Optimising mineral sun care formulations

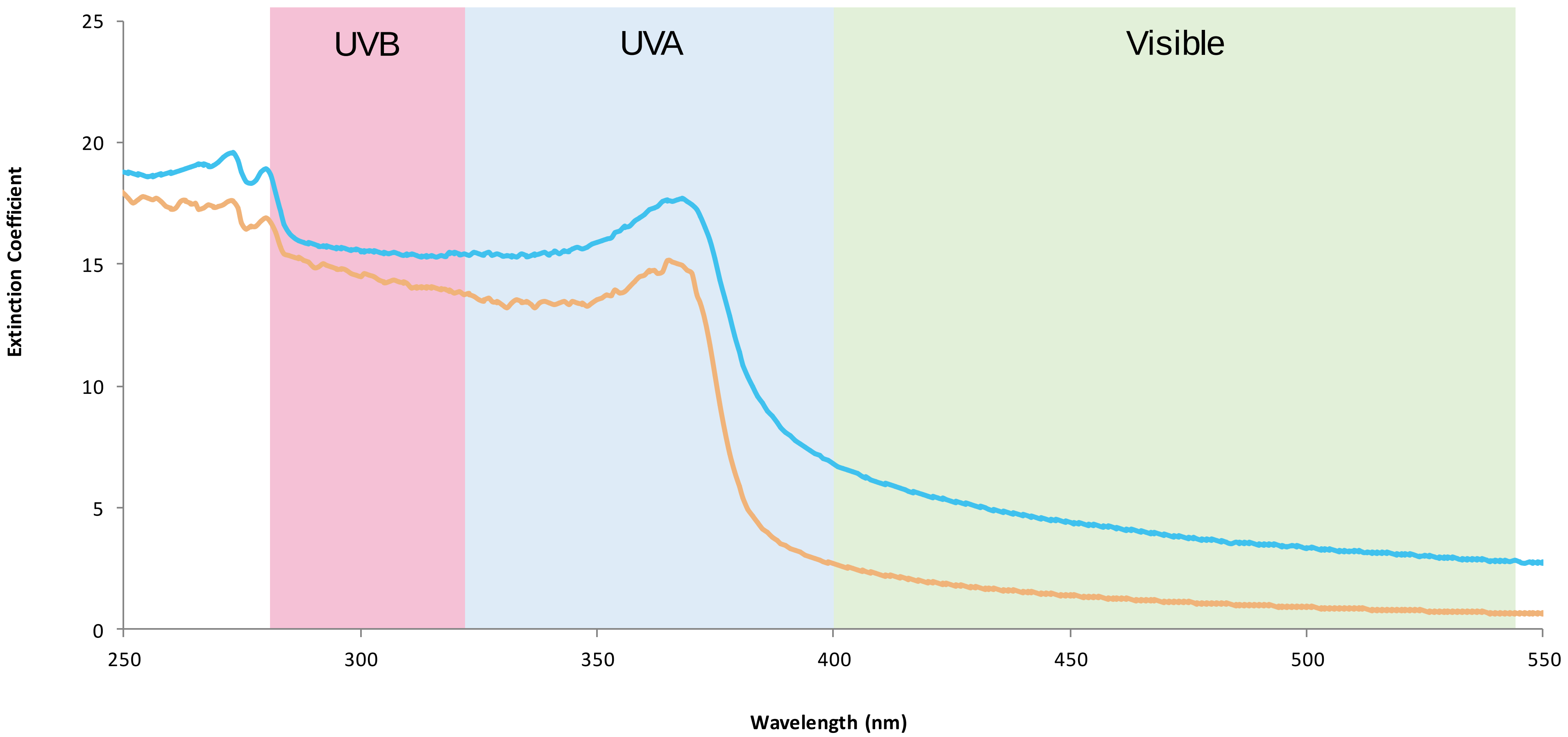
Milano, 22-23 Novembre

UV Filter Selection

- The heart of the solar formulation
- The selection of filter is crucial to achieving optimum performance and meeting regulatory requirements
- In Europe, the UVA protection is required to be at least one third of the labelled SPF

