

We create chemistry

Care Creations™

Z-COTE® UV Filters Formulation Tip Guide

Trusted Technology for Everyday Protection

www.carecreations.basf.us



Zinc Oxide has evolved into an everyday necessity

Use of Zinc Oxide-based sunscreen formulations is on the rise in North America. The current regulatory climate surrounding organic UV filters, consumer awareness of Zinc Oxide and their concern about the safety of the ingredients used in the products they purchase all fuel the demand.

Zinc Oxide is the only UV filter that can singlehandedly deliver complete broad-spectrum sun protection as required by the FDA. The Z-COTE® product line from BASF Care Creations has a proven history of providing safe-use Zinc Oxide UV filters that continuously evolve to address the newest and most relevant market and formulation needs.

We help our customers solve common and difficult formulation challenges by combining the best ingredients with specialized expertise to ensure that your efficacy and aesthetic targets are met and exceeded.

- Broad-spectrum sun protection
- Critical wavelength of at least 370 nm
- Best-in-class photostability
- Low whitening on varied skin types
- Non-staining, non-greasy
- Naturally derived, locally sourced
- FDA-approved

BASF understands that to effectively prevent long-term skin damage, consumers must feel comfortable and confident using your sun care products anytime, anywhere.

Easy-to-use Z-COTE® ingredient forms

Z-COTE® UV filters are available in versatile ingredient forms — powders, pourable dispersions, coated, and uncoated — for optimal flexibility and performance. Formulators can select the form, coating, and particle size that's best for their manufacturing processes and finished product format, as well as for the efficacy and aesthetics of the product itself. BASF also offers a wide selection of functional and performance-based sun care ingredients that work in tandem with Z-COTE® to combine excellent aesthetics with proven anytime protection.

Z-COTE®'s surface treatment is hydrophobically modified, so we recommend adding these grades to the oil phase. The coating improves stability and reduces agglomeration and ion shifting. The denser powder has less volume and is easier to handle.

Tradename	INCI Designation
Z-COTE®	Zinc Oxide
Z-COTE® HP1	Zinc Oxide (and) Triethyoxycaprylylsilane
Z-COTE® HP1 X	Zinc Oxide (and) Triethyoxycaprylylsilane
Z-COTE® LSA	Zinc Oxide (and) Triethyoxycaprylylsilane
Z-COTE® LSA UC	Zinc Oxide
Z-COTE® Simple (pourable 70% Zinc Oxide dispersion)	Zinc Oxide (and) Caprylic/Capric Triglyceride (and) Polyhydroxystearic Acid (and) Triethoxycaprylylsilane



Transparency

Z-COTE®
Z-COTE® HP1
Z-COTE® HP1 X

Provide excellent transparency with sufficient levels of UVA protection to meet requirements for broad-spectrum claim.

Z-COTE® LSA
Z-COTE® LSA UC
Z-COTE® Simple

Provide best UVA protection and a boost of critical wavelength to meet requirements for broad-spectrum claim.

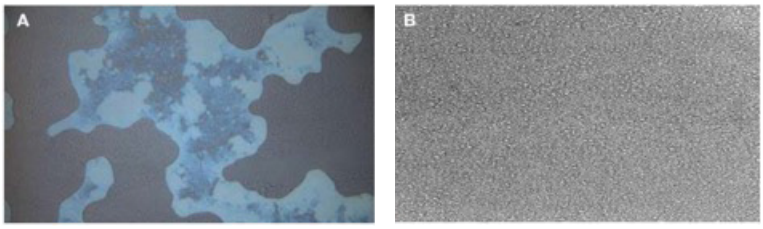
Particle Size

Formulation guidelines

Dispersions

Proper dispersion is essential for optimal UV filter performance. It provides better UV protection, improves stability and reduces whitening.

Optical microscopy of dispersion differences for Zinc Oxide in an emulsion.

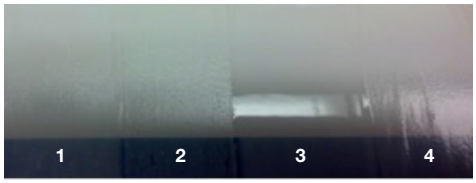


(A) Inadequate dispersion (B) Adequate dispersion

Selection of emollients

Untreated powders require high-polarity emollients for better dispersion in oil. The higher the polarity, the better the dispersion. Myritol® 331 (Cocoglycerides) and Cetiol® B (Dibutyl Adipate) are recommended emollients when using Z-COTE® in untreated powder forms.

Z-COTE® (Zinc Oxide), untreated, dispersed in different emollients at room temperature



1 Dicaprylyl Carbonate (Cetiol® CC)
2 Mineral Oil
3 Cocoglycerides (Myritol® 331) – Higher polarity / Best option
4 Caprylyl Caprylate/Caprate (Cetiol® RLF)

Surface treated powders allow for excellent dispersions with a wider range of emollients. The more hydrophobic the coating is, the lower polarity of the emollient required for a good dispersion. Here we recommend Cetiol® CC (Dicaprylyl Carbonate), Luvitol® Lite EM (Hydrogenated Polyisobutene), or Cetiol® Sensoft (Propylheptyl Caprylate).

