Application of micronized titanium dioxide as inorganic UV - absorber

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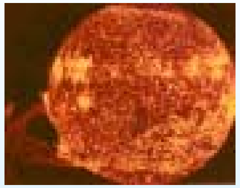
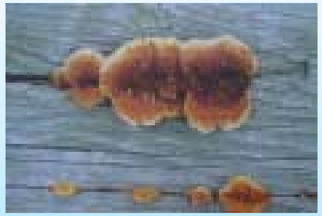
Hazards on wood



Physical: temperature, mechanical stress,

Chemical: humidity, oxygen, industrial pollution

Biological: algae, fungi, mildews, animals, micro organism



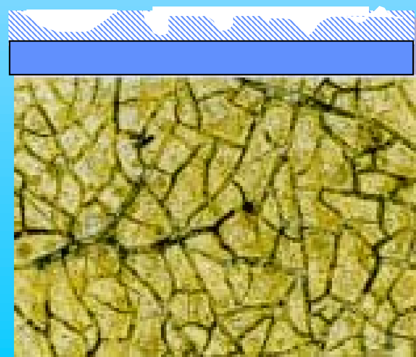
shortwave radiation

UV-A (100 - 280 nm):	not absorbed by the ozone layer
UV-B (280 -315 nm):	mostly absorbed, but some does reach the Earth’s surface
UV-C (315 - 380 nm):	completely absorbed by the ozone layer and oxygen

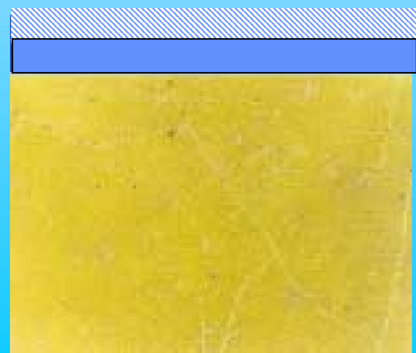
critical wavelengths to crack the following bonds:

C - C	346,1 nm
S - H	344,5 nm
N - H	336,4 nm
C - O	334,4 nm
C - H	289,7 nm

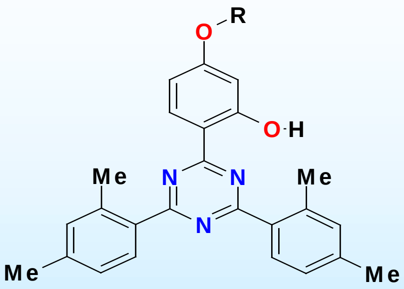
without UV- protection



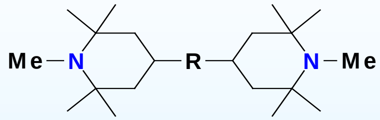
with UV- protection



Organic and inorganic UV- absorbers



• **triazine - type**



• **HALS - type**

• **no UV- absorption**
• **trapping of free radicals formed during polymer degradation**

