Baycusan® C 1000 & C 1004

Publication: 15-02-2022

»Protects your body, protects the ocean«

Ocean-friendly sun care with Baycusan® biodegradeable film formers

Clean Beauty accelerates the demand for safer, more effective, and more environmentally-friendly cosmetics. Although they play a crucial part in skin protection, sun screen products have come into focus for their potentially negative impact on marine life.

This has led to the ban of various UV filters – a wakeup call for the industry. We need to rethink sun care formulations to find the best trade-off between performance and environmental compatibility.

Sun Protection Factor (SPF) boosters help formulating products with fewer UV filters, thereby minimizing their environmental impact. Simultaneously, they ensure effective and long-term protection. We will explore this in more detail, and find out, how to ensure long-term efficacy, unlocked by polyurethane film formers from the **Baycusan®** line.

Challenges with sustainable UV Filters

What counts as "more sustainable UV filter"? To some, inorganic filters are preferred – the downside: They make it more difficult to realize high sun protection with a nice sensory feel. This is why we see increased demand towards modern organic UV filters with a better environmental profile.

Latest research on organic UV filters and their environmental impact shows that it is possible to select filters with the lowest impact.

Baycusan® C 1000 & C 1004

Preferred filters are, e.g., Ethylhexyl Salicilate (EHS), Ethylhexyl Triazone (EHT), Tri-bisphenyl-Triazine (TBPT), Bis-ethylhexyloxyphenol Methoxyphenyl Triazine (BEMT), Methylene Bis-Benzotriazolyl Tetramethylbutylphenol (MBBT), Diethylhexyl butamido triazone (DHHB), Phenylbenzimidazole Sulfonic Acid (PBSA), and Diethylhexyl butamido triazone (DBT).

Filters like Octocrylene (OCR), Benzophenone-3 (BP-3), and Ethylhexyl Methoxycinnamate (OMC), however, tend to have a bad image as they are discussed to cause reef bleaching, which is met by regulations like the Haiwaiian Ban, that put new requirements on sun care formulation. In the past, UV filters like OCR or OMC were popular, as formulating without them appeared difficult: Solubilization of crystalline UV filters was more troublesome, as the heating time took longer and required higher temperatures. Second, with a concentration limitation to max. 5 to 10% of today's preferred UV filters, it became challenging to achieve high SPF values (SPF 50 and 50+) without relying on SPF boosters.

Reaching the right UVA protection also poses a challenge as the supply of ocean-friendly UVA filters to choose from is limited. These UVA- and broadband filters need to be employed to a full extend to achieve high protection formulations meeting sun care regulations.

Baycusan® in sun care formulations

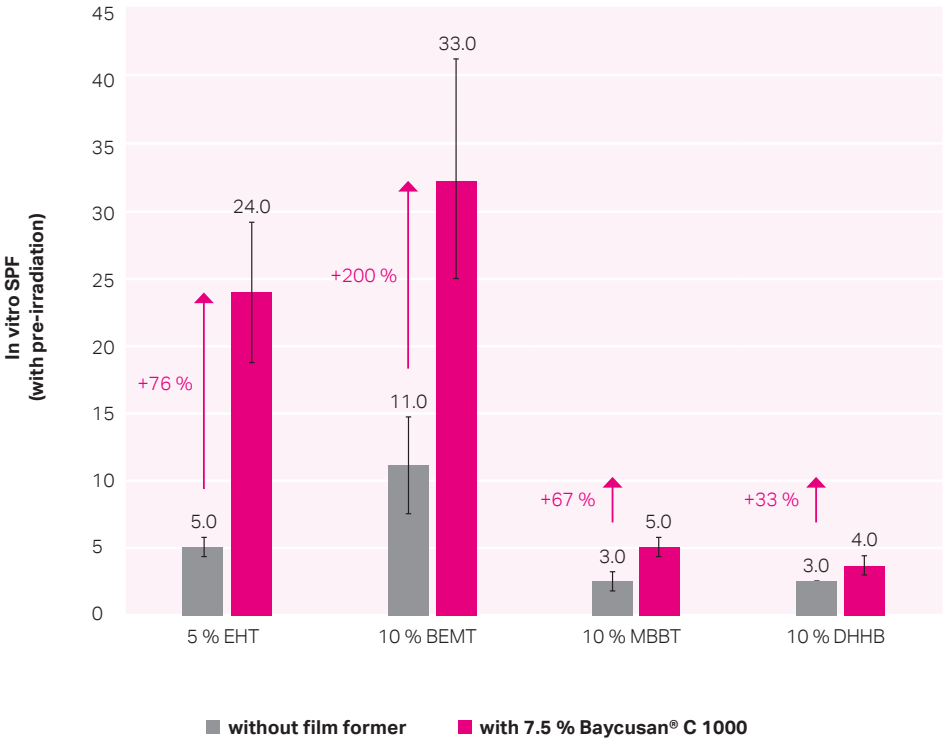
Film formers from the **Baycusan®** line can be a problem solver for formulating more ocean-friendly sun care products. They impart outstanding SPF boosting and water resistance in various systems. All **Baycusan®** film formers can be considered non-persistent, (OECD 302 inherent biodegradability). Moreover, both **Baycusan® C 1000** and **C 1004** achieve biodegradability rates between 50 to 60% within 28 days (OECD 301 ready biodegradability).

