7Uncoated and coated samples under UV light after UV ageing

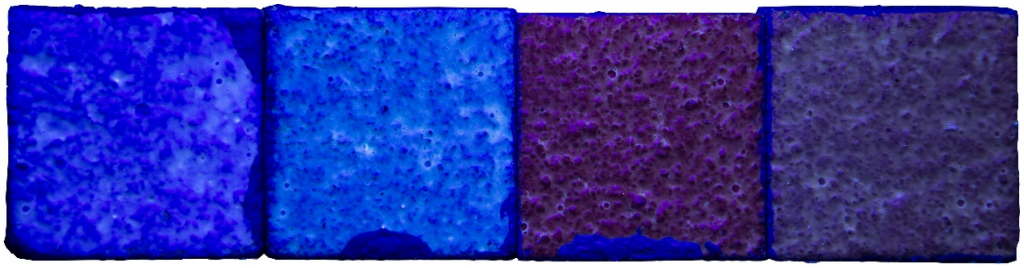
Reference samples (not protected)	
ACPU-clearlaquer (Schmincke)	
Multisurface Acrylic lacquer (Montana)	
Anti-Stain (An.T.A.Res)	

Figure 1 uncoated reference not aged samples (first row from the bottom), uncoated samples after UV aging (second row), uncoated samples after Solar aging (first row from the top)

Figure 2 samples coated with ACPU-Clearlaquer and reference uncoated samples (bottom)

Figure 3 samples coated with Multisurface Acrylic laquer and reference uncoated samples (bottom)

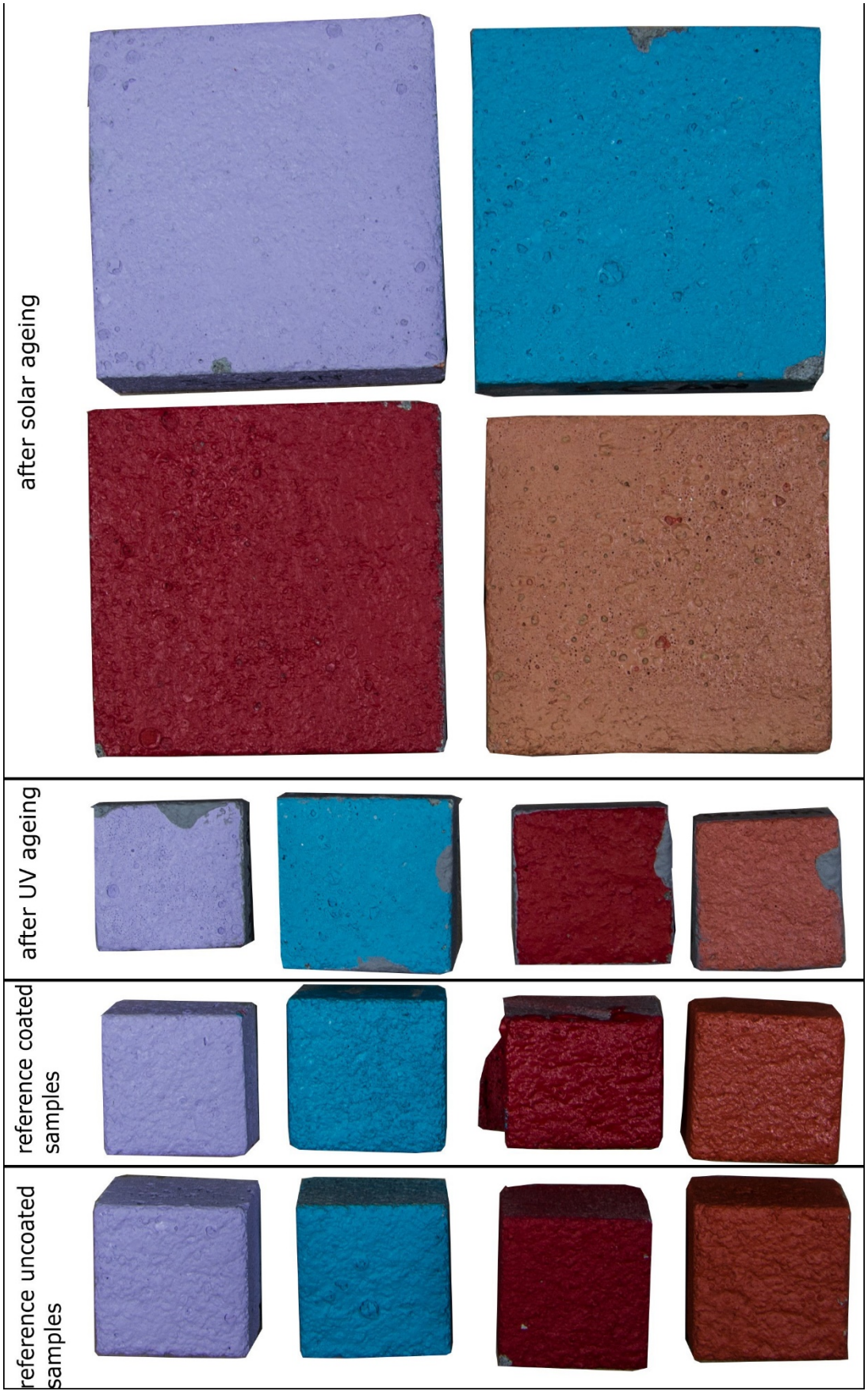


Figure 1 samples coated with Anti-Stain and reference uncoated samples (bottom)

2. Tests at Schmincke within the scope of the collaborative project

Within the framework of the collaborative work, various tests were carried out on concrete samples and samples of the protective coatings on microscope slices, produced by the partners.

In an external Q-SUN test, artificial ageing with respect to sunlight and weathering, as well as mass loss of the coatings were determined. The internal surface free energy (SFE) measurements were performed before and after the Q-SUN test to see how the surface properties change with artificial ageing.

Partial results of these tests are shown at the descriptions of the test methods.

2.1 Surface free energie (SFE)

The surface free energy is used to evaluate and describe surface phenomena such as the wetting and adhesion of coatings on surfaces or the tendency to soil surfaces.

The surface free energy (abbreviation = SFE; symbol = σ_s; unit: mN/m) of a solid has disperse (σ_s^d) and polar (σ_s^p) fractions and was determined by contact angle measurement of at least two different liquids:

$$SFE = \sigma_s = \sigma_s^d + \sigma_s^p \qquad [mN/m]$$

The Drop Shape Analyzer from Krüss (DSA25) uses optical measurements to simultaneously determine the contact angles of two different liquids on the surface to be measured. The test liquids used during the measuring process are water (strongly polar; SFE = 72.8=21.8+51.0 mN/m) and diiodomethane (non-polar; SFE = 50.8=50.8+0 mN/m). Figure 1 shows a typical picture.