• **transparent iron oxide**

• **transparent zinc oxide**

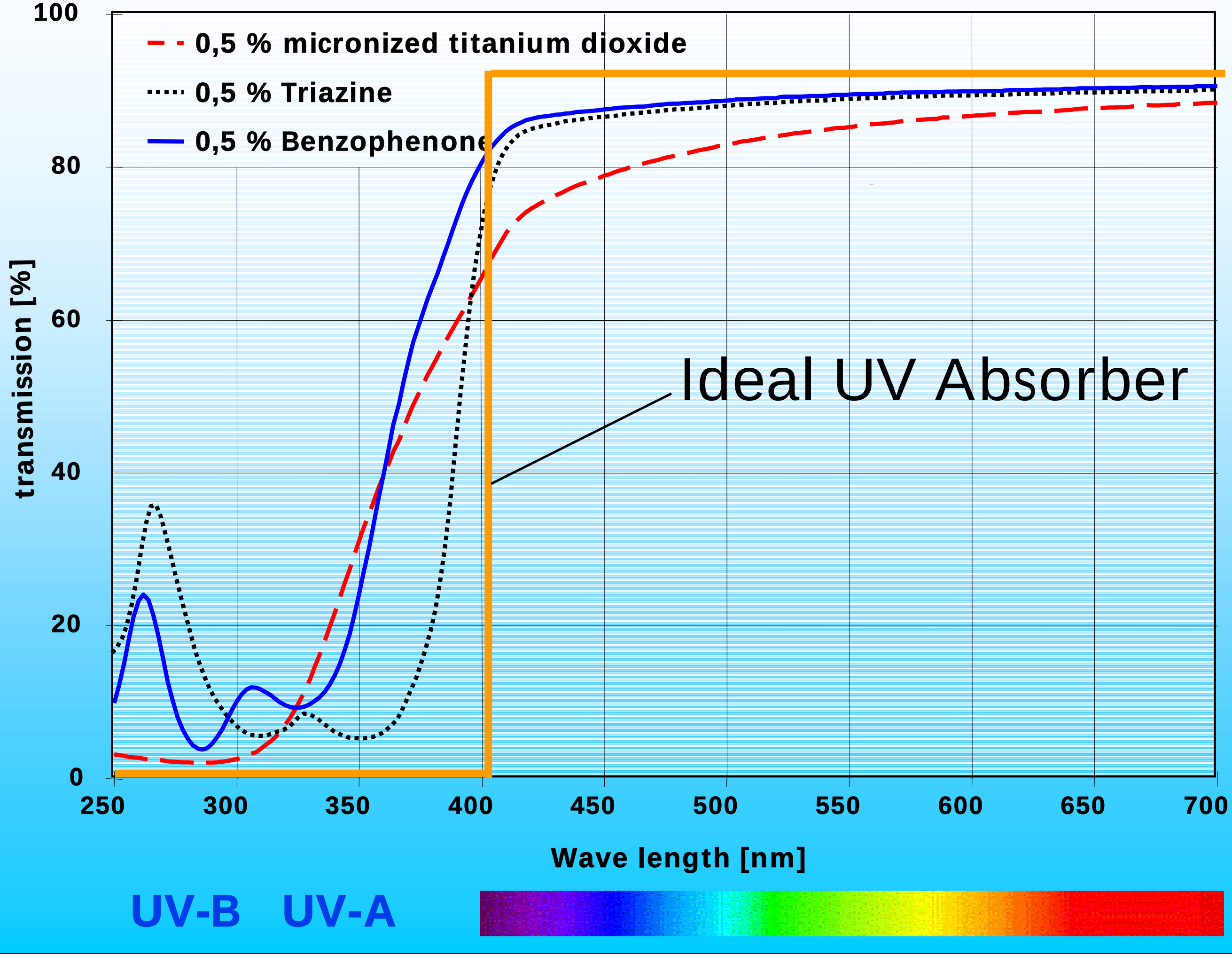
• **transparent titanium dioxide**

UV- absoption and light transmission

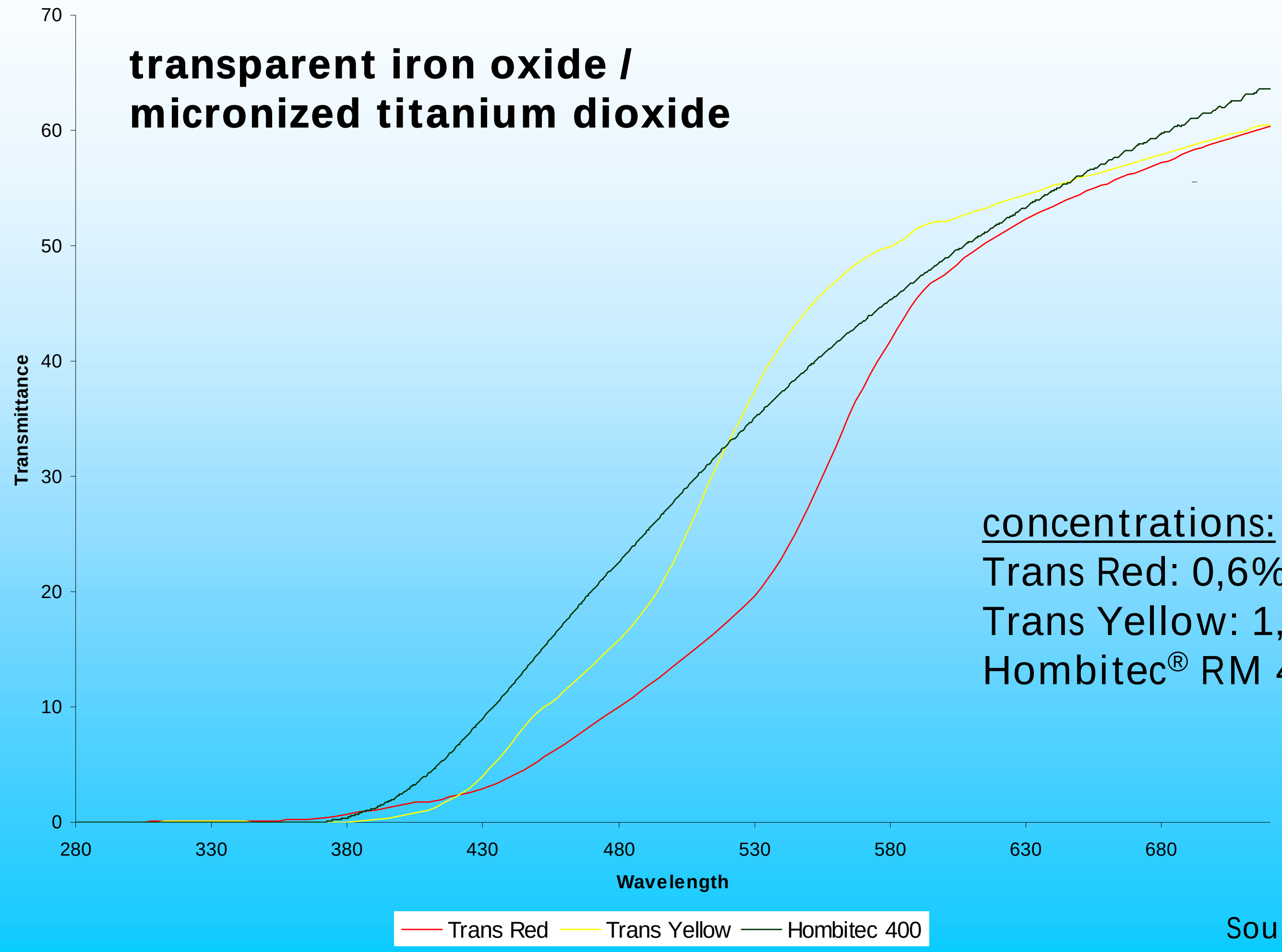
Polymer: LDPE

Elenac/Lupolen 1800H

film thickness 50 µm



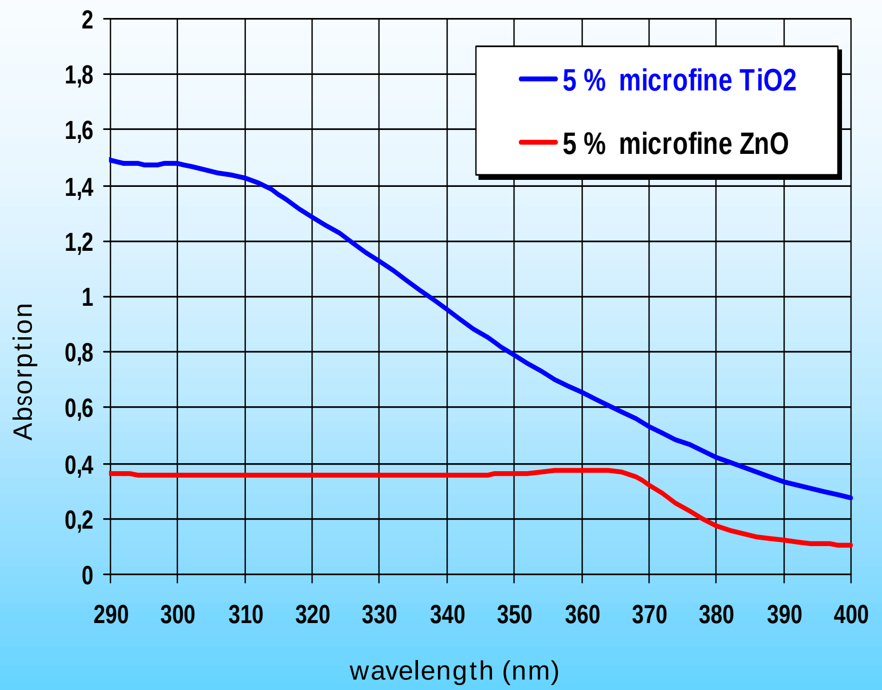
UV- absoption and light transmission