Further, salt tolerance is a critical ingredient attribute in sun care formulations. Both **Baycusan® C 1000** and **C 1004** tolerate sodium chloride in basic solutions up to 0.5%, with **Baycusan® C 1004** showing even slightly higher salt tolerance in formulations that have an increased level of electrolytes.

Combination with oily organic filters

The key attribute of **Baycusan®** is its SPF boosting effect. When combined with EHT, DHB or DHHB and especially BEMT with 200% increase, in vitro SPF values are higher compared to the same formulation without **Baycusan®** (fig 1). This helps achieve high sun protection while reducing the amount of UV filters.

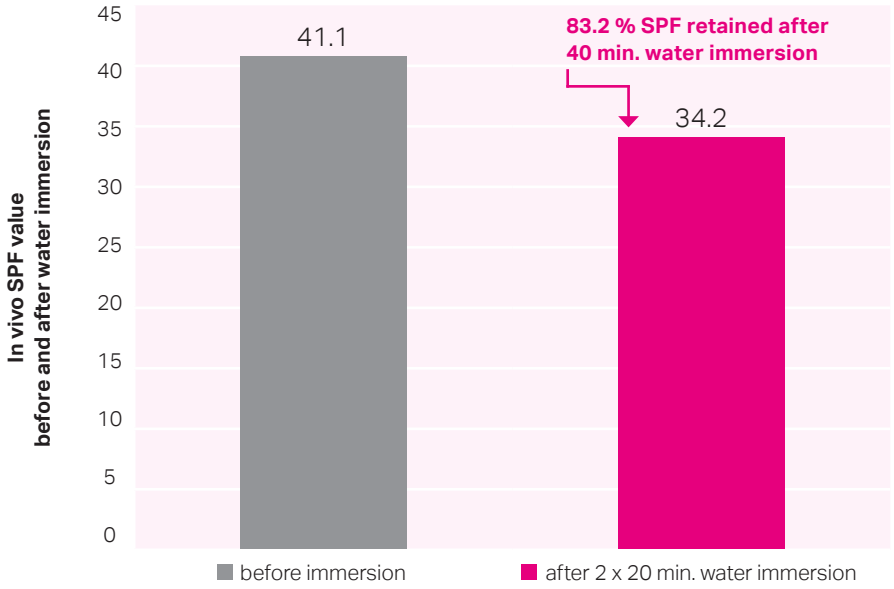
Figure 1: SPF Boosting with oily organic filters



Baycusan® C 1000 & C 1004

Baycusan® C 1000 polymer also enables more water-resistant formulations, ensuring high protection but preventing UV filter dispersion in the sea. For max. water resistance, the emulsifier concentration needs to be as low as possible so as to avoid re-emulsification of the formulation when exposed to water. **Baycusan®** film formers help stabilize the emulsion, acting as co-emulsifiers. In an emulsion with very little emulsifier, 83.2% of SPF can be retained after 40 min. immersion (fig 2).

Figure 2: Water resistance with oily organic filters



*Test formulation contains 6 wt. % **Baycusan® C 1000** as supplied and following UV filters combination: 6% DHHB + 5% EHS + 7% HMS + 5% EHT .*

Combination with organic water-soluble UV filters

The water-soluble UVB filter Phenylbenzimidazole Sulfonic Acid (PBSA) was launched in 1934 but has rarely been employed in the past years for its limited applicability (need for neutralization), as well as potential formula disturbance (due to its water solubility). PBSA has, however, lately been deemed eco-friendly by NGOs for its good ecotoxicity profile – this makes it more appealing for anyone seeking more sustainable formulations.