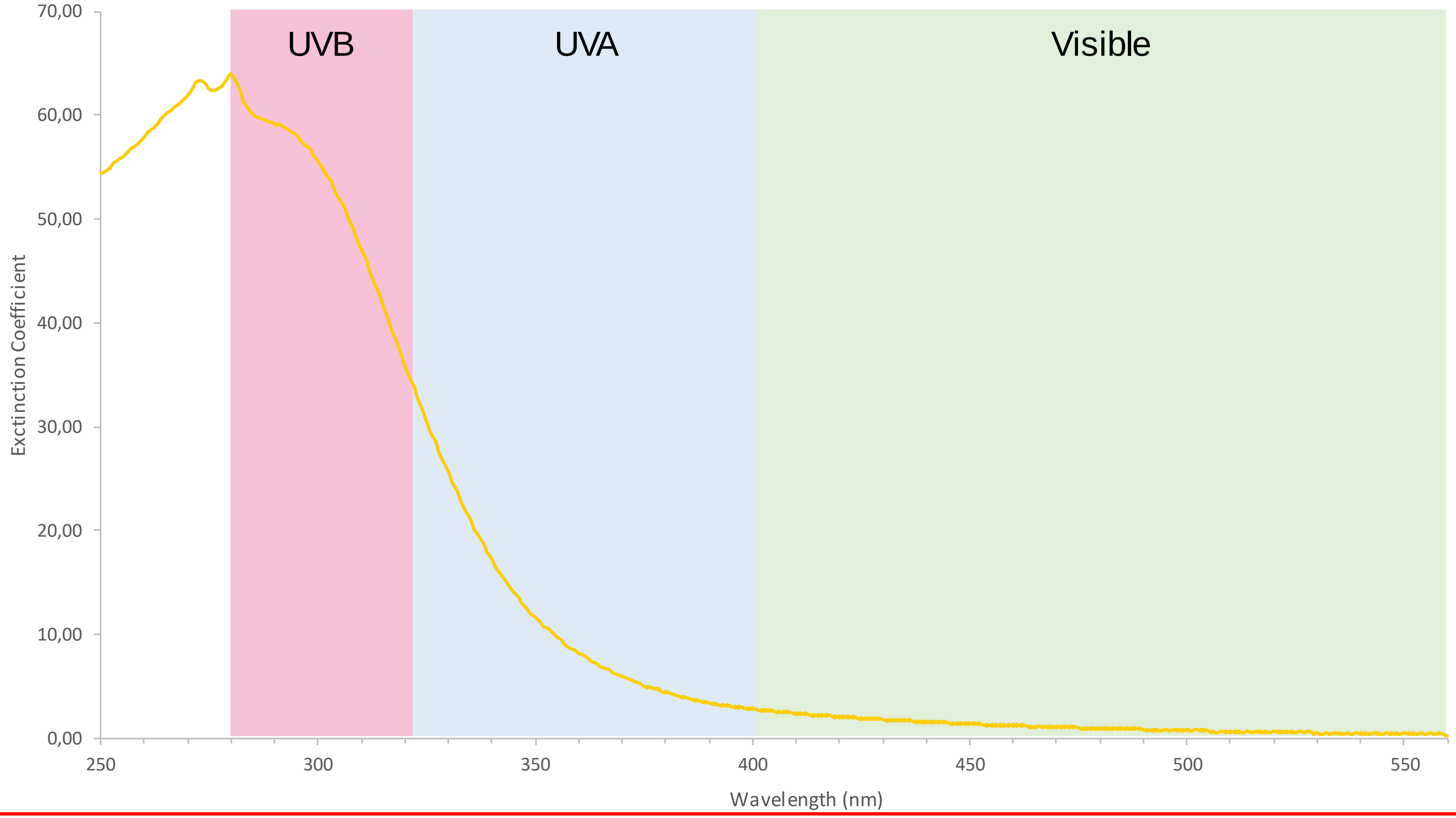
UV Filter Selection

Zinc Oxide



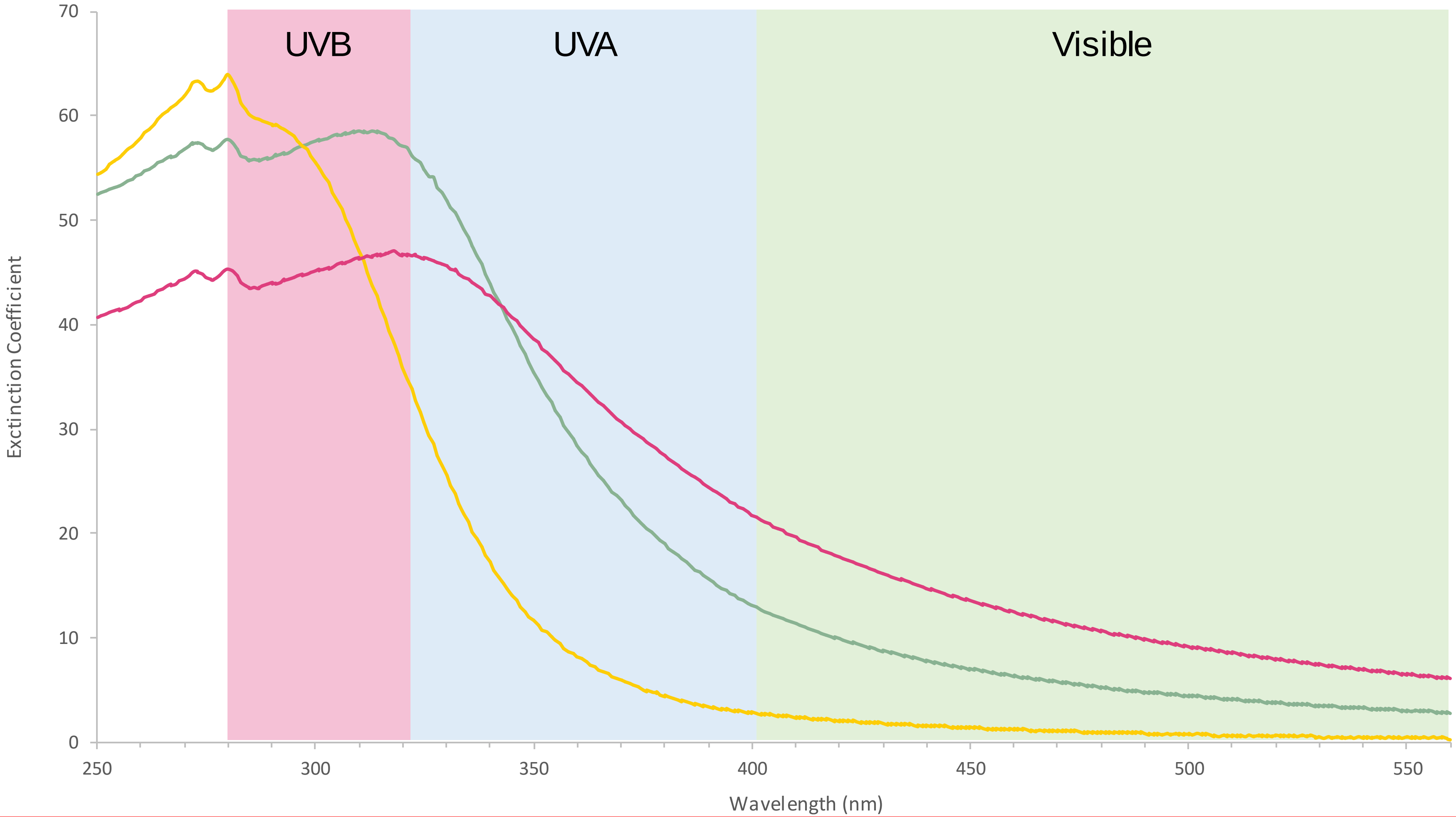
UV Filter Selection

Titanium Dioxide

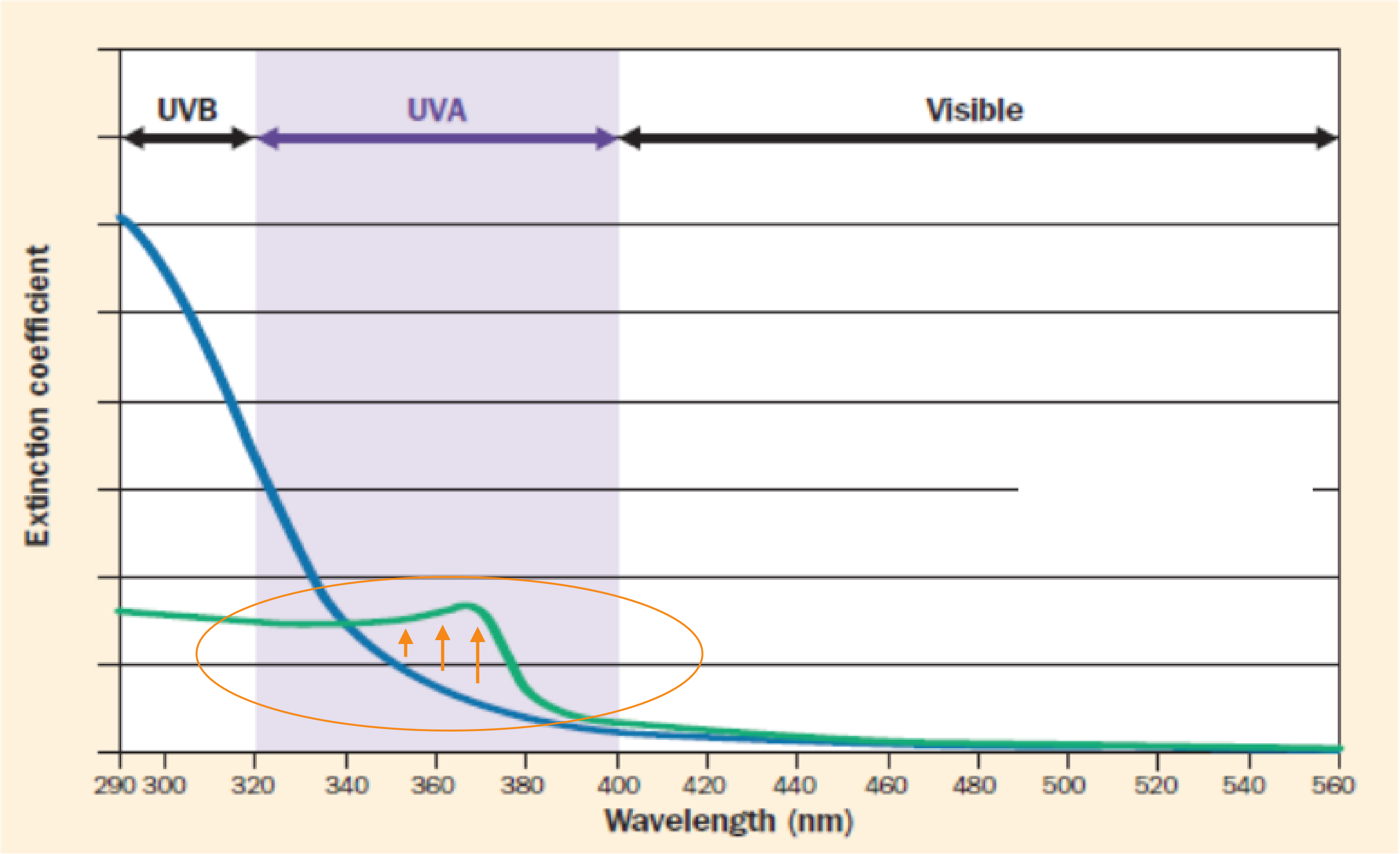


UV Filter Selection

Titanium Dioxide



Combining Titanium Dioxide and Zinc Oxide



- ZnO tends to have high attenuation in the UVA region of the UV spectrum and lower attenuation in the UVB
- TiO_2 tends to have high attenuation in the UVB and lower in the UVA.

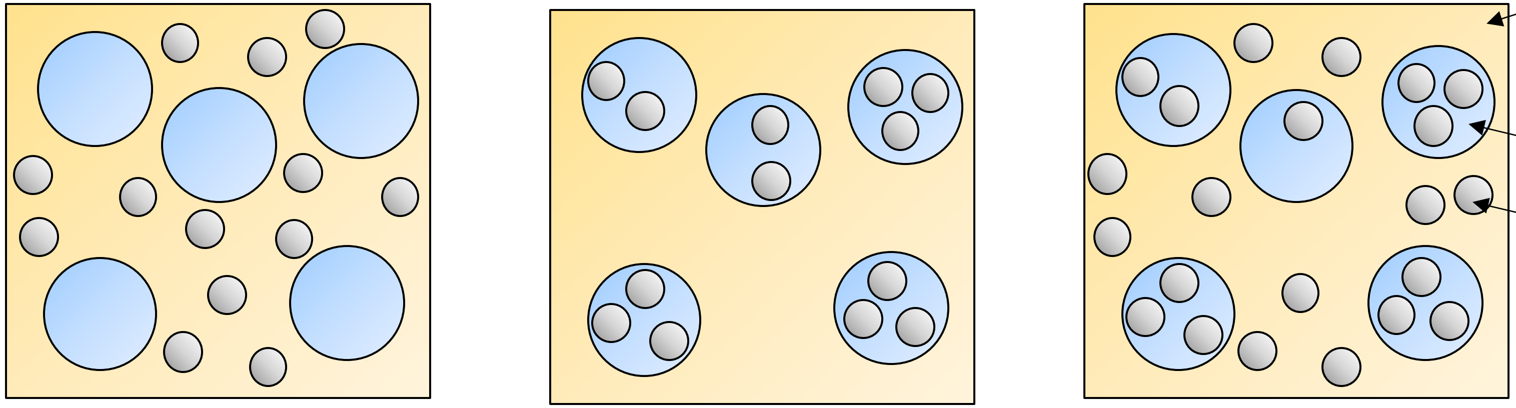
UV Filter Selection

Combining Titanium Dioxide and Zinc Oxide

Formulation	A	B	C	D	E	F
Ratio (ZnO: TiO2)	**10:0**	**9:1**	**8:2**	**7:3**	**6:4**	**5:5**
Percentage of Zinc Oxide (60 % Solids Content)	25.00	22.50	20.00	17.50	15.00	12.50
Percentage of Titanium Dioxide (45 % Solids Content)	0	2.50	5.00	7.50	10.00	12.50
In Vitro SPF	20	22	25	31	34	35
Labelled SPF	20	20	25	30	30	30
In Vitro UVAPF (COLIPA 2011)	11	8	8	7	6	6
Critical Wavelength (COLIPA 2011)	**372**	**371**	**370**	**370**	369	369
COLIPA 2011	**UVA**	**UVA**	-	-	-	-
FDA Prediction (based on COLIPA CW)	BS*	BS*	BS*	BS*	-	-
PA Prediction (Based on COLIPA UVAPF)	PA+++	PA+++	PA+++	PA++	PA++	PA++

