

# A novel O/W sunscreen formulation with enhanced UV protection when subjected to water



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## Introduction:

Whilst highly water-resistance sunscreens are generally W/O formulations, their drawbacks are their sticky and oily texture. On the other hand, many of the O/W formulations too claim to be water-resistant, but their water-based coating film lacks in absorptivity to the skin, and hence prone to be washed away by water. Addition of more water-based coating film to prevent this can negatively affect its texture. Hence, it is difficult to satisfactorily achieve both good texture and UV protectivity, even when water-based coating film with high water repellency is used. To overcome this issue, we attempted to individually look for a "Film Polymer" of soft texture and an alkylene oxide derivative "Film Enhancer" that when combined could offer a water-repellent coat in an O/W sunscreen formulation.

## Conclusions:

- \* The current combination of film polymer and film enhancer does not form a rigid coat as would W/O formulations, but a flexible coat that is resistant to both water and the movement of the skin.
- \* This coat improves its thickness and uniformity as it comes into contact with water, giving it high water-resistance through a new mechanism that remains to be investigated.
- \* This gives refreshing usage at water-rich environments such as swimming pools whilst providing sufficient UV protection which might even improve through sweating or other means of exposure to water.
- \* We proudly give birth to a revolutionary O/W sunscreen formulation that provides water-resistance, UV protection and excellent usability for the benefit of the consumers.

## Materials & Methods:

**Fig.1 Film Polymer**  
(PEG-240/HDI Copolymer Bis-Decyltetradeceth-20 Ether)

Hydrophobic terminal chain      Hydrophilic polymer chain      Hydrophobic terminal chain

**Fig.2 Film Enhancer**  
(PEG/PPG/Polybutylene Glycol-8/5/3 Glycerin)<sup>[1]</sup>

$\text{CH}_2\text{-O-(EO/PO)-BO-H}$       EO : Oxethylene group (8mol)  
 $\text{CH}_2\text{-O-(EO/PO)-BO-H}$       PO : Oxpropylene group (5mol)  
 $\text{CH}_2\text{-O-(EO/PO)-BO-H}$       BO : Oxbutylene group (3mol)

**Table 1 Conventional and new O/W formulations**

Ingredients	Control (Conventional O/W formulation)	With Film Enhancer (New O/W formulation)
Water phase	63.45%	61.45%
Oil phase	35.55%	35.55%
Film Polymer*	1.00%	1.00%
Film Enhancer**	0%	2.00%
<b>Total</b>	<b>100%</b>	<b>100%</b>

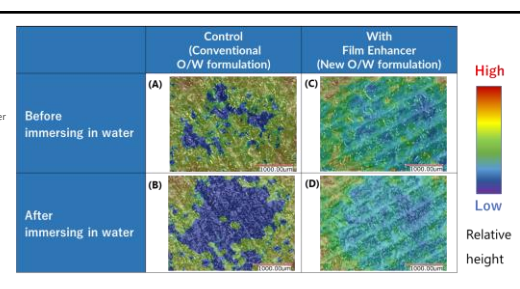
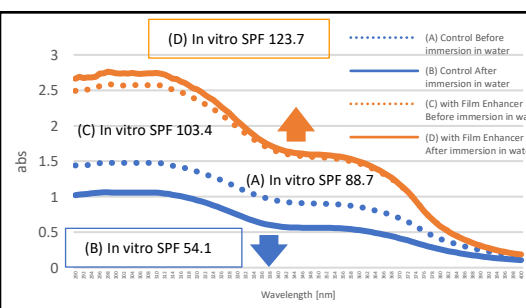
\*PEG-240/HDI Copolymer Bis-Decyltetradeceth-20 Ether  
\*\*PEG/PPG/Polybutylene Glycol-8/5/3 Glycerin

**In vivo SPF water resistance**  
An in vivo SPF water resistance test was conducted in accordance with ISO 18861<sup>[2]</sup>.

**Treatment of control and new formulations**

\*The formulation was applied onto a PMMA plate after which it was dried.  
\*The PMMA plate was immersed in water and shaken for 20 minutes.  
\*The procedure was repeated twice.  
\*The PMMA plate was left for over 30 minutes to dry.  
\*Measure using the SPF Analyzer, digital microscope, X-ray CT.

## Results & Discussion:



	Before immersion in water	After immersion in water
Image	(C)	(D)
Film thickness (mean)	2μm	4μm

Fig.5 The thickness of coating film before and after immersion in water.

	Before Bathing	During Bathing	Drying
Image			
SPF	28.6	12.4	17.7
Water resistance [%]	Control: 41.56	With Film Enhancer: 51.94	

Fig.6 in vivo SPF water resistance of control and new formulation before and after bathing in accordance with ISO 18861 (Black: Control, White: With Film Enhancer).

## References:

[1] Koji Sekiguchi (2019) Types and Characteristics of Moisturizer for Cosmetics: Application of an Amphiphilic Polymer and Phospholipid Polymer. J. Soc. Cosmet. Chem. Jpn. 53(4): 253-259  
[2] INTERNATIONAL STANDARD ISO 18861 Cosmetics – Sun protection test methods – Percentage of water resistance (2020)