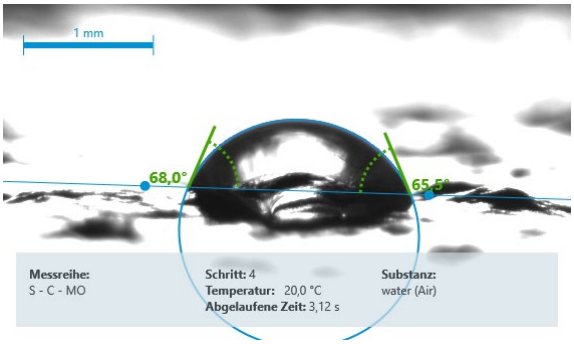


Fig 1 : Determination of the contact angle. Example

Water drops on pattern surface

The values of the disperse and polar fractions of the SFE are calculated from these optical measurements according to mathematical formulae for describing surface phenomena. With the help of evaluation programs based on these formulas it is possible to describe these values quite accurately.

Further literature, e.g. formulas / theory can be found on the following website of the company Krüss:

DE : https://www.kruss-scientific.com/de/service/schulung-theorie/glossar/

EN : https://www.kruss-scientific.com/services/education-theory/glossary/

To interpret the obtained values of the surface free energy, limit value considerations show the direction of the evaluation.

1.) If the contact angle = 0° (zero) the drop forms a monomolecular layer on the surface which corresponds to an optimal wetting.

2.) If the contact angle = 180° the drop forms a point on the surface which corresponds to non-wetting and no adhesion. Therefore, if the contact angle is very high, e.g. surfaces with lotus effect, they can be cleaned easily.

3.) The surface tension of liquids is identical to the free surface energy.

4.) From 3.) It follows that there is good wetting by the coating material if the surface tension of the liquid is equal to or less than the SFE of the surface to be coated.
If the polar and disperse fractions match, good adhesion is also assumed. So, wetting and adhesion are at their maximum when not only the SFS of the solid and the liquid are the same, but also the polar and disperse parts.

5.) It also follows from this that the lower the SFE of a surface is the worse it is to coat.
Examples for surfaces :

Polymethylmetacrylate (PMMA, e.g. acrylic paints): SFE = 33 - 44 mN/m

with disperse portion 25.7 to 44.2 mN/m

Oil colours : SFE = 20- 30 mN/m

with polar fraction <2 mN/m

Dirt particles on the surface have a very low SFE, which is the reason for a poor coating.

Therefore clean surfaces before coating !

The following SFE's were measured in the collaborative test :

1) the colours on the concrete

2) the different coatings on these colours :

SC = ACPU-Clear-lacquer, silky gloss, acrylic-polyurethane, waterbased (Schmincke)

MO = Multisurface acrylic lacquer, waterbased (Montana)

AN = Anti-Stain, fluoropolymers and waxes, waterbased (Antares)

3) the aged surfaces after the weathering tests with Q-Sun and UV-C

In the following two examples the results of surface measurements of the pure coating materials on glass before and after a UV-C test (example A), as well as the results of surface measurements of the pure colours and the three different coatings (concrete samples) before and after weathering in Q-Sun (example B) are presented.

Example A : The coating materials SC, MO, AN in the 24 hours UV-C test. Surface free energy values before and after irradiation. All values in mN/m.

Coating material	SFE before 24h UV-C			SFE after 24h UV-C			Results delta OFE	
	σ_s	σ_s^d	σ_s^p	σ_s	σ_s^d	σ_s^p		
SC	24,2	23,4	0,8	25,1	23,7	1,5	0,9	SFE almost equal, trace polar
MO	44,6	38	6,6	36,9	31,9	5	-8	Smaller SFE
AN	29,9	19,9	10	38,1	22,4	15,7	8	Larger SFE, polar

One interpretation of the results could be that the coating SC remains stable and unchanged in this test, which indicates a high stability. The two other coating materials change their SFE, with MO the SFE decreases, i.e. the surface becomes less wettable, with AN the SFE increases, especially the polar parts, i.e. the surface becomes more wettable, e.g. with regard to moisture (water).

Example B : Measurement of the SFE on the test colours and the samples coated with SC, MO, AN before and after weathering in Q-SUN (xenon). All values in mN/m.

Colour	without protective coating						SC: ACPU-Clear lacquer, silky gloss, Acrylic-Polyurethane, waterbased					
				after 1400h Q-SUN						after 1400h Q-SUN		
	σ_s	σ_s^d	σ_s^p	σ_s	σ_s^d	σ_s^p	σ_s	σ_s^d	σ_s^p	σ_s	σ_s^d	σ_s^p
S-Orange	30,1	26,8	3,2	46,2	39,5	6,7	29,6	25,9	3,8	36,9	34,4	2,5
S-Red	37,1	30,0	7,1	52,5	43,6	8,9	30,2	27,1	3,1	39,9	35,7	4,2
S-Violet	32,8	31,2	1,5	45,8	31,8	14,0	37,7	33,8	4,0	40,3	37,2	3,1
S-Cyan	25,1	24,2	0,9	48,9	39,5	9,3	29,3	23,7	5,5	30,7	27,3	3,4

Colour	MO: Multisurface acrylic lacquer, Acrylic waterbased						AN: Anti-Stain, Fluoropolymers and waxes, waterbased					
				after 1400h Q-SUN						after 1400h Q-SUN		
	σ_s	σ_s^d	σ_s^p	σ_s	σ_s^d	σ_s^p	σ_s	σ_s^d	σ_s^p	σ_s	σ_s^d	σ_s^p
S-Orange	53,3	43,7	9,6	49,4	43,5	6,0	32,4	28,4	4,0	26,9	26,6	0,3
S-Red	50,8	41,8	9,0	44,0	26,8	17,3	34,9	31,3	3,7	30,0	27,8	2,2
S-Violet	49,5	40,7	8,7	46,1	39,7	6,4	35,4	31,2	4,2	32,2	31,9	0,3
S-Cyan	47,5	40,8	6,6	50,5	41,2	9,3	33,3	32,3	1,0	27,8	26,6	1,2

This is also a possible interpretation of the results. The colour samples without protective coating increase their SFE proportionally most, both in the disperse and polar fractions. They can thus be better wetted by moisture. With the two coating materials MO and SC the SFE values change moderately, except for the colour shade S-Red, where the values change most. The SFE values change least with the coating AN. After this test, for example, a statement would be that a protective layer is better than none in any case, in comparison, the coating AN would be the most suitable, since the smallest surface changes were measured here.