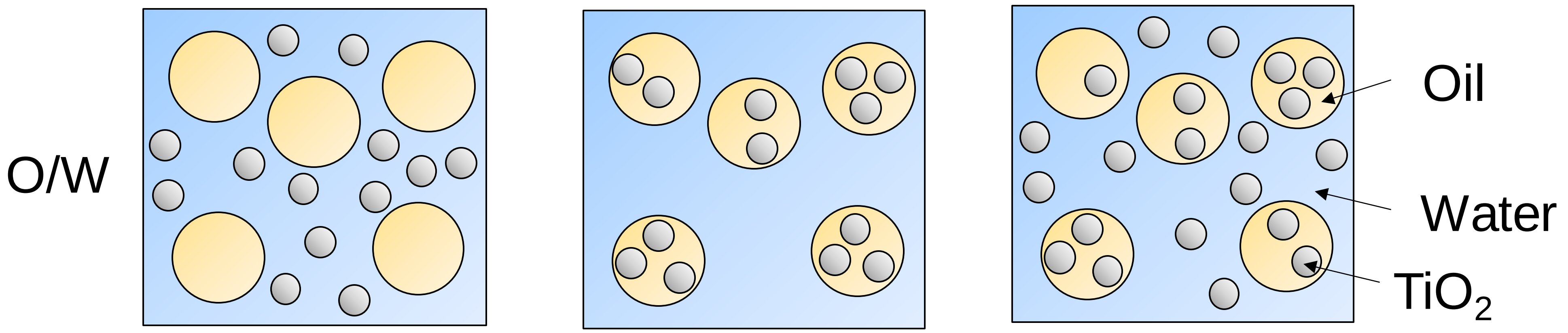
Actives in which phase?

W/O



- Oil based dispersions tend to be most suited to the oil phase of W/O emulsions (external phase is oil)
- Use of water-based dispersions in the internal phase can be difficult to stability in W/O system
- Can achieve synergy when dispersion is used in both phases, plus a higher loading of solids is possible

Actives in which phase?



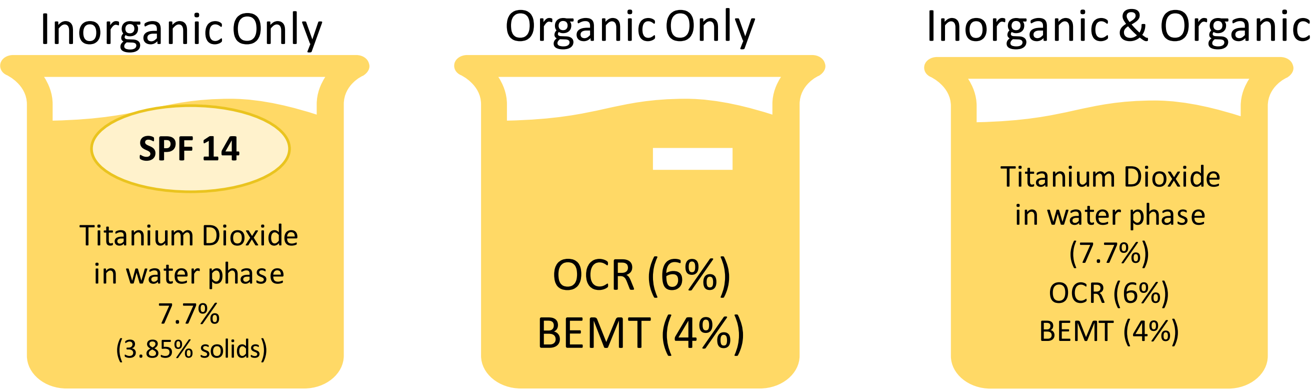
- Water based dispersions tend to be most suited to the water phase of O/W emulsions (external phase is water)
- Oil based dispersion can be use in the internal phase with no stability concerns
- Can achieve synergy when dispersion is used in both phases, plus a higher loading of solids is possible

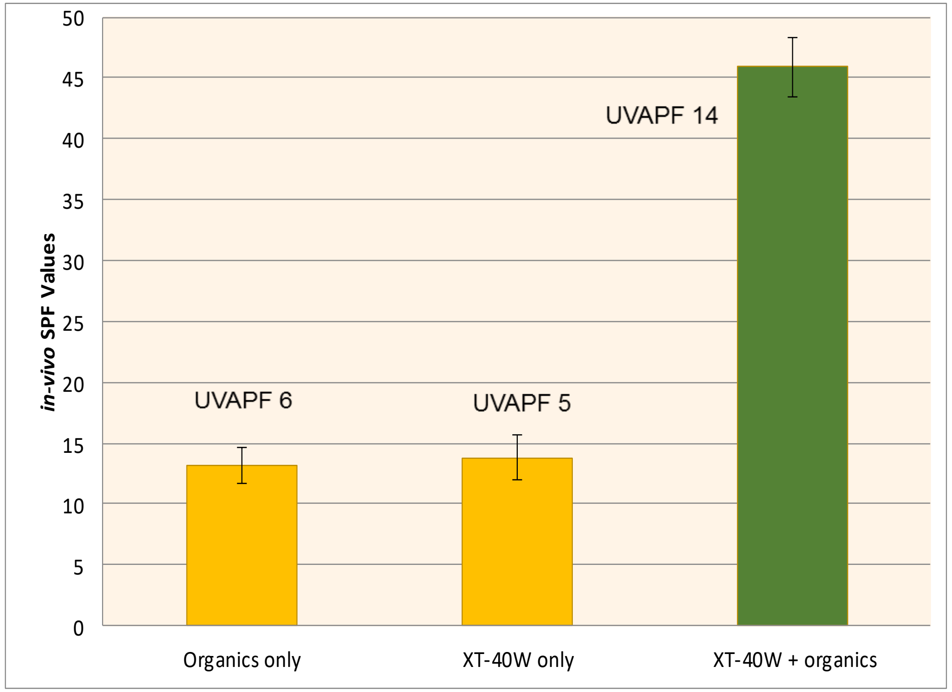
  – Biphasal distribution also recommended