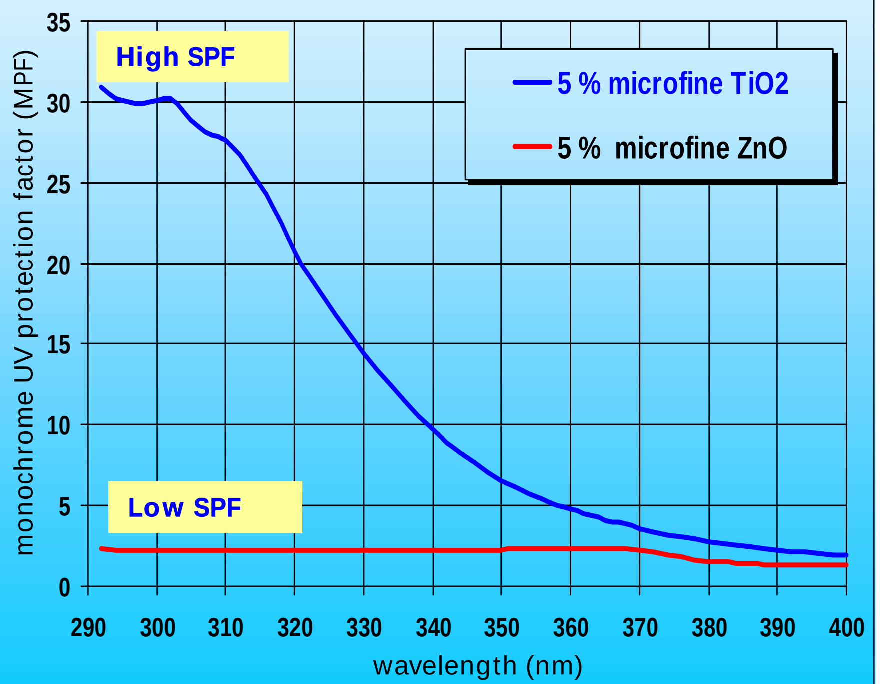
concentrations:
Trans Red: 0,6%
Trans Yellow: 1,6%
Hombitec® RM 400: 1,5%

Source: Rockwood Pigments

UV- absoption and light transmission



Sun milk Formulation



Source: Merck KGaA

Light scattering & transmittance of TiO_2

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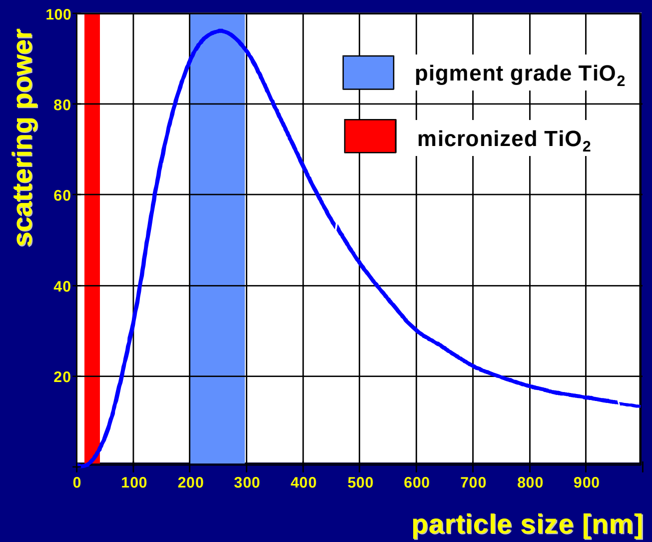

