ABSTRACT

PRESENTER: Dr. Robert Hu

COMPANY: Hallstar

JOB TITLE: President & Chief Technology Officer

Podium Title: *"Real-time" Study of Avobenzone Photodegradation and Its Stabilization in Sunscreen Films*

Background information (Short introduction)

While there are many published literature regarding the photodegradation of Avobenzone, almost exclusively conducted in common organic solvents under simulated UV irradiation, there have been no quantitative study of Avobenzone photodegradation in situ in sunscreen films. We therefore conducted this study to completely elucidate all the photodegradation reaction mechanism of Avobenzone in sunscreen films, with and without photostabilizers.

Objective

- Carry out the world's first quantitative photochemical study of Avobenzone in situ in sunscreen film in real time
- Elucidate all photochemical and photophysical processes of Avobenzone, in various sunscreen formulation films, which are different than those reported when the study was carried out in organic solutions
- Understand the interactions between Avobenzone and other formulation ingredients, in real sunscreen film as applied on human skin
- Make Avobenzone stable in sunscreen

Methodology

To conduct quantitative and in-situ studies of the photodegradation of Avobenzone in sunscreen film, we designed a sunscreen deposition platform called Solasure, which enables us to deposit sunscreen of known film thickness onto quartz plates accurately down to micrometer-thickness. Solasure also allows for precisely holding of the sunscreen samples on quartz plates during the irradiation and UV-Vis spectrophotometer measurement, essentially allowing the irradiation and measurement be carried out on the same spot of the sunscreen sample. Monitoring of the reaction process in "real-time" provides rich in-process data, enabling complete kinetic analysis of these photodegradation processes.

Results

Avobenzone photochemical reactions and their kinetics were studied in representative sunscreen films. The rate of Avobenzone disappearance was monitored by measuring the characteristic absorption of enol Avobenzone at 357nm. Photochemical kinetics analysis and conclusions are derived from these in-process real-time data sets. New reaction pathways were discovered in addition to those commonly seen in solution studies and these novel

photochemical reaction products were identified. Precise quantitative interactions between Avobenzone and other ingredients were studied.

Conclusion

We studied the photodegradation of Avobenzone in sunscreen films and discovered new photoreactions for Avobenzone under these practical application conditions. We also researched the photoreaction kinetics for Avobenzone in sunscreen films under different irradiation conditions, with and without a photostabilizer. We observed that Avobenzone photoreaction patterns and kinetics are dependent on the irradiation light source.Interactions with other formulation ingredients have been quantified. There are very effective photostabilization methods capable of almost total protection of Avobenzone against all its photodegradation pathways under practical skin application conditions.

Why is this important to the industry?

- Avobenzone is the only globally-approved UVA filter
- Its photoreactions and therefore instability has been a major hurdle for its broader application
- All prior studies were carried out in solution and monitored only at the end of a particular irradiation time
- Understand, quantify all photochemical and photophysical processes of Avobenzone in-situ in sunscreen film under real application conditions allows us to design most effective and applicable ways to make Avobenzone stable

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Robert Shengkui Hu received his Ph.D. in Photochemical Sciences in 1998 from The Center for Photochemical Sciences at Bowling Green State University. While serving in technical leadership roles in PPG Industries and the Beckers Group, Robert has devoted his professional career in applying photochemical sciences in various industrial applications, such as radiation curable coatings and inks, photoresists, photochromic materials, and photo protective technologies. Since joining Hallstar in 2012, Robert has been heavily involved in the photo-protection technology development for the personal care markets.