Formulation Optimisation – Hybrid Formulations

- Substantial “synergistic” effects can be observed when organic and inorganic filters are combined

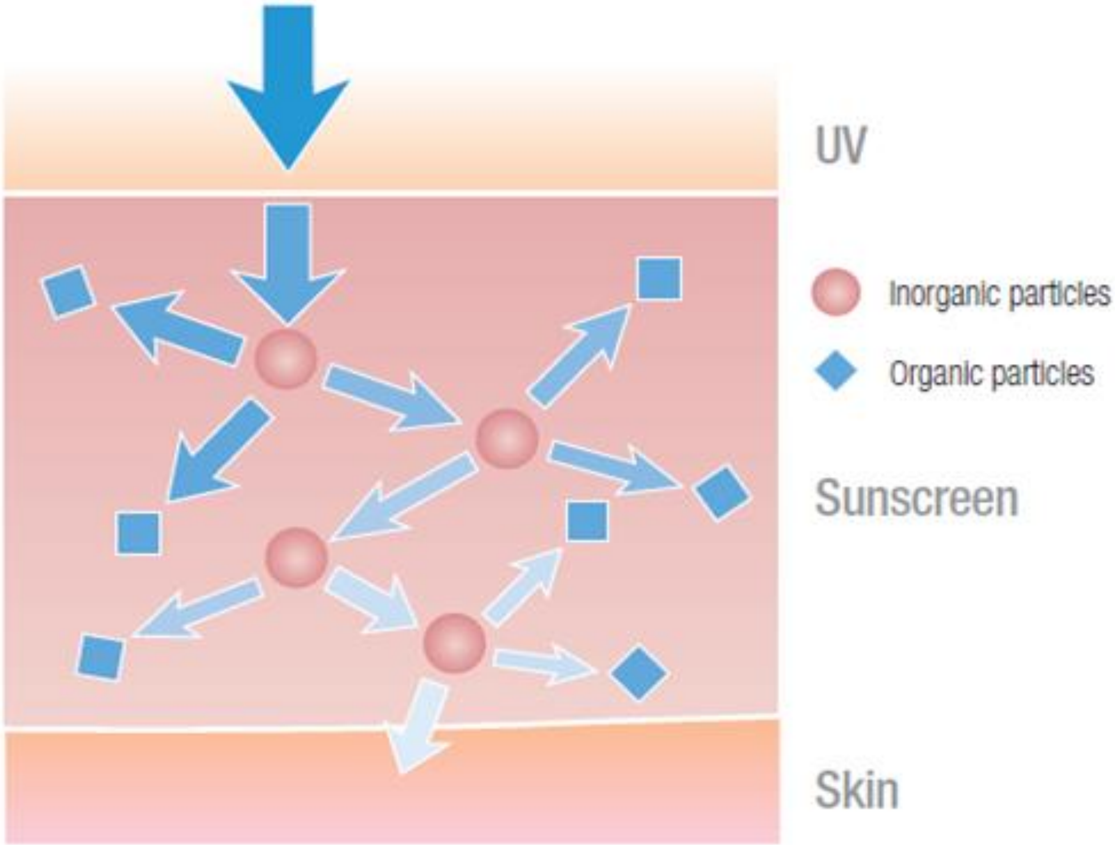
Three O/W formulations were created





Formulation Optimisation – Hybrid Formulations

Biphasal distribution of actives

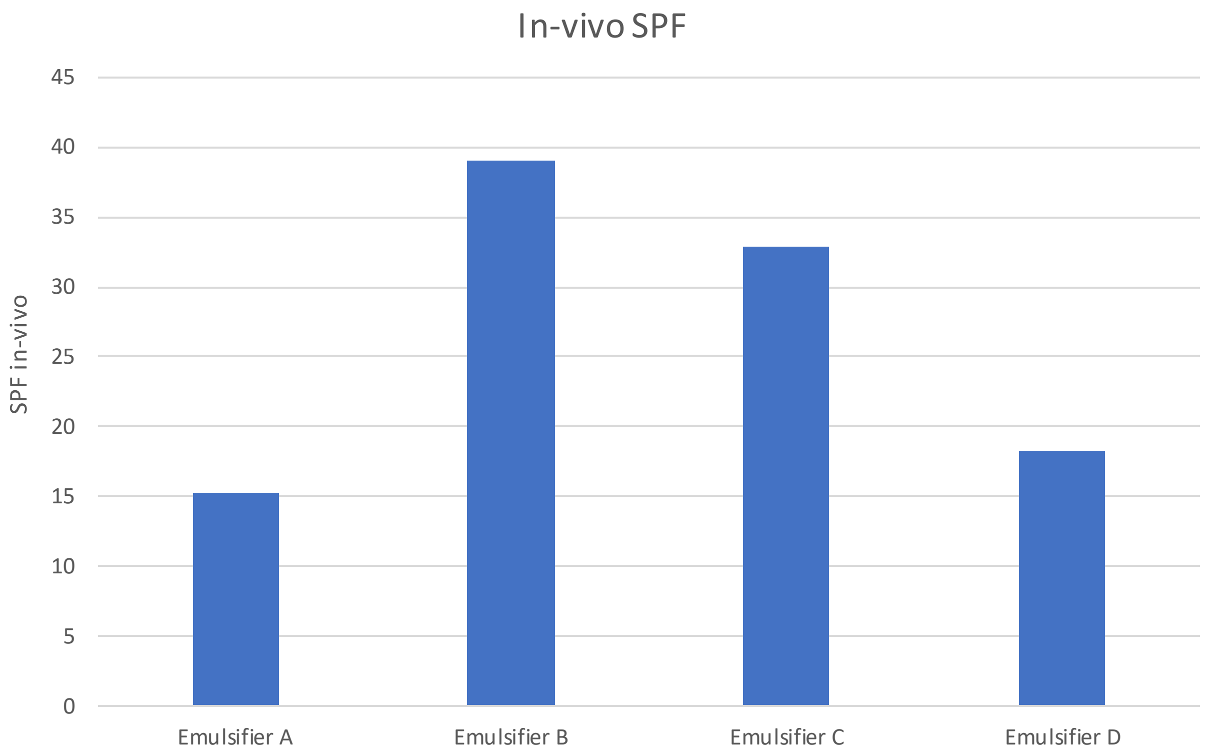


Water-based TiO_2 dispersions allow the **biphasal distribution** of UV filters

Allows the use of both organic and inorganic filters **without complexation** which causes yellowing