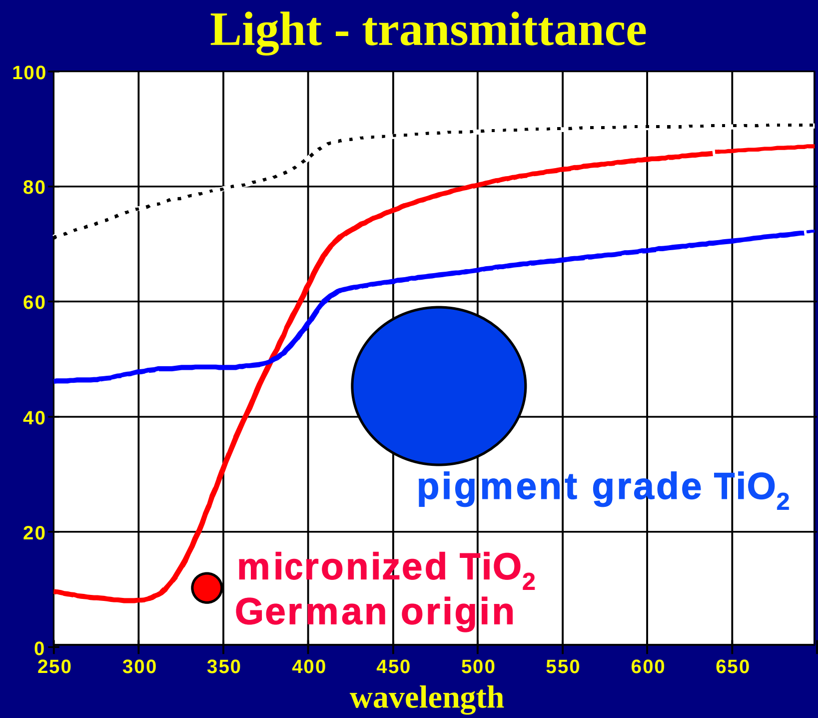

REM pictures

pigment grade TiO_2

micronized TiO_2
German origin

Photo stability of TiO_2

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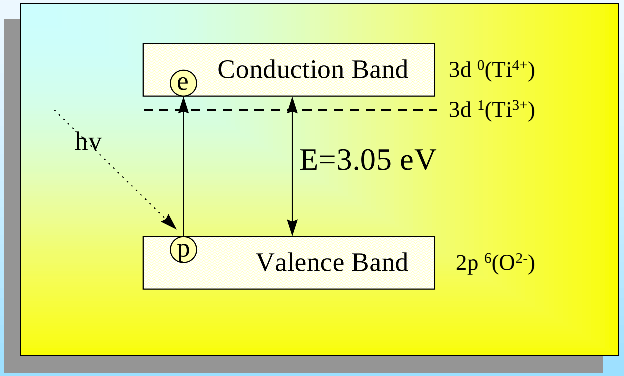
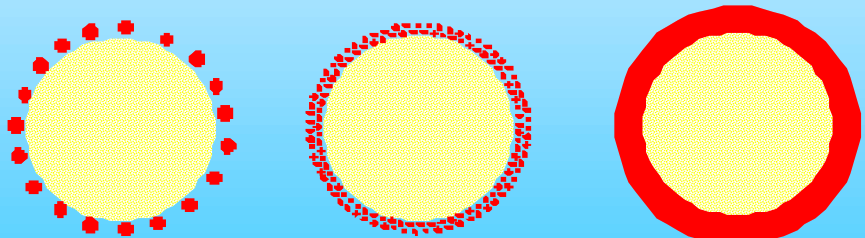
UV- radiation causes reversible photophysical and irreversible photochemical reactions of TiO_2 pigments in organic vehicles



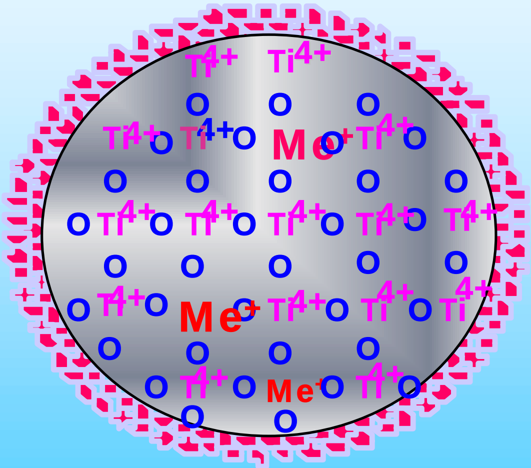
1) Surface coating increases weathering stability and dispersibility



