Correlation of In-Vitro and In-Vivo SPF Testing Using the Solar Light® SPF-290AS™

Introduction

The Solar Light® SPF-290AS™ has been designed to measure the SPF values of various types of material con- taining sunscreen products. This application note describes the fundamental design of the instrument, the method used to make the measurements and tabulates the results of in-vitro and in-vivo measurements.

SPF-290S Instrumentation

The SPF-290AS™ was designed specifically to measure the transmittance of material containing sunscreen products. Since these materials typically have low transmittance, the instrument was designed to detect very low levels of transmitted light.

The source is a high output continuous 125 watt xenon lamp. Light from the lamp passes directly through the sample. Since the output from the lamp has similar spectral characteristics to radiation from the sun, the illumination of the sample approximates in-vivo measurement illumination.

One problem associated with SPF measurements is the accurate spreading of the sample on the support medium (e.g.,Transpore tape). The protocol requires a concentration of 2 µl/cm^2 of sample spread evenly on the support medium. To achieve this, the SPF-290AS™ is provided with a syringe capable of accurately dispensing 110µl over an area of 55 cm^2. To eliminate variations due to spreading technique, the instrument makes automatic measurements over the entire area, therefore integrating any irregularities due to spreading techniques.

Suncreens absorb and diffract light to varying degrees depending on the type and chemical composition of the sunscreen. Accurate measurements require that only absorbed light is measured by the detector and that as much apparent absorption due to diffracted light as possible is eliminated from the measurements.

The SPF-290AS™ gives results that closely approximate in-vivo measurements

To accomplish this, the sample is placed close to the entrance port of an integrating sphere. The integrating sphere and the close proximity of the sample to the entrance port combine to collect all of the transmitted light and most of the diffracted light.

In order to measure the transmittance of the sunscreen material over the UVA and UVB region of the spectrum, the light collected by the sphere must be diffracted by a high resolution monochromator with low stray light characteristics. The energy in each wave- length must be measured by a high performance detector. For an in-depth technical discussion on optical reciprocity, see Application note #2.

Because the samples have low transmittance, a monochromator and a highly sensitive photomultiplier tube are used to give the best monochromatic resolution and highest signal-to-noise ratio.

This SPF-290AS™ monochromator and photomultiplier detection system was designed to provide the best results at low transmittance and therefore high SPF values. Alternate designs using diode array detectors are faster, but do not have the high signal-to-noise detection ratio required for the accurate and precise measurements of these types of samples.

Sample and Methods

Twelve samples of varying types and SPF values were chosen in this study as representative of the types of samples frequently measured by cosmetic chemists. The samples were spread onto the support medium and measurements were made on the SPF-290AS™ over a 55cm^2 area. In each case, nine measurements were made and the instrument's software calculated the mean SPF value and the standard deviation of each of the series of nine measurements.

Result

The mean SPF values of the twelve samples are shown in the table on next page:

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Sample Type	In-Vitro	Result In-Vivo	Result Variance
TiO2 (w/Iron Oxides) Lotion	18.2	17	1.2
TiO2 (w/Iron Oxides) Cream	25	21.2	3.8
TiO2 Cream	21.4	17.25	4.15
Octylmethoxy			
Cinnamate (E-232)	16.3	17	0.7
Waterproof SunBlock Stick	18	20	2.0
TiO2 Waterproof Cream	11	12	1.0
Spray	20	20	0.0
TiO_2 5% Active	10.3	11.04	0.74
TiO_2 7.5% Active	17.1	17.2	0.1
TiO_2 / I.O.	16.5	16.87	0.37
TiO_2, TiO_2 / P.E. Blends	14.3	13.2	1.1
TiO_2, Melanin, Octylmethoxy Cinnamate, Benzephone-3, Octyl Salycilate	16.5	18.7	2.2

Conclusion

The data show that in-vitro measurements on the Solar Light® SPF-290AS™ give results that closely approximate in-vivo measurements for a wide variety of sunscreen materials.