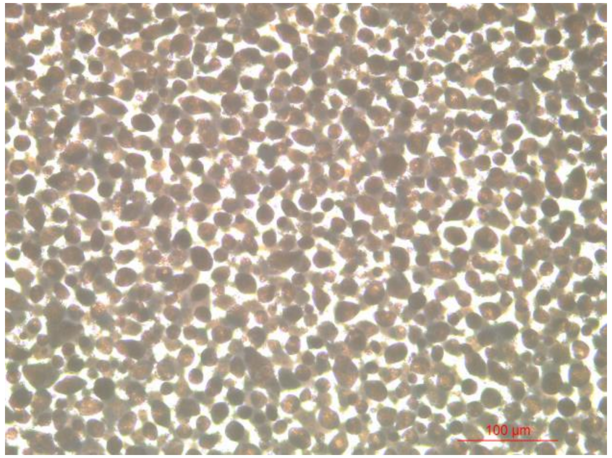
Synergy article
http://content.yudu.com/web/fiqy/0A4426p/CosmeticsBusDec20/html/index.html?page=22&origin=readerIf

Formulation Optimisation – Emulsifier Choice

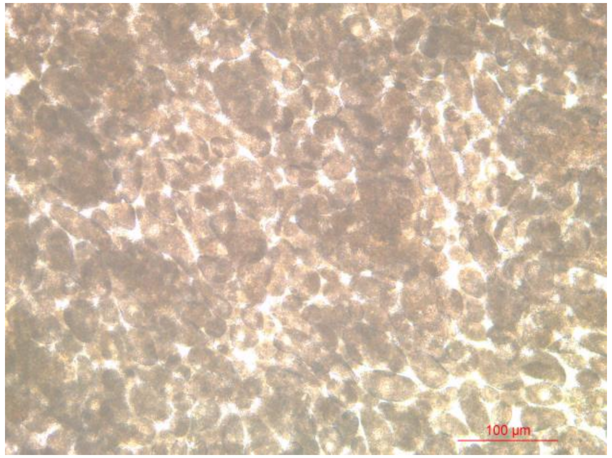


An ongoing study which used the same UV filter (water dispersion TiO2) at 15% in 4 different O/W emulsifiers, showed the emulsifier play an important role on the efficacy of the formulation.