In a study on a formulation mostly containing ocean-friendly ingredients (fig 3), the well-known SPF boosting of PBSA in combination with oily UV filters is demonstrated: 1.5 wt.% PBSA increases the SPF value to 48%. The addition of 6 wt. % **Baycusan® C 1004** (as supplied) in this formulation increases the SPF boosting to 137% enabling to claim SPF 50+ (fig 4).

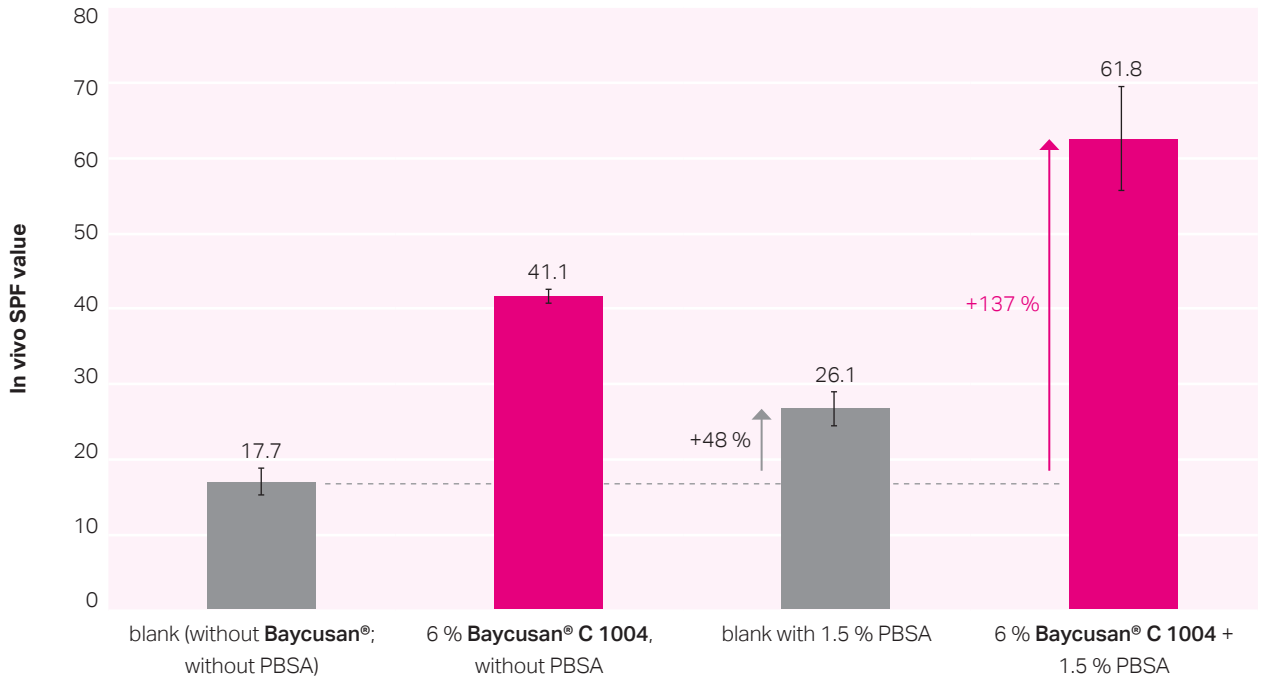
Figure 3: Ocean-friendly test formulation

Phase	Ingredients (INCI)	% by wt.
Phase A	Water (Aqua)	q.s.
	Disodium EDTA	0.20
	Phenylpropanol (and) Propanediol (and) Caprylyl Glycol (and) Tocopherol[1]	1.00
	Glycerin	3.00
	Propylene Glycol	5.00
	Sodium Stearoyl Glutamate	1.00
Phase B	C12-15 Alkyl Benzoate	7.00
	Diethylamino Hydroxybenzoyl Hexyl Benzoate	6.00
	Ethylhexyl Salicylate	5.00
	Glyceryl Stearate	2.00
	Dibutyl Adipate	7.00
	Homosalate	7.00
	Ethylhexyl Triazone	5.00
Phase C	Xanthan Gum	0.30
Phase D	Water (Aqua)	10.00
	Phenylbenzimidazole Sulfonic Acid (PBSA)	0 or 1.50
	Tromethamine	q.s.
Phase E	Simmondsia Chinensis (Jojoba) Seed Oil	3.00
	Panthenol	0.50
	Tocopheryl Acetate	0.20
	Alcohol	5.00
Phase F	Baycusan® C 1004	0 or 6.00

