Stability Study of Avobenzone with Inorganic Sunscreens

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Introduction

Titanium dioxide and zinc oxide are preferable UVA / UVB sunscreens because of their efficiency and low irritation. In order to increase the protection in the UVA range, in many countries, Avobenzone has been used in combination with titanium dioxide and / or zinc oxide. However, in the USA combinations of Avobenzone and physical sunscreens are not permitted. Avobenzone has been reported to be unstable when contained in formulations with physical sunscreens. Surface coating of the pigment has sometimes been shown to increase its stability

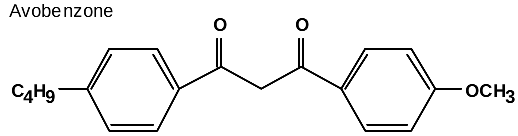
Objective

In this study combinations of Avobenzone and inorganic pigments were irradiated in order to determine the influence of the pigments and their surface treatments on stability of Avobenzone.

Sample Preparation

- 0.04% Avobenzone was dispersed with 4.0% inorganic pigment in Ethanol.
- Each sample was irradiated (Spectroline UV lamps - XX-15NB) for one week, then centrifuged to separate the solution from the inorganic pigment.
- All samples were diluted to 0.001% w/w Avobenzone based on its initially added amount.
- Transmittance and absorbance were measured using UV/Vis spectrophotometer (U-3010 from Hitachi).

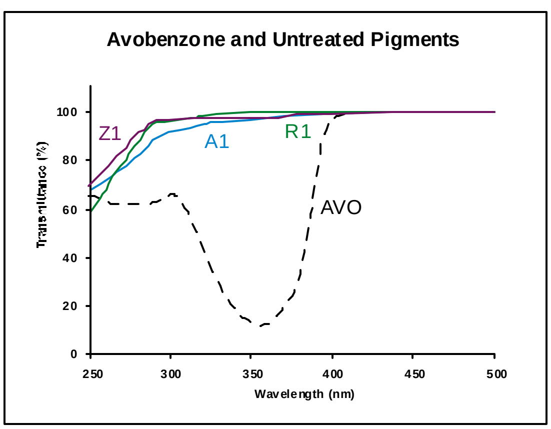
Avobenzone



References

- Development of Thin-layer Silica-coated Zinc Oxide and Superior Sunscreens;
  N. Ishii, K. Wada, M. Takama, K. Ogawa, K. Joichi and K. Ohno
  Proceeding XXI IFSCC International Congress 2000, Berlin, p. 519
- Photocatalytic Activity of Titanium Dioxide and Zinc Oxide;
  M. Kobayashi and W. Kalriess
  Cosmetics & Toiletries, vol. 112, no 6, p. 83

1. Influence of Untreated Physical Sunscreens on the Stability of Avobenzone



Reference	Pigment Type	Avobenzone remaining after irradiation	Primary particle size (PPS) in nm
Avobenzone	None	100 %	-
R1	Rutile TiO2	< 1%	200
R2	Rutile TiO2	< 1%	200
A1	Anatase TiO2	< 1%	300
A2	Anatase TiO2	< 1%	300
Z1	Zinc Oxide	< 1%	35

- No significant change was observed in the transmittance of Avobenzone after irradiation.
- Untreated titanium dioxide and zinc oxide degraded Avobenzone.