Z-COTE® HP1 (Zinc Oxide (and) Triethoxycaprylylsilane) dispersed in different emollients at room temperature



Medium polarity | Medium polarity | Low polarity | High polarity (negative control)

1 Dicaprylyl Carbonate (Cetiol® CC)
2 Propylheptyl Caprylate (Cetiol® Sensoft)
3 Hydrogenated Polyisobutene (Luvitol® Lite EM)
4 Cocoglycerides (Myritol® 331)

Dispersing in oil

Coated Zinc Oxides are recommended for the oil phase. Add Z-COTE® to the heated oil phase and mix well to wet the particles and displace air pockets. Homogenize the oil phase to optimize the dispersion.

The particles should be invisible to the naked eye and the dispersion should look like paint. Properly homogenize during emulsification.



Cold mix Hot mix



Hot mix after homogenization

Hot pour tips

Follow the same instructions for dispersing in oil. Melt all solids in the oils. Add Z-COTE® and mix well to displace air pockets. Homogenize until uniform, then mix continuously until optimal filling temperature is achieved.

Water dispersions

Premixing untreated Zinc Oxide with a humectant or water-soluble emollient can improve dispersion. Mix Z-COTE® in the water phase until uniform and the emulsion is properly homogenized. We recommend testing the final product on a black surface to ensure uniformity and adequate dispersion.

Z-COTE® emulsion guidelines

Add the lipophillic dispersion to the oil phase and keep the pH above 7.0. Do not use cationic ingredients or acrylates.

Keep pH above 7.0

- Always keep at pH 7.1 or higher. A pH of less than 7.0 will allow divalent zinc ions to migrate into the water phase, making the formulation unstable.
- Zinc ions can interact with rheology modifiers, film formers and emulsifiers.
- Coated forms of Zinc Oxide minimize ion migration.

Acrylate-derived polymers are sensitive to Zn^{2+}

- Complexes form that disrupt the polymer matrix and cause instability.
- Effects are more pronounced with uncoated Zinc Oxide.

Chelating agents help in the aqueous phase

- Na_2EDTA can help with stability.

During formulation the pH may rise

- Use buffering agents (citric acid, lactic acid, or others).
- Check pH at 0 hours and 24 hours and adjust if necessary.

During stability testing the pH may rise

- This is a normal phenomenon that should stop before the pH rises too high.
- A pH that rises higher than 8 may cause physical changes to occur.

Rheology modifiers – Non-ionic

- Optimal for inorganic UV filters.
- Xanthan gum (Rheocare® XGN), Clays, Hydroxyethyl Cellulose or Hydroxypropyl Methyl Cellulose work well.

Rheology modifiers – Ionic

- Uncoated Zinc Oxide is incompatible with ionic rheology modifiers such as carbomers. Use coated Zinc Oxide with caution.
- Ionic rheology modifiers affect pH, cosmetic appeal and UV performance.
- The emulsion may appear stable at first, then eventually separate or show signs of instability.

Emulsifiers – Non-ionic

- Ideal for inorganic sunscreens.
- Can be incorporated into water-in-oil (W/O) or in oil-in-water (O/W) systems.
- Recommended emulsifiers:
  - W/O: Polyglyceryl-2 Dipolyhydroxystearate (Dehymuls® PGPH), Polyglyceryl-3 Diisostearate (Lameform® TGI), Ceteareth-25, Ceteareth-6 (and) Stearyl Alcohol, Ceteareth-20
  - O/W: Stearates, Glucosides, Oleates

Emulsifiers – Ionic

- May cause instability.
- Shifts in pH affect cosmetic appeal and UV performance.

Emulsions – Water-in-oil (W/O)

- Usually provide better UV performance and better film.
- Provide a heavier, more substantial feel.
- Provide water resistance.
- Do not affect pH.
- Optimal for combining Zinc Oxide with Titanium Dioxide.
- Slight whitening at ~15%+ active concentration levels.
- Whitening effect is formulation-dependent; proper dispersion helps to mitigate.

Emulsions – Oil-in-water (O/W)

- Can achieve UV performance comparable to W/O.
- Provides a lighter feel than W/O.
- Recommended to use with water-resistant enhancers.
- Recommended pH minimum of 7.1.
- Use natural gums or non-ionic thickeners such as Rheocare® XGN.
- Oil droplets become denser than the water at high loads of ZnO.
  - Agglomeration and settling of droplets occurs.
  - Emulsifiers and rheology modifier concentrations increase.
- Proper selection and dispersion of Zinc Oxide helps mitigate whitening effects.



Z-COTE®
UV Filters

Trusted Technology for Everyday Protection

Z-COTE® UV filters help you set your formulations apart. Our ingredients and technical expertise help formulators meet today's sun care needs.

Explore our complete portfolio at www.carecreations.basf.us

About the Care Chemicals division at BASF

The BASF division Care Chemicals offers a broad range of ingredients for personal care, home care, industrial & institutional cleaning, and technical applications. We are a leading global supplier for the cosmetics industry as well as the detergent and cleaner industry, and support our customers with innovative and sustainable products, solutions and concepts. The division's high-performance product portfolio includes surfactants, emulsifiers, polymers, emollients, chelating agents, cosmetic active ingredients and UV filters. We have production and development sites in all regions and are expanding our presence in emerging markets. Further information is available online at **www.care-chemicals.basf.com**

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