Partial Coat **Porous Coat** **Dense Coat**

Photo stability of TiO_2

2) Doping with special elements reduces the photo activity



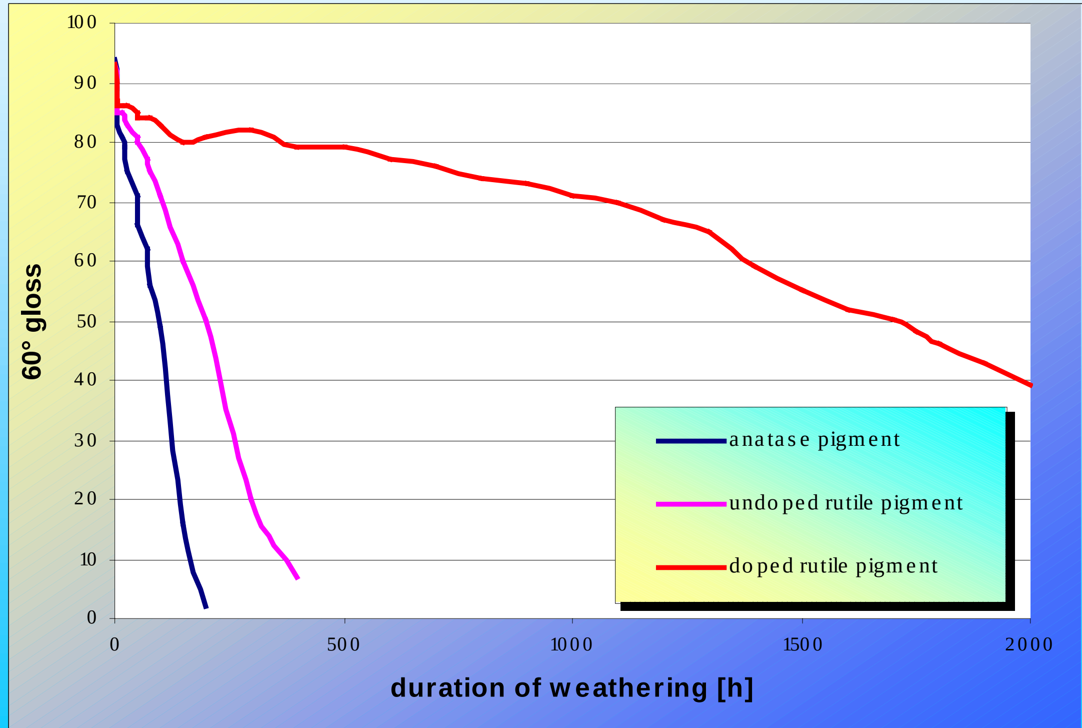


Photo stability of micronized TiO_2

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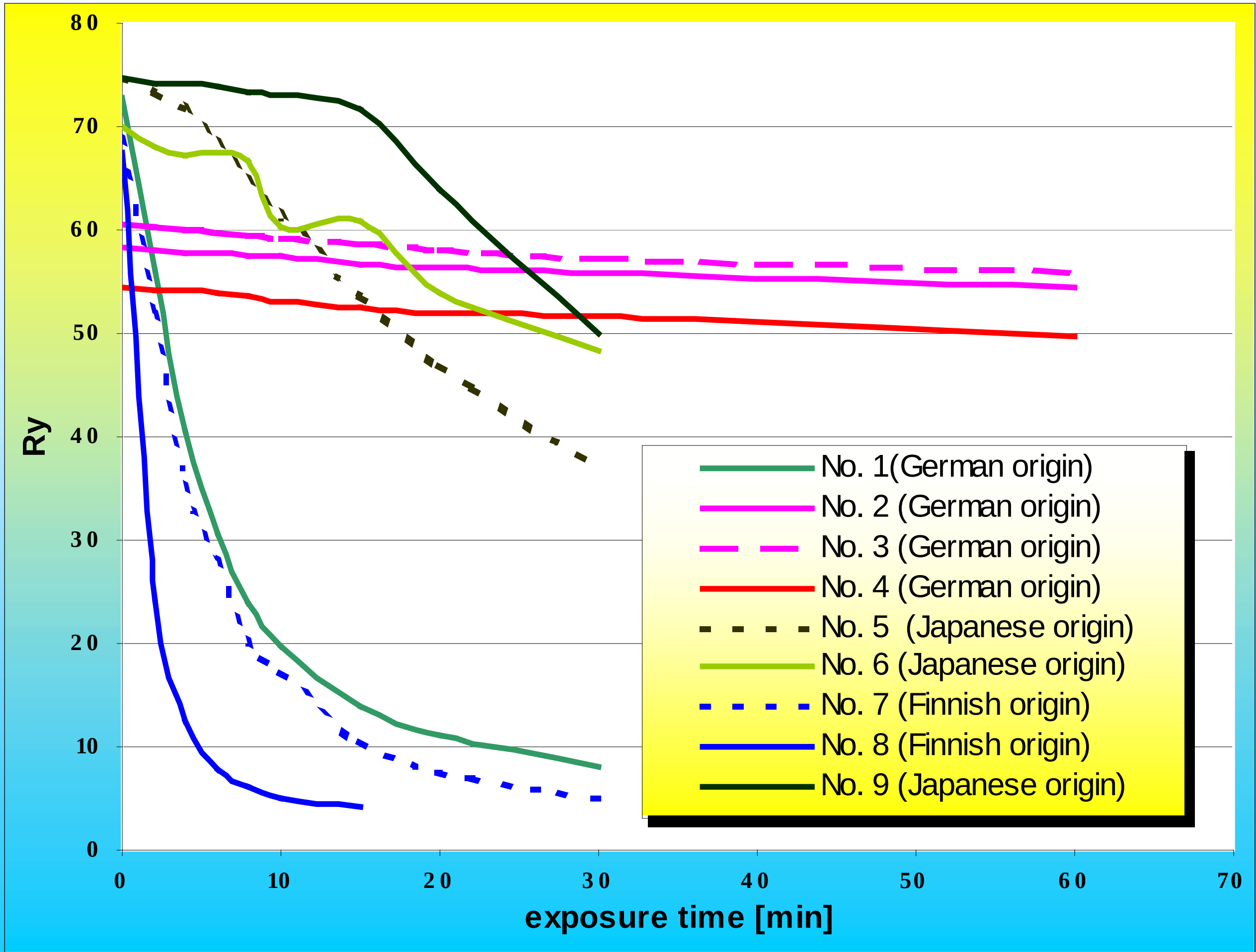

Effect of surface coating & crystal - latice doping on micronized titanium dioxide demonstrated by „lead carbonate test“

