

Non-nano Zinc Oxide for UV Protection

Yun Shao, Ph.D., and David Schlossman- Kobo Products, Inc. - South Plainfield, NJ, USA

Introduction

The term "nanotechnology" is generally used to refer to the development of materials that have at least one dimension in the range of 1-100 nanometers and possess novel properties because of their extremely small size. Inorganic UV filters are usually made to be nano particles in order to be transparent on skin and effective against UV. They are preferred as sunscreen agents because of their physical and chemical stability and are non-irritating. However, there are recent concerns in the market over their potential ability to penetrate skin and can bio-accumulate in human body.

In light of the perceived health risk associated with nanoparticles, pigment producers have been challenged recently to create particles that are, preferably, all or almost all larger than 100 nm. In this poster, such Zinc Oxide is presented.

Experimental

- 1) ZnO-C was produced by Sumitomo Osaka Cement. Primary particle size of ZnO is calculated from their BET specific surface area.
- 2) Treated ZnO was dispersed in C12-15 Alkyl benzoate and milled to the desired size.
- 3) In-vivo SPF and PFA (PPD method) were tested on 3 panelist. In-vitro testing was done using 3M Transpore tape
- 4) Particle size in dispersion was measured using a Horiba LA-910 light scattering size analyzer. Volume-weighted mean size was reported.

1. ZnO-C - non-nano zinc oxide

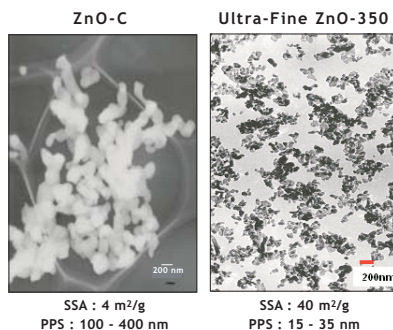


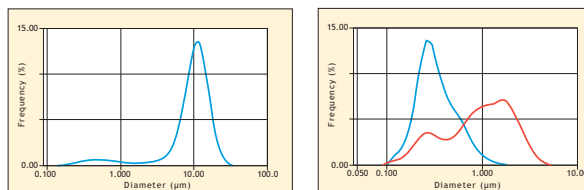
Fig. 1 shows the TEM picture ZnO-C and lists its specific surface area. The calculated mean primary particle size (PPS) is 263 nm and all sizes are in the range of 100 - 400 nm. No particle under 100 nm can be observed on the TEM picture, which confirms there are no so-called nano-particles. This is in a clear contrast to the ultra fine grade ZnO-350.

Acknowledgement

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2. Size analysis by light scattering size analyzer

Fig. 3. Size distribution curve of ZnO-C Dispersion



Light scattering size analyzer is commonly used in cosmetic industry for size measured. Both powder and the dispersion of the ZnO-C were analyzed. When base ZnO-C powder was analyzed, no particle was found to be under 100 nm. Even after the powder was aggressively milled to de-agglomerate and to improve transparency, the portion of particle under 100 nm is < 0.3% when the dispersion was diluted with either polar or non-polar solvent.

3. Optical properties

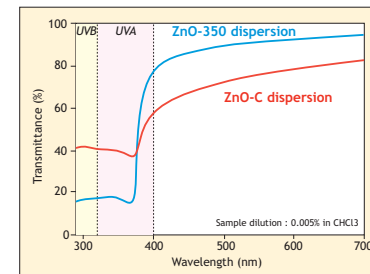


Fig. 3. Transmittance curve of ZnO Dispersion

4. Performance in sunscreen lotion

Sunscreen lotion with ZnO (Formula 1)



Table 1. In-vitro test result of Formula 1

| | ZnO-350 | ZnO-C |
|-----------|---------|-------|
| SPF | 28.6 | 24.4 |
| UVA ratio | 0.80 | 0.88 |

* Data from Sumitomo Osaka Cement

Tint sunscreen lotion with TiO₂ and ZnO (Formula 2)



Table 2. In-vitro and In-vivo test result of Formula 2

| | | |
|----------|---------------------|-------|
| In-vivo | SPF | 32 |
| | PFA | 12.66 |
| In-vitro | SPF | 23.7 |
| | UVAPF | 16.28 |
| | UVA/B ratio | 0.90 |
| | Critical wavelength | 382nm |

The results in Table 1 and Table 2 indicate that ZnO-C can provide very effective UV attenuation and provide a broad-spectrum protection at a high use level. Although the opacity can increase as the particle size increases, it is acceptable due to its low refractive index.