Raw materials: *Dermosoft® OMP, Evonik Dr. Straetmans GmbH*

Processing: *Add all ingredients of phase A and heat it to 80°C. Stirr until homogenous. Phase B is heated to 90°C in a separated vessel and stirred until homogenous. Phase B is added to Phase A while mixing. Homogenize with Ultra Turrax with 10.000 rpm for 3 min. Cool down while stirring with 300rpm. Add Phase C while stirring. Add Phase D and stirr for 5 min. Adjust the pH with TRIS (30% solution) at 7-7.5. Homogenize shortly with Ultra Turrax. Cool down to room temperature and add Phase E. Add Phase F while mixing.*

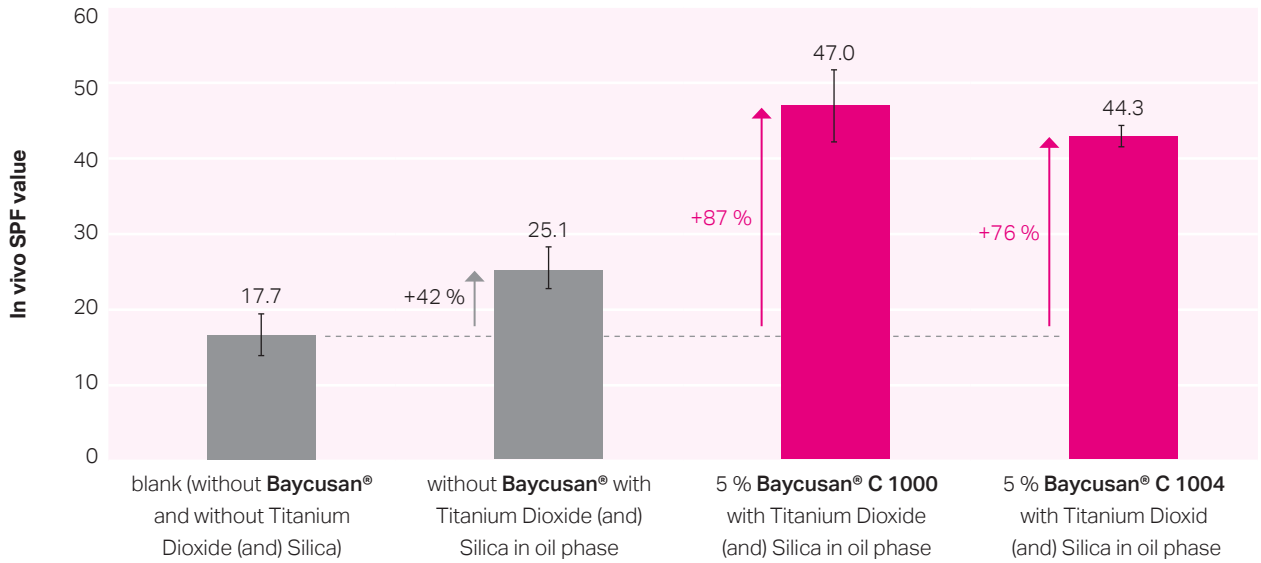
Figure 4: SPF boosting with organic water-soluble UV filters



In combination with inorganic UV filters

First, the formulation stability with 2% of several Titanium Dioxide grades was tested. A test formulation (fig 3) without PBSA was used to find which Titanium Dioxide grade can be used to increase the SPF value. Stable formulations were obtained with the following grades: Eusolex T-Avo (Titanium Dioxide (and) Silica), Micro Titanium Dioxide MT-100 WP (Titanium Dioxide (and) Hydrated Silica), and Micro Titanium Dioxide MT 200 ST (Titanium Dioxide (and) Stearic Acid). Best in vivo SPF results and water resistance have been reached with Eusolex T-AVO and are respectively shown in fig 5 and 6.