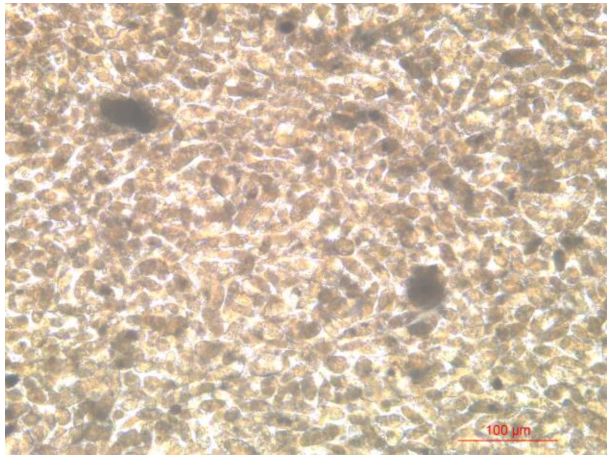
Formulation Optimisation – Coating



Non nano TiO2
Alumina coated



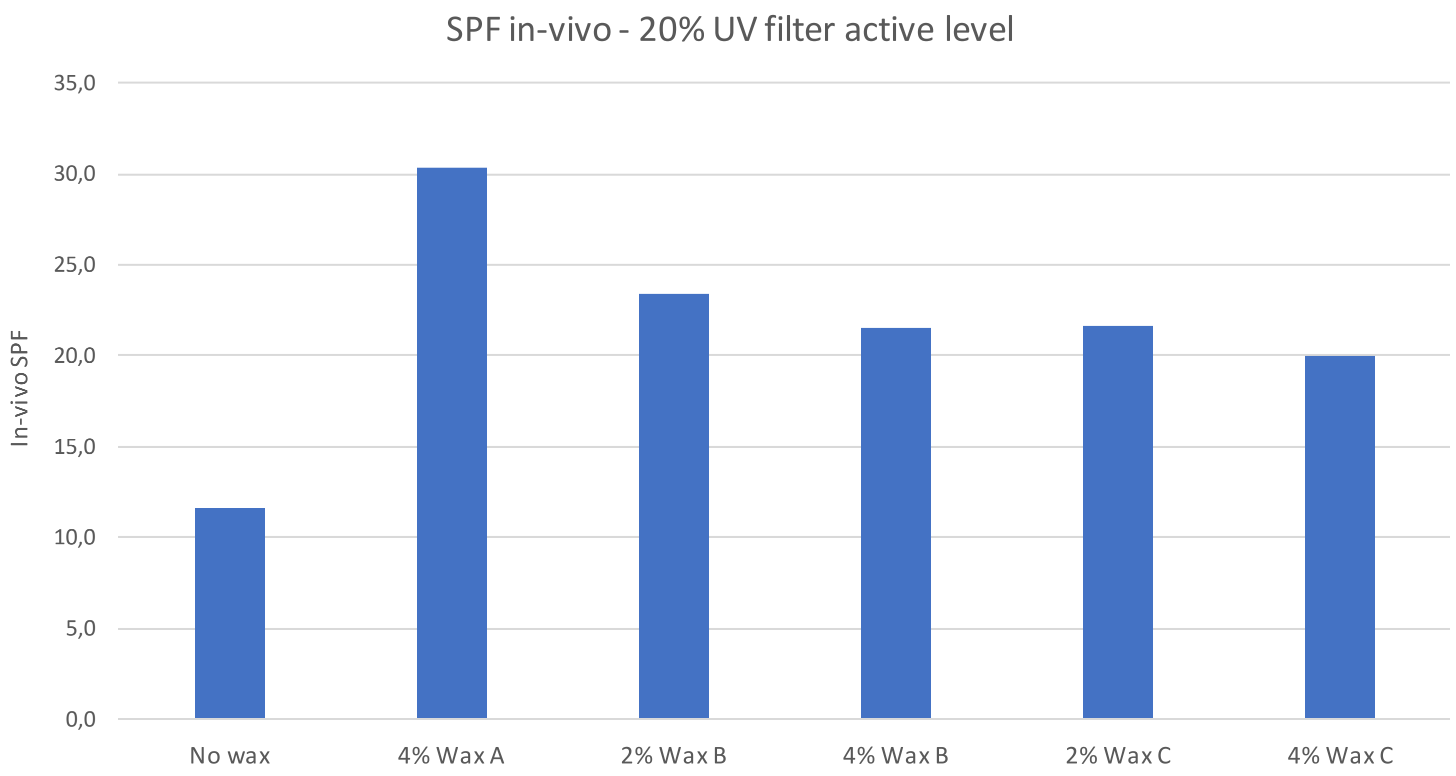
Nano TiO2
Alumina coated



Non Nano ZnO
uncoated

- Same emulsifier
- Different UV filters all at 10%
- Images taken at the same magnification
- Different shapes of the micelle – which can lead to different efficacy performance

Formulation Optimisation – Waxes



An ongoing study which used the same UV filter (oil carrier dispersion ZnO) at 20% in W/O emulsion and 3 different waxes showed waxes play an important role on the efficacy of the formulation.

Product Distribution on Skin

- In order to achieve high efficacy of sunscreen actives, it is essential that the sunscreen is evenly distributed on the uneven skin surface

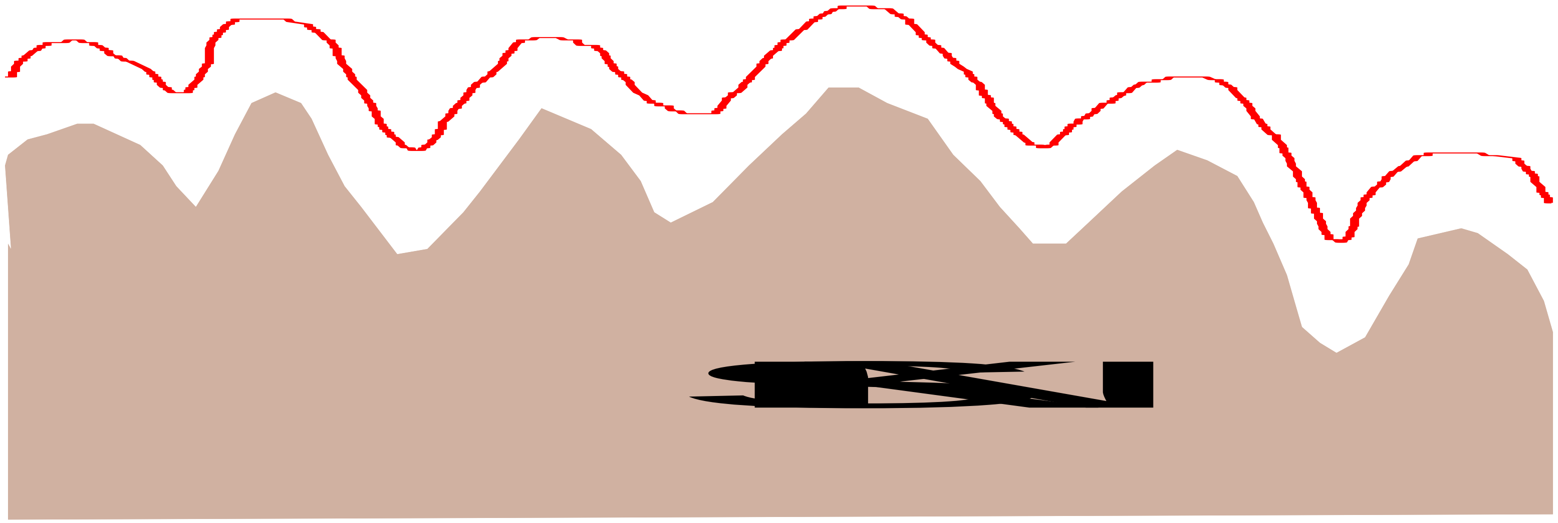
- This principle applies to all sunscreen actives, whether organic or inorganic, but is particularly important for mineral sunscreens, since efficacy is critically influenced by size and distribution of particles

- For high efficacy, therefore, there are four main requirements:
  1. Coherent protective film on skin after application and dry-down
  2. Maximum amount of sunscreen active within this film
  3. Even distribution of sunscreen particles
  4. Optimum particle size