Formula 1: Sunscreen lotion with ZnO

| | |
|---|-------|
| 1. HEXALAN(T.I.O) | 4.0% |
| 2. SILICONE OIL KF-96A 6CS - Dimethicone 6 Cst | 6.0% |
| 3. JOJOBA OIL | 1.0% |
| 4. SILICONE DC345 - Cyclopentasiloxane | 5.0% |
| 5. KF-6017 - PEG-10 Dimethicone | 4.0% |
| 6. ZnO * | 22.0% |
| 7. SILICONE KF-6028 - PEG-9 Polydimethylsiloxethyl Dimethicone | 2.0% |
| 8. SILICONE KSG-210 - Dimethicone (And) PEG-10 Dimethicone Crosspolymer | 3.5% |
| 9. SILICONE SH245 - Cyclopentasiloxane | 20.4% |
| 10. BENTONE 38 | 1.0% |
| 11. SIO1-2 TALC JA46R | 3.0% |
| 12. NYLON POWDER SP-500 | 2.0% |
| 13. 1,3-BUTYLENE GLYCOL | 5.0% |
| 14. METHYLPARABEN | 0.2% |
| 15. PROPYLPARABEN | 0.1% |
| 16. DE-IONIZED WATER | 20.2% |
| 17. MAGNESIUM SULFATE | 0.5% |
| 18. EDTA-ZNA | 0.1% |

* Coated with Dimethicone / Methicone Copolymer

Formula 2: Tint sunscreen lotion with TiO₂ and ZnO

| | |
|--|--------|
| 1. ZnO-C dispersion in ester | 31.30% |
| 2. Non-nano attenuation grade TiO ₂ dispersion Triocetyldecyl Citrate | 5.63% |
| 3. Cyclopentasiloxane | 5.27% |
| 4. Polyglyceryl-4 Isostearate (And) Cetyl PEG/PPG-10/1 Dimethicone (And) Hexyl Laurate | 5.00% |
| 5. Caprylyl Methicone | 3.00% |
| 6. 350 cSt Dimethicone | 1.00% |
| 7. Lithium Magnesium Sodium Silicate (And) Distearaldimonium Chloride | 1.00% |
| 8. Sorbitan Isostearate | 0.75% |
| 9. Propylene Carbonate | 0.10% |
| 10. Distilled Water 39.57 | |
| 11. PEG-150/Decyl Alcohol/SMDI Copolymer | 3.50% |
| 12. Sodium Chloride | 1.00% |
| 13. Propylene Glycol (And) Diazolidinyl Urea (And) Methylparaben (And) Propylparaben | 1.00% |
| 14. Polysorbate 20 | 0.50% |
| 15. Transparent yellow dispersion | 1.20% |
| 16. Transparent yellow dispersion | 0.16% |
| 17. Black dispersion | 0.02% |

Active ingredients : ZnO, 21.47% ; TiO₂, 1.8%

Conclusions

In this work, a new zinc oxide was developed where all primary particles are greater than 100 nm. Its distribution was analyzed with both imaging techniques and a more commonly used light scattering technique. The UV transmittance curve indicated a moderate UV attenuation power. The powder was then surface treated and was applied in sunscreen formulation. It was found that this ZnO can be effective in UVA protection and can boost UVB protection when used in combination with other organic sunscreens such as titanium dioxide. The aesthetics of the sunscreen formulation was good when the use level of this ZnO was moderate.

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