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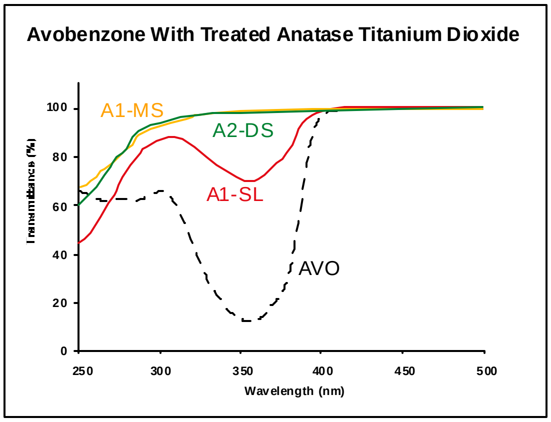
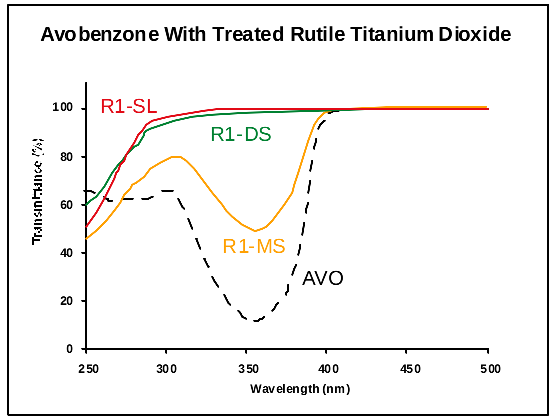
2. Influence of Treated Titanium Dioxides on the Stability of Avobenzone



Reference	Pigment Type	Treatment Type	Avobenzone remaining after irradiation
A1-SL	Anatase TiO2	Silane	19%
A1-MS	Anatase TiO2	Methicone	< 1%
A2-SL	Anatase TiO2	Silane	< 1%
A2-MS	Anatase TiO2	Methicone	< 1%
A2-DS	Anatase TiO2	Dimethicone	< 1%

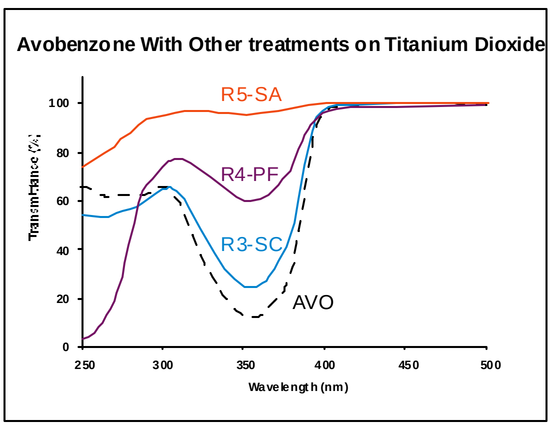
Reference	Pigment Type	Treatment Type	Avobenzone remaining after irradiation
R1-SL	Rutile TiO2	Silane	< 1%
R2-SL	Rutile TiO2	Silane	< 1%
R1-MS	Rutile TiO2	Methicone	38%
R1-DS	Rutile TiO2	Dimethicone	< 1%



Comparisons of anatase and rutile pigments after treatment with methicone, dimethicone, and octyltriethoxy silane were made.

Silane treatment: anatase A1-SL gave a better stability.

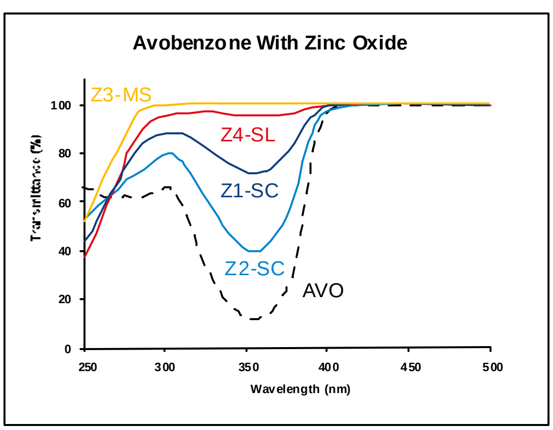
- Methicone treatment: rutile R1-MS gave a better stability.
- Anatase A2 had poor stability with all treatments.