This result must of course be seen in context with the other tests carried out in order to arrive at a final evaluation of the collective test.

2.1.1 Artificial weathering / aging by different methods

For the artificial weathering of the concrete specimens investigated in the joint test, the methods chosen were QUV weathering, Q-Sun weathering and, for one test, UV-C exposure.

Although the tests appear to be similar, there are differences between the individual tests which make the application of all three tests reasonable. The differences between the methods lie in the type of irradiation spectrum, temperature exposure and exposure to moisture, as shown in Table 1.

Tab. 1 : Conditions of the different weathering tests

	QUV-Test	Q-SUN Test	UV-C Test
Irradiation type	Short wave UV (300 bis 400nm)	UV light, visible light, infrared (300 bis 800nm)	Short wave UV, line at 253nm
Temperature	50°C	50°C	room temperature
Humidity	Humidification via condensation, 100% humidity	Humidification via water spray function	None
Possible Observations	polymer degradation	pigment changes, polymer degradation	pigment changes, polymer degradation

The differences between the different types of irradiation are shown in Figure 2 in comparison to the spectrum of sunlight.

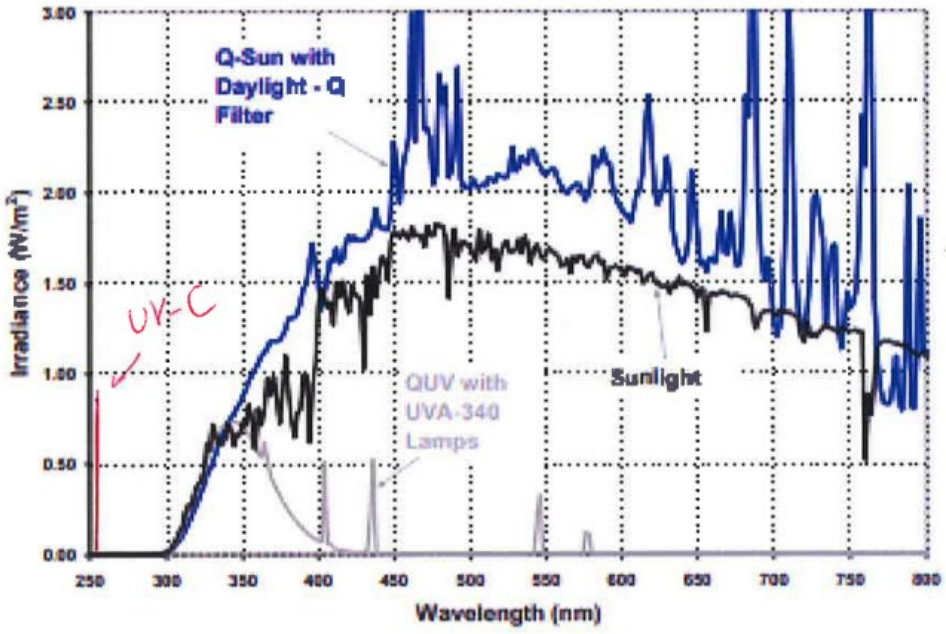


Fig. 2 : The spectral distribution of the different types of irradiation compared to sunlight.

What effects can be expected from the individual tests :

QUV -Test : The irradiation is carried out with fluorescent lamps, especially in short wave UV, at 50°C and a more realistic outdoor exposure to humidity by a condensation process (100% relative humidity). These conditions show possible polymer deformations of the binder which can occur in outdoor areas.

Q-Sun-Test : The irradiation is carried out with a xenon lamp covering the UV range, visible light and the infrared range, at 50°C and a humidity exposure via water spray system. These conditions show possible changes in pigmentation as well as the resulting polymer deformations.

UV-C test : The irradiation is done with UV-C lamps which have a strong line at 253nm. Contrary to the QUV and Q-SUN test, the UV-C test is very fast at 24h and shows pigment changes and polymer deformation which are only caused by very short wave UV light. The samples are not subjected to thermal stress or moisture.

The results of all three tests together can be used to determine the individual influences of light, temperature and humidity on the samples.

Within the scope of the joint test, both the concrete samples and the microscopy slices were exposed to the weather test in Q-SUN using the test standard ISO 16474-2:2013 (cycle: 102 min. xenon light with 60 W/m² @ 300-400 nm, Daylight-Q filter, 65 °C BST, 38 °C KT, 50 % rel. humidity, followed by 18 min. light and water spray; duration: 1400 hours).

A second set of microscope slices with the pure coating materials was tested in a 24h UV-C test.

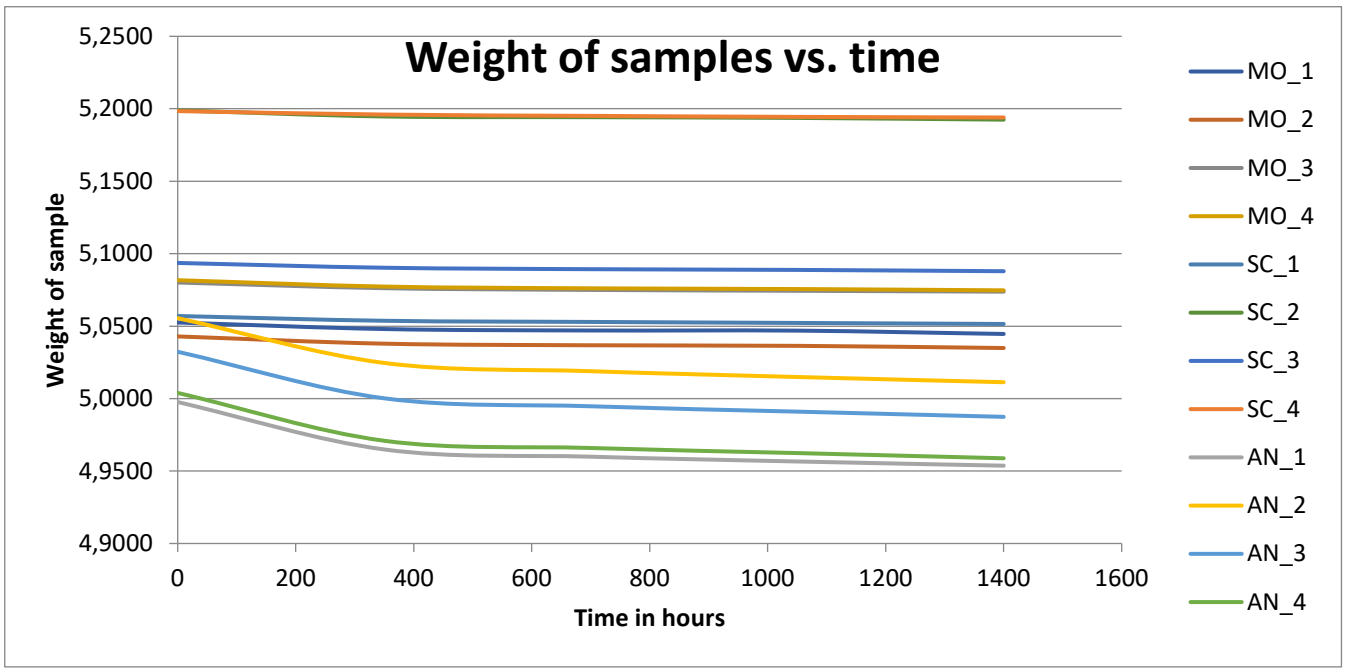
All results are documented in the Schmincke test report (appendix x.4) of the collaborative test.