Outdoor applications

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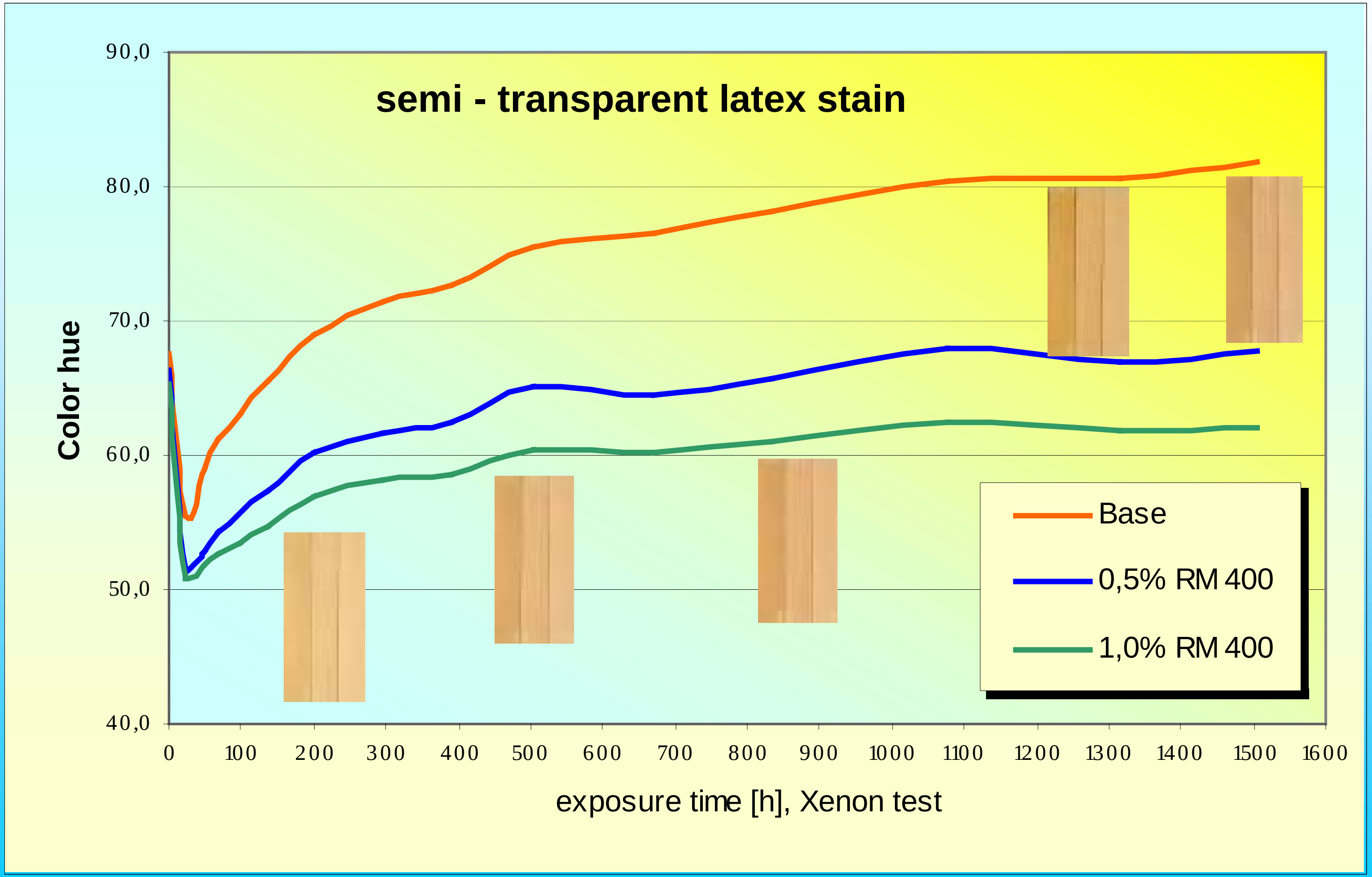


Outdoor applications

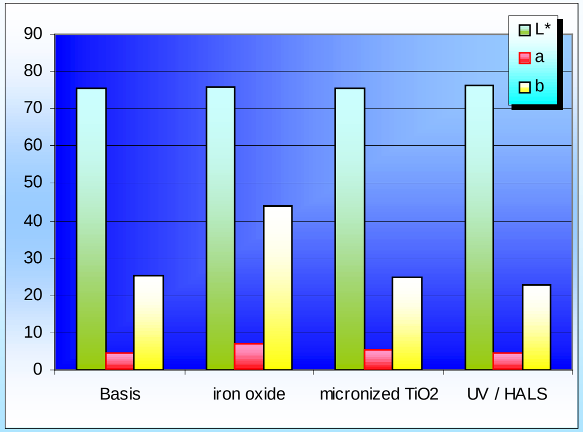
1 x blue stain inhibiting primer
3 x wood stain (base)

1 x blue stain inhibiting primer
2 x wood stain (base)
1 x stain plus micronized TiO_2

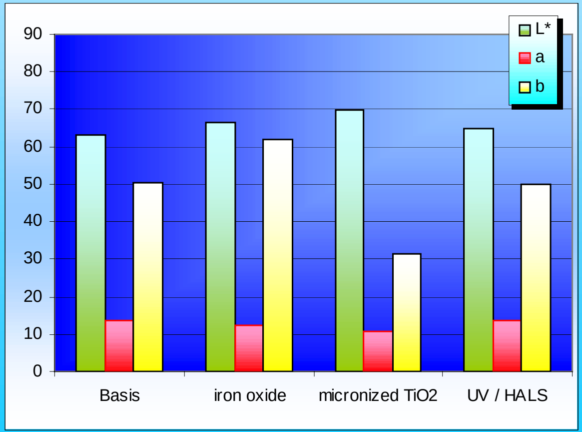
water based acrylic clear coat after two years outdoor exposure in S- Germany