Product Distribution on Skin

Optimal Efficacy

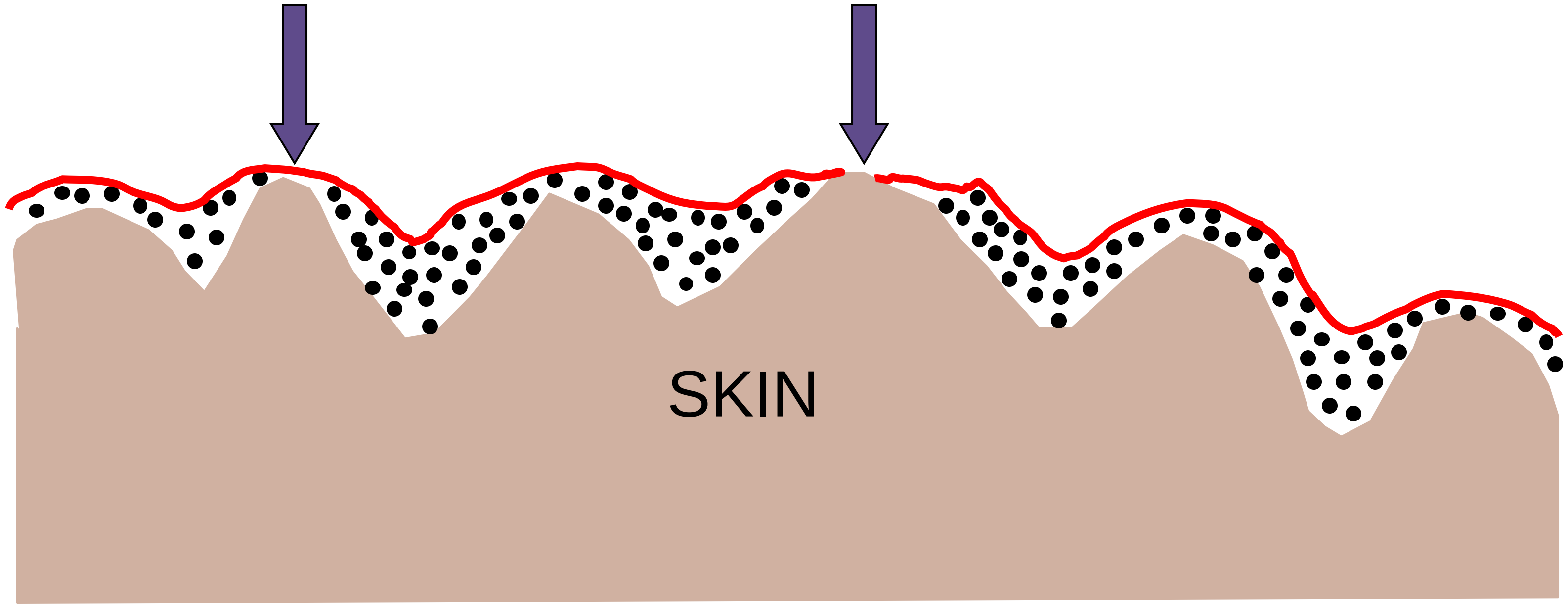
- Even product film on skin
- Even distribution of actives within this film



Product Distribution on Skin

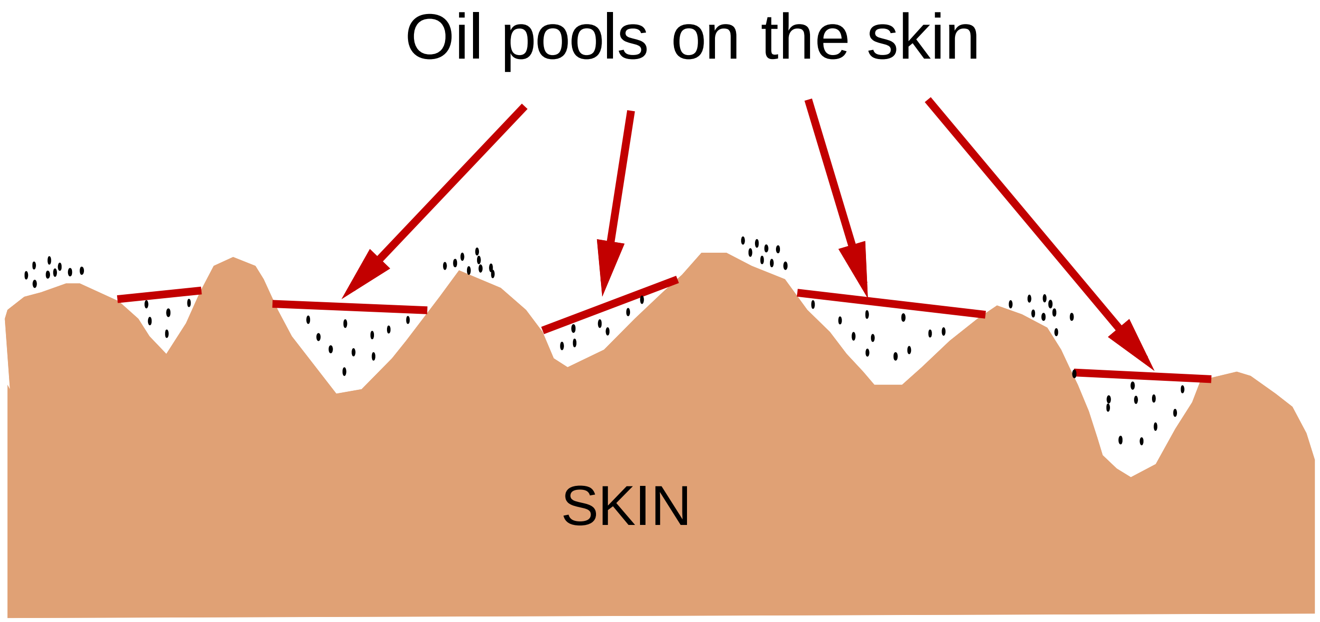
Reality

A thin film model shows that these gaps contribute to 10% of the total skin area



Product Distribution on Skin

Poor Distribution of Actives



Poor distribution of actives leads to poor efficacy of actives, because:

- The oil film is discontinuous, leaving some areas of the skin with no protection
- The distribution of the active particles is inconsistent
- Some of the sunscreen active is excluded from the oil film; without a dispersing medium, it will tend to aggregate

Poor Distribution of Actives

- Depends on the type of emulsion:
  - W/O - evaporation of water is relatively slow, so the film can be considered as consisting of the emulsion itself
  - O/W - more rapid evaporation of water, the film consists of oils, emulsifiers, active, and any other non-volatile ingredients

- In either case, the film should be as continuous and even as possible

- Achieving such an even film depends critically on the rheology of the product

Product rheology

- product must spread well to give good initial coverage of the skin (a low viscosity under high shear conditions)
- then rapid recovery of structure after spreading to maintain an even film (once shear is removed)

SPF Boosting

- Necessary to get maximum performance out of UV filters
  - Minimise cost
  - Adhere to usage level restrictions
  - Improve skin feel
  - Improve transparency
  - Reduce level of contact on the skin

- Any strategies to improve SPF should not be counterproductive – eg increasing SPF but increasing stickiness

- Different strategies can be used for improving the efficacy of a sunscreen
  - Improving the film formation
  - Increasing the UV scattering ability of sunscreens

Oil soluble and hydrophilic polymers
Emollients
Waxes

Thank you