For further information about weathering : https://www.q-lab.com/de-de/resources/technical-articles.aspx

2.1.2 Degradation of protective coatings through artificial weathering / ageing

In the Q-SUN test, not only the change in colour was determined, but also the degradation of the protective coatings was determined by regular weighing of the samples.

The following diagram shows the degradation of the three examined protective coatings during the test:



The two acrylic coatings (MO_1 to MO_4 and SC_1 to SC_4) degrade very little over the test period of 1400 hours. The fluoropolymer (AN_1 to AN_4) degrades more strongly in the first 400 hours than in the remaining 1000 hours. Overall, the degradation here is greater by a factor of 10.

2.2 Appendix

2.2.1 Concrete-plates for weathering

Surfaces before testing

	SCHMINCKE	MONTANA	ANTARES
 S-O	 S-O-SC	 S-O-MO	 S-O-AN
 S-R	 S-R-SC	 S-R-MO	 S-R-AN
 S-V	 S-V-SC	 S-V-MO	 S-V-AN
 S-C	 S-C-SC	 S-C-MO	 S-C-AN

Surfaces after testing

	SCHMINCKE	MONTANA	ANTARES
 S-O	 S-O-SC	 S-O-MO	 S-O-AN
 S-R	 S-R-SC	 S-R-MO	 S-R-AN
 S-V	 S-V-SC	 S-V-MO	 S-V-AN
 S-C	 S-C-SC	 S-C-MO	 S-C-AN

L a b-datas **L/a/b (ΔE)**

	S-O	S-O-SC	S-O-MO	S-O-AN
0-sample	53,1 / 39,4 / 36,4	52,8 / 40,2 / 38,1	52,4 / 39,4 / 36,5	53,3 / 39,1 / 36,2
0-sample	53,6 / 39,6 / 37,7	53,1 / 39,9 / 38,6	52,5 / 38,8 / 36,1	53,3 / 38,6 / 36,3
350 h	55,4/33,7/32,3 (8,2)	55,6/32,6/35,7 (8,2)	55,0/32,2/32,4 (8,0)	57,8/33,1/32,8 (6,7)
700 h	57,4/28,8/29,3 (14,2)	58,4/26,7/33,6 (15,1)	57,0/27,0/29,9 (14,1)	56,5/28,6/30,3 (12,1)
1050 h	58,8/25,3/28,6 (17,8)	59,9/23,3/32,9 (18,8)	58,6/23,2/29,5 (18,1)	57,7/25,4/29,4 (15,6)
1400 h	60,3/21,8/27,2 (21,7)	60,9/20,9/33,0 (21,3)	59,6/21,1/29,1 (20,3)	58,3/23,0/28,7 (18,0)
1400 h	59,5/22,5/26,7 (20,6)	59,4/22,6/31,7 (19,8)	59,6/20,8/29,2 (21,2)	58,2/23,3/28,2 (18,4)

	S-R	S-R-SC	S-R-MO	S-R-AN
0-sample	40,0 / 48,8 / 27,0	39,9 / 47,5 / 26,5	40,6 / 48,7 / 26,7	40,8 / 50,2 / 28,4
0-sample	39,7 / 48,3 / 27,7	41,2 / 48,8 / 27,5	41,4 / 49,2 / 26,6	41,5 / 50,2 / 28,7
350 h	39,2/48,2/27,7 (0,4)	40,7/49,7/28,3 (1,3)	41,3/48,2/25,8 (1,2)	41,0/49,8/27,9 (1,1)
700 h	38,9/48,4/25,6 (2,3)	40,3/49,6/27,9 (1,3)	41,1/49,1/26,4 (0,3)	40,5/49,6/27,6 (1,6)
1050 h	40,6/46,3/21,6 (6,5)	40,3/49,1/26,8 (1,2)	42,3/46,3/23,2 (4,5)	40,2/49,6/27,7 (1,7)
1400 h	43,1/41,7/16,1 (13,7)	40,5/48,3/25,6 (2,1)	43,8/47,0/22,6 (5,0)	39,9/49,6/28,0 (1,9)
1400 h	42,6/40,8/15,4 (14,4)	38,5/46,5/24,7 (2,1)	40,6/45,3/23,1 (5,0)	39,6/47,8/26,1 (3,5)

	S-V	S-V-SC	S-V-MO	S-V-AN
0-sample	73,6 / 8,0 / -14,7	74,0 / 6,8 / -10,2	74,6 / 6,6 / -11,0	75,5 / 8,0 / -13,8
0-sample	74,7 / 8,5 / -14,3	73,7 / 6,8 / -9,8	74,6 / 6,6 / -11,0	75,9 / 7,8 /-13,0
350 h	74,9/8,5/-15,3 (1,0)	75,2/7,2/-11,9 (2,6)	77,2/6,7/-12,2 (2,8)	76,3/8,2/-14,2 (1,3)
700 h	73,9/8,2/-15,1 (1,1)	76,4/6,3/-11,8 (3,4)	78,5/5,6/-10,7 (4,0)	76,3/8,0/-13,9 (1,0)
1050 h	74,6/8,0/-14,7 (0,4)	76,2/6,1/-11,4 (3,1)	78,5/5,3/-10,5 (4,1)	76,3/7,8/-13,7 (0,8)
1400 h	74,5/8,0/-14,6 (0,4)	76,7/5,9/-11,2 (3,5)	79,8/4,4/-9,0 (5,9)	76,3/7,7/-13,4 (0,6)
1400 h	74,5/8,0/-14,9 (0,9)	75,1/7,2/-12,8 (2,9)	75,7/6,7/-13,0 (2,3)	75,8/7,6/-13,7 (0,4)