Reference	Pigment Type	Treatment Type	Avobenzone remaining after irradiation	P.P.S. (nm)
R3-SC	Rutile TiO2	Silica	76%	90
R4-PF	Rutile TiO2	C9-15 Fluoro-Alcoholphosphate	28%	300
R5-SA	Rutile TiO2	Stearic Acid and Aluminum Hydroxide	3%	15

- Other treatments were also evaluated. The silica treated titanium dioxide (R3-SC) gave the best stability.

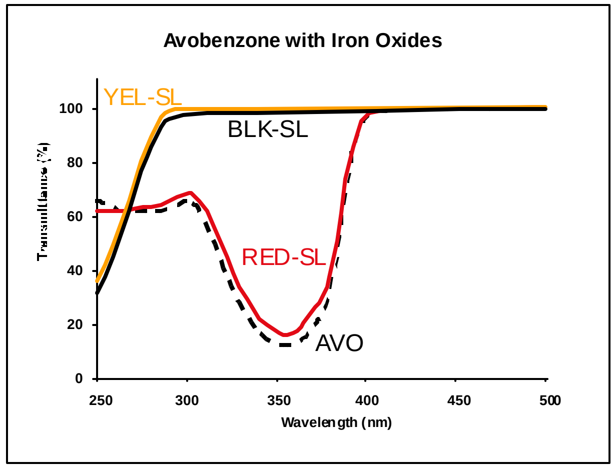
3. Influence of Treated Zinc Oxides and Iron Oxides on the Stability of Avobenzone



Reference	Pigment Type	Avobenzone remaining after irradiation	Primary particle size (PPS) in nm
Z2-SC	Silica	49 %	25
Z1-SC	Silica	18 %	35
Z3-MS	Methicone	< 1%	25
Z4-SL	Silane	3 %	120

- Treated zinc oxides were evaluated. Avobenzone is more stable with the presence of Silica treated ZnO.

Reference	Treatment Type	Avobenzone remaining after irradiation
RED-SL	Silane	97 %
YEL-SL	Silane	< 1 %
BLK-SL	Silane	< 1 %



Avobenzone may also be formulated in make-up products. We evaluated several grades of Iron Oxides, in order to determine if these pigments would impair the activity of Avobenzone. Red iron oxide was found to have a negligible effect on the stability of Avobenzone, while yellow and black iron oxides, on the contrary, lead to a complete degradation of Avobenzone.

Conclusion

In the course of this study, we have shown that Avobenzone, when combined with uncoated physical sunscreens, retains little activity following irradiation.
We also demonstrated that the surface treatment of pigments could limit this degradation, and in the best case of silica treated Titanium dioxide R3-SC, 76 percent of the activity was retained.

Additional measurements are needed to better understand the UV properties of combinations of Avobenzone and inorganic pigments. Work is in progress in our laboratories to determine the influence of the following parameters :

- Pigment type and morphology;
- Extent and type of surface treatment;
- Particle size of the pigment.

The results will need to be correlated with approved methods for testing sunscreens formulations.

Acknowledgment
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Reference Codes and Trade Names of Pigments used in this study :

Reference code	Trade name	Reference code	Trade name
A1	CTFA328	R3-SC	MAX LIGHT TS-04
A1-SL	BTD-11S2	R4-PF	PF-5 TIO2 CR-50
A1-MS	BTD-MS2	R5-SA	TTO-51-C
A2	TiO2 FF PHARMA	Z1	ZNO-350
A2-MS	TIO2 FFP-MS2	Z1-SC	ZNO-350 SIO2(5)
A2-DS	TIO2 FFP-DS4	Z2-SC	MAX LIGHT ZS-032
R1	Tronox CR-837	Z3-MS	ZNO XZ-MS4
R1-SL	RBTD-11S2	Z4-SL	A120-ZNO-11S3
R1-MS	RBTD-MS2	BLK-SL	BBO-11S2
R1-DS	RBTD-DS4	RED-SL	BRO-11S2
R2	CR-834	YEL-SL	BYO-11S2
R2-SL	RBTD-834-11S2		

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