Outdoor applications

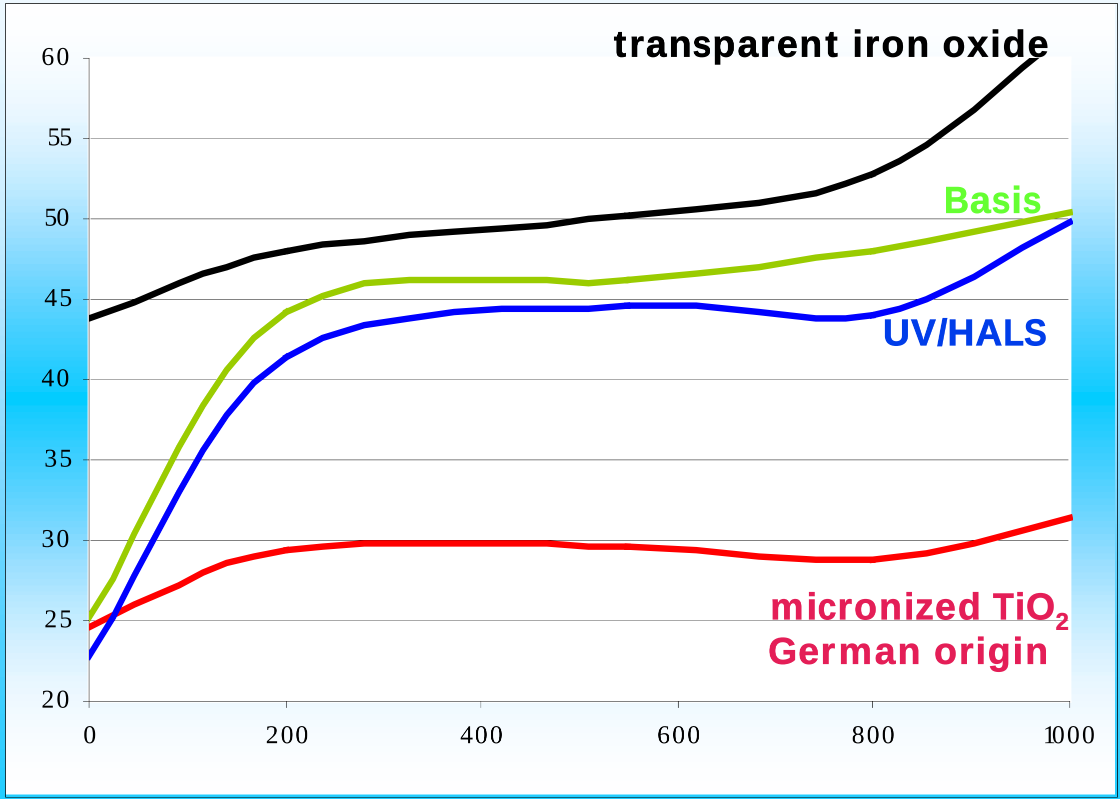
Styrene acrylate dispersion



before exposure by QUV, 313 nm



after 1000 h exposure by QUV, 313 nm



b- values during 1000 h exposure by QUV, 313 nm

Decomposition

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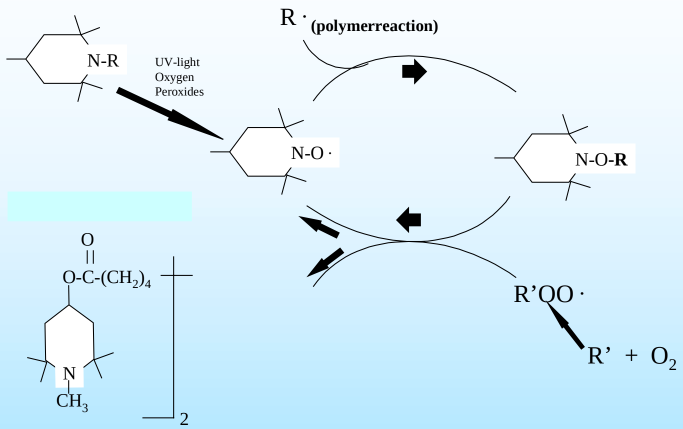
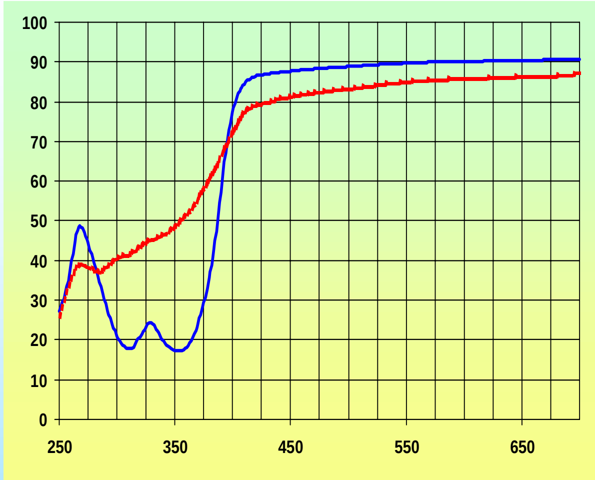
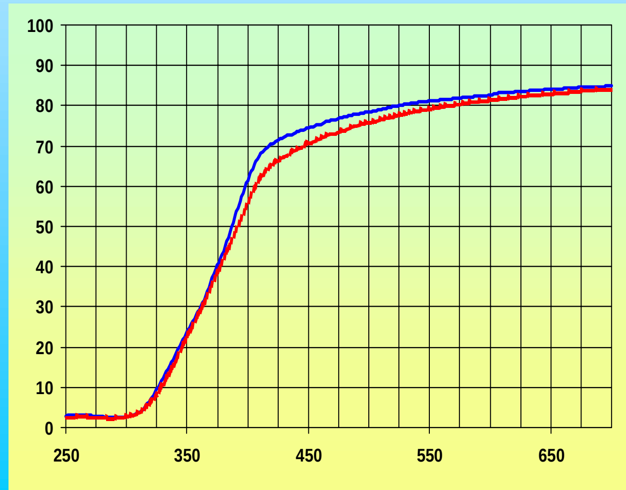