	S-C	S-C-SC	S-C-MO	S-C-AN
0-sample	60,7 / -30,7 / -15,7	61,3 / -31,0 / -14,1	61,4 / -31,8 / -13,7	61,1 / -31,2 / -15,4
0-sample	61,0 / -30,7 / -16,1	61,2 / -30,7 / -14,6	61,2 / -31,36 / -14,6	61,2 / -30,7 / -15,5
350 h	61,2/-30,0/-16,5 (0,8)	61,4/-30,0/-16,0 (1,7)	61,6/-29,8/-16,2 (2,2)	60,9/-30,0/-16,3 (1,0)
700 h	61,2/-30,0/-16,4 (0,8)	61,3/-29,9/-16,1 (1,8)	61,5/-29,9/-16,2 (2,1)	60,6/-30,1/-16,2 (1,0)
1050 h	61,1/-29,8/-16,2 (0,9)	61,4/-29,5/-15,9 (1,9)	61,6/-29,8/-16,0 (2,1)	60,6/-29,8/-15,9 (1,1)
1400 h	60,7/-29,6/-16,0 (1,2)	61,4/-29,3/-15,7 (1,9)	61,8/-29,2/-15,7 (2,5)	60,5/-29,5/-15,8 (1,4)
1400 h	61,0/-29,8/-15,6 (1,0)	61,5/-29,4/-15,1 (1,9)	62,1/-29,6/-15,4 (2,8)	60,5/-30,0/-15,5 (1,3)

surface energies (γ) **free surface energy / dispersive / polar [mN/m]**

contact angles

water / diiod-methane

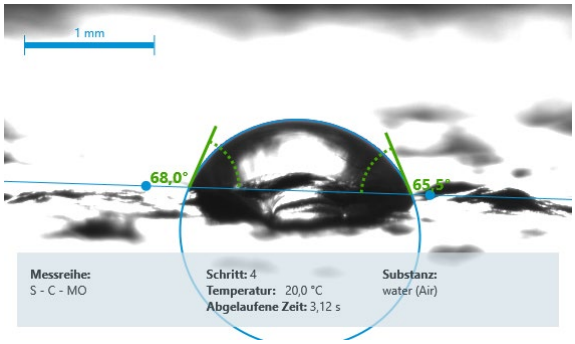
	S-O	S-O-SC	S-O-MO	S-O-AN
0-sample	30,1 / 26,8 / 3,2 89,0° / 63,1°	29,6 / 25,9 / 3,8 88,1° / 64,7°	53,3 / 43,7 / 9,6 63,0° / 31,1°	32,4 / 28,4 / 4,0 88,1° / 64,7°
1400 h	46,2 / 39,5 / 6,7 71,8° / 40,2°	36,9 / 34,4 / 2,5 86,4° / 49,9°	49,4 / 43,5 / 6,0 71,0° / 31,8°	26,9 / 26,6 / 0,3 103,0° / 63,4°

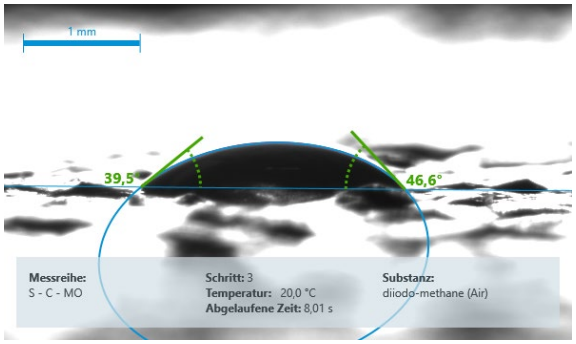
	S-R	S-R-SC	S-R-MO	S-R-AN
0-sample	37,1 / 30 / 7,1 77,0° / 57,5°	30,2 / 27,1 / 3,1 89,2° / 62,5°	50,8 / 41,8 / 9,0 65,4° / 35,5°	34,9 / 31,3 / 3,7 84,7° / 55,3°
1400 h	52,5 / 43,6 / 8,9 64,3° / 31,5°	39,9 / 35,7 / 4,2 80,3 / 47,4°	44,0 / 26,8 / 17,3 61,4° / 63,2°	30,0 / 27,8 / 2,2 91,9° / 61,3°

	S-V	S-V-SC	S-V-MO	S-V-AN
0-sample	32,8 / 31,2 / 1,5 92,4° / 55,4°	37,7 / 33,8 / 4,0 82,2° / 50,9 °	49,5 / 40,7 / 8,7 66,5° / 37,7°	35,4 / 31,2 / 4,2 83,3 / 55,5°
1400 h	45,8 / 31,8 / 14,0 62,8° / 54,3°	40,3 / 37,2 / 3,1 82,8° / 44,6°	46,1 / 39,7 / 6,4 72,2° / 39,9°	32,2 / 31,9 / 0,3 99,9° / 54,2°

	S-C	S-C-SC	S-C-MO	S-C-AN
0-sample	25,1 / 24,2 / 0,9 96,7° / 67,6°	29,3 / 23,7 / 5,5 85,0° / 65,2°	47,5 / 40,8 / 6,6 71,0° / 37,6°	33,3 / 32,3 / 1,0 94,2° / 53,5°
1400 h	48,9 / 39,5 / 9,3 66,1° / 40,2°	30,7 / 27,3 / 3,4 88,1° / 62,3°	50,5 / 41,2 / 9,3 65,1° / 36,8°	27,8 / 26,6 / 1,2 96,9° / 54,2°

Example (S-C-MO - 0-sample)