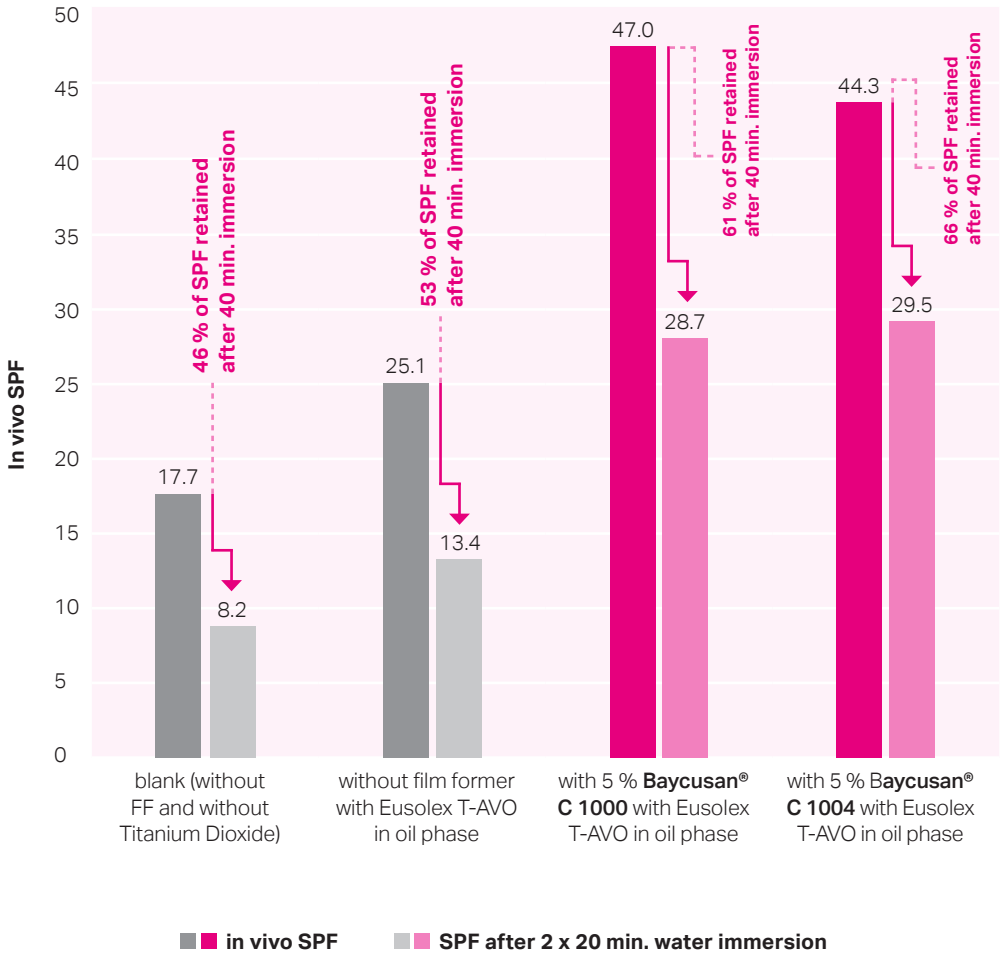
Figure 5: SPF boosting with inorganic UV filters



Baycusan® C 1000 & C 1004

The addition of 2% Titanium Dioxide showed 42% of SPF increase. Thanks to **Baycusan®** in combination with the selected UV filters, the SPF boosting of respectively 165% and 150% were achieved for **Baycusan® C 1000** and **C 1004**.

Figure 6: Water resistance with inorganic UV filters



All tested formulations, containing **Baycusan® C 1000** or **C 1004** film former and Titanium Dioxide, are water resistant. Also the formulation without film formers slightly passed the 50% level. The addition of film formers increases the percentage of water resistance, maintaining 61 to 67% of SPF after immersion.

Conclusion

We showed, that high-performance and an improved biodegradability profile, specifically enhanced ocean-friendliness of sun care formulations, can be unlocked by **Baycusan®** film formers. In formulations with organic UV filters, **Baycusan®** SPF boosting helped achieve high SPF values, yet reducing the amount of UV filters required. The outstanding water resistance of a sun care formula containing **Baycusan®** film formers also supports high- and long-term protection, while reducing the amount of UV filters released to the ocean. This holds true even for formulations with PBSA – lately proven to show a good ecotoxicity profile – or inorganic filters, like Titanium Dioxide. Either way to formulate enables high SPF values with a lower environmental impact.

Covestro Deutschland AG
Kaiser-Wilhelm-Allee 60
51373 Leverkusen
Germany

cosmetics.covestro.com
info@covestro.com

Edition: 2022 · Printed in Germany