cyclic mechanism of HALS - radical scavengers

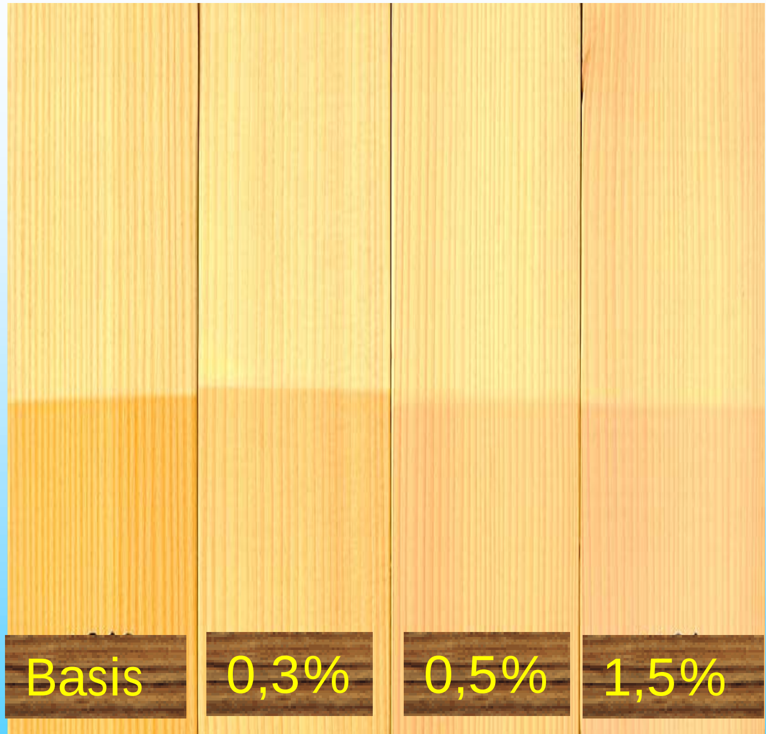


light transmittance curves before and after 400 h weathering with the Weather-O-Meter CI-65

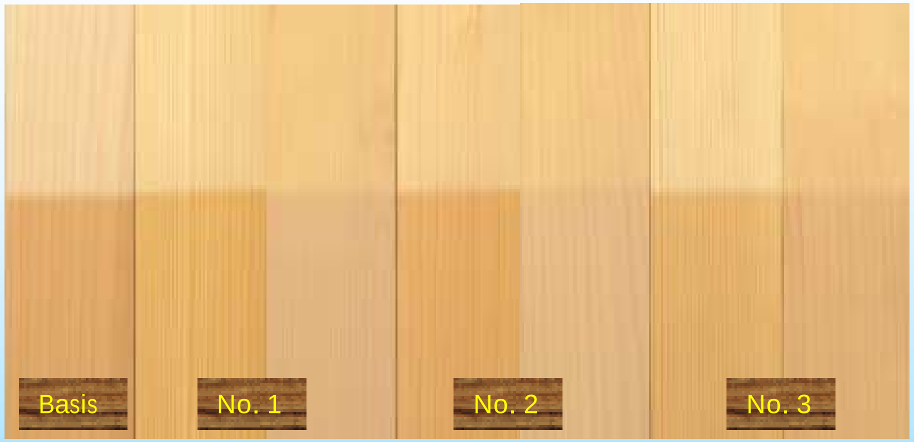


Micronized TiO_2: transfer of UV- light into caloric energy

Indoor applications



Parquet coatings with micronized TiO_2



Waxes with (right) and without (left) micronized TiO_2

Processing hints

1) The transmission depends on the concentration of transparent titanium dioxide and is based on the rule by Lambert - Beer.

2) Irrespective of the application, all micronized titanium dioxide grades have to be uniformely dispersed in order to achieve maximum efficiency by means of transparency and UV- protection.

$$E = \varepsilon \cdot c \cdot d = \log (I_0/I)$$

E = extinction
ε = extinctionscoefiecient [l x mol^{-1} x cm^{-1}]
c = concentration [mol/l]
d = thickness [cm]
I_0= intensity of irradiate light
I = intensity of transmission light

A dosage of 0,5 - 1,0% micronized titanium dioxide is recommended for initial tests at a film thickness of approximately 40 - 50 µm.

Pros and cons

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	UV/HALS	ZnO	Fe_2O_3	TiO_2, undoped	TiO_2, doped
transparency	+	-	+	-	-
system compatibility	-	-	+	+	+
UV- absorption	+	-	+	+	+
long - term performance	-	-	+	-	+
dosage	-	-	-	+	+
familiarity	+	-	+	-	-
handling	+	+	+	+	+
color neutrality	+	+	-	+	+
price / performance	+	-	+	+	+

Conclusion

- all evaluated UV - absorbers have advantages and disadvantages
- the decision upon the right choice of UV - absorber depends on the applications‘ requirements

→ micronized titanium dioxide (doped grade) leads to best performance regarding long- term stability of wood protective systems intended fo the use on pale colored timber

- further evaluations regarding combinations of all discussed types have to be done in terms of optimizing formulations as to the customers‘ need