2.2.2 Glas-slices for weathering

L a b-datas **L/a/b (ΔE)**

	SC_1	SC_2	SC_3	SC_4
0-sample	89,3 / -1,0 / 6,0	87,9 / -1,1 / 6,5	88,7 / -1,1 / 6,1	90,2 / -1,0 / 5,8
0-sample	90,6 / -1,3 / 6,5	90,0 / -1,5 / 6,8	90,1 / -1,4 / 6,8	91,5 / -1,1 / 6,2
350 h	91,0/-0,7/5,5 (1,2)	90,3/-0,8/5,4 (1,6)	90,5/-0,8/5,6 (1,5)	90,8/-0,7/5,5 (0,8)
700 h	91,2/-0,7/5,5 (1,3)	90,4/-0,8/5,5 (1,6)	90,8/-0,8/5,6 (1,6)	92,0/-0,7/5,5 (1,0)
1050 h	91,1/-0,6/3,5 (3,2)	90,4/-0,6/3,4 (3,6)	90,3/-0,6/3,5 (3,5)	91,4/-0,5/3,6 (2,7)
1400 h	90,9/-0,5/3,6 (3,1)	90,5/-0,6/3,4 (3,6)	90,3/-0,6/3,6 (3,4)	91,6/-0,5/3,6 (2,6)
1400 h	90,6/-0,7/5,5 (1,5)	88,9/-0,6/5,6 (1,5)	89,4/-0,7/5,5 (1,0)	90,7/-0,6/5,8 (0,5)

	MO_1	MO_2	MO_3	MO_4
0-sample	90,4 / -1,1 / 6,0	90,2 / -1,1 / 6,3	90,9 / -1,0 / 5,8	90,4 / -1,1 / 6,2
0-sample	91,5 / -1,3 / 5,7	91,4 / -1,4 / 5,9	91,8 / -1,2 / 5,6	91,6 / -1,3 / 5,8
350 h	91,3/-0,8/5,6 (0,6)	91,1/-0,8/5,6 (0,7)	91,3/-0,7/5,4 (0,7)	91,1/-0,7/5,7 (0,8)
700 h	91,2/-0,7/5,6 (0,7)	91,0/-0,7/5,6 (0,8)	91,0/-0,7/5,5 (1,0)	90,9/-0,8/5,8 (0,9)
1050 h	90,9/-0,6/3,5 (2,4)	90,4/-0,6/3,6 (2,6)	90,1/-0,6/3,4 (2,8)	90,4/-0,6/3,6 (2,6)
1400 h	90,8/-0,5/3,7 (2,3)	90,6/-0,6/3,6 (2,5)	90,6/-0,6/3,6 (2,5)	90,4/-0,5/3,7 (2,5)
1400 h	89,6/-0,6/5,9 (0,9)	89,5/-0,6/6,0 (0,9)	88,9/-0,6/6,1 (2,1)	89,7/-0,6/5,9 (0,9)

	AN_1	AN_2	AN_3	AN_4
0-sample	87,4 / -1,3 / 8,0	87,3 / -1,3 / 8,2	87,5 / -1,2 / 8,7	87,5 / -1,2 / 8,43
0-sample	89,6 / -1,6 / 9,0	89,4 / -1,6 / 9,6	89,4 / -1,7 / 9,6	89,6 / -1,6 / 9,0
350 h	89,8/-0,7/5,4 (3,7)	89,8/-0,7/5,4 (4,3)	89,8/-0,8/5,4 (4,3)	90,1/-0,7/5,3 (3,8)
700 h	90,5/-0,7/5,4 (3,8)	90,1/-0,8/5,5 (4,2)	89,9/-0,7/5,5 (4,3)	90,2/-0,8/5,4 (3,7)
1050 h	90,3/-0,6/3,4 (5,8)	90,0/-0,6/3,4 (6,3)	89,7/-0,6/3,5 (6,2)	90,2/-0,6/3,4 (5,8)
1400 h	89,9/-0,6/3,5 (5,6)	89,8/-0,6/3,6 (6,2)	89,7/-0,6/3,6 (6,1)	90,0/-0,6/3,4 (5,7)
1400 h	87,4/-0,6/5,9 (2,2)	87,9/-0,6/5,9 (2,5)	87,6/-0,6/6,0 (2,8)	88,5/-0,7/5,5 (3,1)

	Ø SC	Ø MO	Ø AN
0-sample	89,1 / -1,1 / 6,1	90,5 / -1,1 / 6,1	87,4 / -1,2 / 8,3
0-sample	90,6 / -1,3 / 6,6	91,6 / -1,3 / 5,7	89,5 / -1,6 / 9,3
350 h	90,9/-0,7/5,5 (1,3)	91,2/-0,7/5,6 (0,7)	89,9/-0,7/5,4 (4,0)
700 h	91,1/-0,7/5,5 (1,4)	91,0/-0,7/5,6 (0,8)	90,2/-0,7/5,5 (4,0)
1050 h	90,8/-0,6/3,5 (3,2)	90,5/-0,6/3,5 (2,6)	90,0/-0,6/3,4 (6,0)
1400 h	90,8/-0,5/3,5 (3,2)	89,8/-0,6/3,5 (2,5)	90,6/-0,5/3,6 (5,9)
1400 h	89,9/-0,6/5,6 (1,1)	89,4/-0,6/5,9 (1,2)	87,9/-0,6/5,8 (2,6)

Weight

	SC_1	SC_2	SC_3	SC_4
0-sample	5,0521 g	5,1941 g	5,0888 g	5,1950 g
0-sample	5,0570 g	5,1989 g	5,0936 g	5,1984 g
350 h	5,0537 g	5,1947 g	5,0903 g	5,1960 g
700 h	5,0529 g	5,1942 g	5,0893 g	5,1951 g
1050 h	5,0522 g	5,1937 g	5,0888 g	5,1944 g
1400 h	5,0515 g	5,1925 g	5,0879 g	5,1940 g
1400 h	not weightable – Surfaces “destroyed” and slices labeled			

	MO_1	MO_2	MO_3	MO_4
0-sample	5,0472 g	5,0380 g	5,0745 g	5,0770 g
0-sample	5,0525 g	5,0429 g	5,0801 g	5,0817 g
350 h	5,0480 g	5,0379 g	5,0762 g	5,0773 g
700 h	5,0470 g	5,0368 g	5,0750 g	5,0529 g
1050 h	5,0469 g	5,0364 g	5,0744 g	5,0756 g
1400 h	5,0446 g	5,0349 g	5,0738 g	5,0747 g
1400 h	not weightable – Surfaces “destroyed” and slices labeled			

	AN_1	AN_2	AN_3	AN_4
0-sample	4,9917 g	5,0501 g	5,0266 g	4,9983 g
0-sample	4,9976 g	5,0555 g	5,0323 g	5,0039 g
350 h	4,9649 g	5,0246 g	5,0002 g	4,9709 g
700 h	4,9599 g	5,0189 g	4,9947 g	4,9659 g
1050 h	4,9566 g	5,0149 g	4,9910 g	4,9624 g
1400 h	4,9537 g	5,0113 g	4,9874 g	4,9588 g
1400 h	not weightable – Surfaces “destroyed” and slices labeled			

	Ø SC	Ø MO	Ø N
350 h	- 0,0024 g	- 0,0045 g	- 0,0309 g
700 h	- 0,0041 g	- 0,0056 g	- 0,0375 g
1050 h	- 0,0047 g	- 0,0060 g	- 0,0411 g
1400 h	- 0,0055 g	- 0,0073 g	- 0,0445 g
1400	not weightable – Surfaces “destroyed” and slices labeled		

2.2.3 Glas-slices for uv-c-test

L a b-datas **L/a/b (ΔE)**

	UV-SC_1	UV-SC_2	UV-SC_3	UV-SC_4
0-sample	90,6 / -1,0 / 5,2	89,6 / -1,1 / 5,8	90,3 / -1,0 / 5,3	89,9 / -1,0 / 5,5
24 h	89,7 / -1,7 / 8,4	89,4 / -1,7 / 8,6	90,7 / -1,6 / 7,3	90,5 / -1,7 / 7,4

	UV-MO_1	UV-MO_2	UV-MO_3	UV-MO_4
0-sample	91,8 / -0,9 / 4,8	92,1 / -0,9 / 4,9	92,1 / -0,9 / 4,8	91,9 / -0,9 / 5,0
24 h	91,7 / -0,8 / 5,0	91,8 / -0,9 / 5,1	91,8 / -0,9 / 4,9	91,7 / -1,0 / 5,6

	UV-AN_1	UV-AN_2	UV-AN_3	UV-AN_4
0-sample	92,5 / -0,9 / 4,9	92,0 / -0,9 / 5,3	91,3 / -0,9 / 5,4	91,6 / -0,9 / 5,6
24 h	91,3 / -0,8 / 5,0	91,8 / -0,8 / 5,1	91,9 / -0,8 / 5,1	91,4 / -0,8 / 5,0

	Ø UV-SC	Ø UV-MO	Ø UV-AN
0-sample	90,1 / -1,0 / 5,5	92,0 / -0,9 / 4,9	91,8 / -0,9 / 5,3
24 h	90,0 / -1,7 / 7,9 (2,5)	91,7 / -0,9 / 5,2 (0,4)	91,6 / -0,8 / 5,0 (0,4)

surface energies (γ) **free surface energy / dispersive / polar [mN/m]**

contact angles

water / diiod-methane

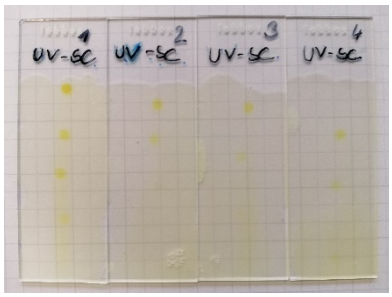
	UV-SC_1	UV-SC_2	UV-SC_3	UV-SC_4
0-sample	24,8 / 23,8 / 1,0 100,2,0° / 68,3°	24,4 / 23,6 / 0,8 101,5° / 68,7°	24,1 / 23,2 / 0,9 101,2° / 69,5°	23,6 / 22,9 / 0,7 102,6° / 70,0°
24 h	24,7 / 23,3 / 1,5 98,3° / 69,3°	24,3 / 23,0 / 1,3 99,2° / 69,8°	25,8 / 24,0 / 1,8 96,2° / 68,0°	25,8 / 24,5 / 1,3 98,0° / 67,2°

	UV-MO_1	UV-MO_2	UV-MO_3	UV-MO_4
0-sample	43,7 / 38,1 / 5,5 75,3° / 42,9°	44,1 / 37,7 / 6,5 73,4° / 43,8°	45,6 / 38,6 / 7,0 71,6° / 42,0°	45,1 / 37,7 / 7,4 71,2° / 43,8°
24 h	36,6 / 31,9 / 4,7 81,5° / 54,2°	37,6 / 31,4 / 6,1 78,2° / 55,0°	35,9 / 32,1 / 3,8 83,8° / 53,9°	37,6 / 31,8 / 5,8 78,8° / 54,3°

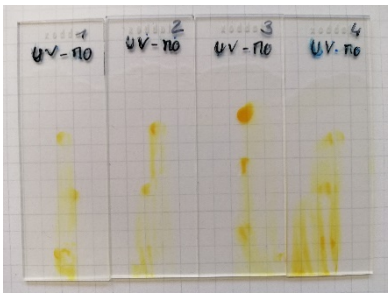
	UV-AN_1	UV-AN_2	UV-AN_3	UV-AN_4
0-sample	31,8 / 19,1 / 12,7 75,0° / 76,8°	26,9 / 20,1 / 6,7 85,2° / 75,0°	31,3 / 20,8 / 10,5 77,3° / 73,7°	29,5 / 19,4 / 10,1 79,2° / 76,4°
24 h	29,7 / 21,7 / 8,1 81,1° / 72,2°	54,9 / 27,7 / 27,2 45,7° / 61,5°	38,9 / 24,1 / 14,8 61,4° / 67,8°	29,0 / 16,1 / 12,9 77,4° / 82,8°

Ø UV-SC	**Ø UV-MO**	**Ø UV-AN**
25,1 / 23,7 / 1,5 97,9° / 68,6°	36,9 / 31,85 / 5,1 80,5° / 54,4°	38,1 / 22,4 / 15,7 67,9° / 71,1°

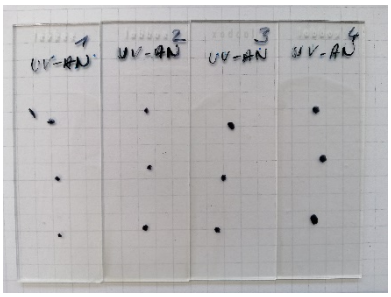
2.2.4 Glas-slices after 24h UV-C



UV-SC



UV-MO



UV-AN

UV-SC & UV-MO: The yellow discolorations are a contamination (with diiod-methane).

UV-AN: The dist. Water (for the surface energy measurement) immediately attacks the surface. The black dots mark the damaged area.

Weight

	UV-SC_1	UV-SC_2	UV-SC_3	UV-SC_4
0-sample	5,2673 g	5,2900 g	5,2524 g	5,2112 g
24 h	5,2663 g	5,2889 g	5,2515 g	5,2102 g

	UV-MO_1	UV-MO_2	UV-MO_3	UV-MO_4
0-sample	5,1600 g	5,1515 g	5,1638 g	5,1706 g
24 h	5,1583 g	5,1494 g	5,1621 g	5,1691 g

	UV-AN_1	UV-AN_2	UV-AN_3	UV-AN_4
0-sample	5,1859 g	5,1690 g	5,1210 g	5,1842 g
24 5,1854 g	5,1680 g	5,1197 g	5,1830 g	

2.2.5 Glas-slices from montana

surface energies (γ) **free surface energy / dispersive / polar [mN/m]**

contact angles

water / diiod-methane

SC1 *	**SC2 ***	**SC3 ***	**SC4 ***
28,0 / 27,3 / 0,8 99,1° / 62,3°	28,9 / 27,9 / 1,0 97,1° / 61,2°	27,9 / 26,7 / 1,2 97,0° / 63,2°	27,6 / 27,3 / 0,3 102,5° / 62,3°
MO1 *	**MO2 ***	**MO3 ***	**MO4 ***
38,4 / 32,2 / 6,3 77,4° / 53,8°	37,7 / 31,1 / 6,6 77,3° / 55,6°	38,8 / 34,0 / 4,8 79,8° / 50,4°	41,2 / 34,6 / 6,6 75,0° / 49,5°
AN1 *	**AN2 ***	**AN3 ***	**AN4 ***
25,6 / 23,8 / 1,9 96,2° / 68,4°	26,7 / 21,9 / 4,9 88,1° / 71,8°	28,1 / 21,0 / 7,1 83,7° / 73,4°	25,2 / 22,4 / 2,7 94,0° / 77,8°

Ø SC *	**Ø MO ***	**Ø AN ***
28,1 / 27,3 / 0,8 98,9° / 62,2°	39,0 / 33,0 / 6,1 77,4° / 52,3°	26,4 / 22,3 / 4,1 90,5° / 71,1°

2.2.6 Test certificate and test confirmation

Q-Lab Deutschland GmbH
In den Hallen 30
66115 Saarbrücken

Prüfzertifikat
Laborbewitterung
23 December 2019

Prüfnummer:	*HSC-0001*
Firma:	*H.Schmincke & Co. GmbH & Co. KG*
Adresse:	*Otto-Hahn-Str. 2* *40699 Erkrath,* *GERMANY*
Ansprechpartner:	*Dr. Wolfgang Müller*
Zahlungsart:	*Brief 10 Okt 2019*
Anzahl der Probenstücke:	*28 Glas- und Betonproben*
Probenbezeichnung:	*Glass Mo_1; Glass Mo_2; Glass Mo_3; Glass Mo_4;* *Glass SC_1; Glass SC_2; Glass SC_3; Glass SC_4;* *Glass AN_1; Glass AN_2; Glass AN_3; Glass AN_4;* *Concrete w/out layer Red + Orange + Türkis + Pink;* *Concrete Schminke Prot. Red + Orange + Türkis + Pink;* *Concrete Montanas Prot. Red + Orange + Türkis + Pink;* *Concrete Antares Prot. Red + Orange + Türkis + Pink*
Geprüft nach:	*ISO 16474-2:2013, Zyklus 1*
Abweichungen:	*Keine*
Beginn der Prüfung:	*21 October 2019*
Ende der Prüfung:	*23 December 2019*
Zeitraum der Prüfung:	*1400 Stunden*
Art der Prüfung:	*Beschleunigte Bewitterung* *Xenon Arc Lampen, 60 W/m² @ 300 - 400 nm, Daylight - Q Filter,102 min. Licht ,* *65 °C BST, 38 °C Kammertemperatur, 50 % rel. Feuchte,* *+ 18 min. Licht + Sprühwasser,*
Verwendetes Gerät:	*Tester Model Q-SUN Xe-3HSBC*
Durchgeführt:	Axel Koerper Laborleiter
Genehmigt:	Thomas Allie Laborleiter (USA)

Prüfbestätigung

Q-Lab Deutschland GmbH

An unseren Kunden:
Ihre Proben sind eingetroffen und die Prüfung wurde wie folgt begonnen:

Firma: H.Schmincke & Co. GmbH & Co. KG
Adresse: Otto-Hahn-Str. 2
40699 Erkrath ,
GERMANY

Ansprechpartner: Dr. Wolfgang Müller
Email: mueller@schminke.de

Prüfnummer: HSC-0001
Kundennummer: SCH508
QT Nummer: G01114
Zahlungsart: Brief 10 Okt 2019
Ihre Referenz:
Datum: 21 October 2019

Probenbezeichnung:

28 Glas- und Betonproben
8 x 2,5 cm (Glas) und 7 x 7 cm (Beton)

Probenzustand:

Alle Proben sind in gutem Zustand mit Ausnahme von:
Keine Beanstandungen

Prüfbeschreibung:

Prüfbeginn: 21 October 2019
Art der Prüfung: Beschleunigte Bewitterung
Geprüft nach: ISO 16474-2:2013 Zyklus 1
Abweichungen: Keine
Gerät: Tester Model Q-SUN Xe-3HSBC
Lichtart: Xenon Arc
Beleuchtungsstärke: 60 W/m² @300-400nm
Filters: Daylight - Q
Zyklus: 102 min. Licht 18 min. Licht + Sprühwasser

Temperatur: 65°C BST, 38°C AT
Feuchtigkeit: 50% RH
Wasserart : Entionisiert
Probenrotation: Drei Mal pro Woche
Zeitraum der Prüfung: 1400 Stunden

Evaluierungen und Prüfberichte:

Evaluierungen erforderlich.

Instrumentelle Farbe: Ungereinigte siehe spez. Anw.
CIE L*a*b* D65 10 ° Eingeschlossen

Probe Wiegen: siehe spez. Anw.

Spezielle Anweisungen: Die Evaluierungen werden vor der Prüfung, nach jeweils 350 Stunden und am Prüfungsende durchgeführt. Es werden nur die Glasscheibchen gewogen. Die instrumentellen Farbmessungen erfolgen bei den Glascheibchen auf mitgeliefertem Weißgrund.

Retoure Zeitplan: Nach Ende der Prüfung **Report:** Standard

Bitte überprüfen Sie die Daten und bewahren Sie diese Unterlagen auf. Benutzen Sie die Prüfnummer für zukünftige Korrespondenz.

Vielen Dank für Ihren Auftrag,

Axel Koerper
Laborleiter