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Literature List
SPF-Project

C.M. Throm, G. Wiora, C. Reble, J. Schleusener, S. Schanzer, H. Karrer, L. Kolbe, G. Khazaka, M.C. Meinke, J. Lademann, **In vivo SPF and UVA PF determination using (hybrid) diffuse reflectance spectroscopy and a multi lambda LED light source**, Journal of Biophotonics, October 2020

The sun protection factor (SPF) values are currently determined using an invasive procedure, in which the volunteers are irradiated with ultraviolet (UV) light. Non invasive approaches based on hybrid diffuse reflectance spectroscopy (HDRS) have shown a good correlation with conventional SPF testing. Here, we present a novel compact and adjustable DRS test system. The in vivo measurements were performed using a multi lambda LED light source and an 84 channel imaging spectrograph with a fibre optic probe for detection. A transmission spectrum was calculated based on the reflectance measured with sunscreen and the reflectance measured without sunscreen. The preexposure in vitro spectrum was fitted to the in vivo spectrum. Each of the 11 test products was investigated on 10 volunteers. The SPF and UVA PF values obtained by this new approach were compared to in vivo SPF results determined by certified test institutes. A correlation coefficient R 2 = 0.86 for SPF, and R 2 = 0.92 for UVA PF were calculated. Having examined various approaches to apply the HDRS principle, the method we present was found to produce valid and reproducible results, suggesting that the multi lambda LED device is suitable for in vivo SPF testing based on the HDRS principle as well as for in vivo UVA PF measurements.

U. Osterwalder, S. Uhlig, J. Vollhardt, **Good as Gold – Validating Alternative SPF Methods**, Cosmetics & Toiletries, Vol. 135, No. 4, April 2020

Two years ago, the current authors published the article “SPF Assessment Revisited – Status & Outlook”. The present article provides an update on progress towards alternative SPF methods.

U. Osterwalder, **Sun protection – New SPF methods**, Sun Protection Facilitor GmbH, Basel, CH, Presentation 2020

G. Wiora, C. Throm, C. Reble; S. Schanzer, S. Kobylinski, J. Schleusener, H. Karrer, L. Kolbe, G. Khazaka, M. Meinke, J. Lademann, **Development of a fast non-invasive in vivo measurement of UVA-PF and SPF with a new diffuse reflectance spectroscopy device,** poster presentation at the IFSCC Congress, Milan, September 2019

Two systems for in vivo measurement of UVA-PF and SPF were tested. Results of in vivo measurements with UV diffuse reflection spectroscopy (DRS) are presented. A *Single LED DRS* system showed very good correlation to standard erythema tests (SET). The *Multi-□ DRS* system seems to be promising for in vivo UVA-PF and for hybrid DRS (HDRS) measurements.

M.C. Meinke, S. Schanzer, S. Kobylinski, C. Reble, G. Khazaka, G. Wiora, H. Karrer, J. Lademann, **Non-invasive sun protection factor determination using one UVB LED and reflectance spectroscopy in vitro and first in vivo investigations,** IFSCC congress, Munich, September 2018

Prevention of sunburn premature skin aging and skin tumors is the main goal of sun protection. The application of sunscreen is one protection strategy and various formulations are available. For every new sunscreen or cosmetic product claiming protection from UV radiation, the sun protection factor (SPF) must be determined. The current method is invasive by inducing a sunburn for each product. Due to the invasiveness of this method, the FDA and the corresponding EU commission advised the development of non-invasive measurements years ago.

M.C. Meinke, S. Schanzer, C. Reble, G. Wiora, G. Khazaka, H. Karrer, L. Lademann, **Non-Invasive LED-Based Measurement of the Sun Protection Factor, ISBS Conference San Diego, May 2018**

Introduction: For each new sunscreen formulation, the sun protection factor (SPF) values must be determined, causing sunburns on the backs of at least 10 human test subjects. Due to the invasiveness of this method, a non-invasive method applicable on volunteers to determine SPF values

for new products is strongly requested. Methodology: The measurement principle is the detection of the diffusely reflected light at different distances to the incident beam. As a light source UV-LEDs are used and a spectrometer or photodiodes detect the back scattered light. The fiber bundle enables the spatially resolved reflectance measurement principle at several measurement points on the skin. Results and Conclusions: First measurements were performed on pig ear skin. Eleven different sunscreen formulations (lotions, sprays, creams, mixed or pure physical filters) of different manufacturers have been measured so far. The data from the test institutes correlate with the obtained SPF from the non-invasive method. First in vivo results on human volunteers back confirm the correlation with the reference values.

C. Reble, M. Meinke, J. Rass, **No More Sunburn,** Non-invasive LED-based measurement of the sun protection factor, Optik & Photonik 1/2018

A UV-LED based system was developed that allows to determine the sun protection factor (SPF) of sunscreen lotions in a non-invasive way in vivo. This method is faster and reduces the medical risk for the test subjects.

M. Meinke, S. Schanzer, J. Lademann, S. Kobylinski, C. Reble, G. Wiora, G. Khazaka, H. Karrer, A. Scheel, A. Biedermann, **Entwicklung und Erprobung eines miniaturisierten Verfahrens zur nichtinvasiven Bestimmung des Lichtschutzfaktors von Sonnenschutzmitteln in der menschlichen Haut,** Projekttreffen UV for Life 2017

Zielsetzungen des Projektes: Ausgehend vom Basisprojekt soll die nichtinvasive Bestimmung des Lichtschutzfaktors von Sonnenschutzmitteln in zwei Richtungen weiterentwickelt werden: 1. Zum einen wird ein SPF-Messgerät für Testinstitute entwickelt. Dieses System soll spektral aufgelöst messen, um den Einfluss von einer möglichen Fluoreszenz in den Sonnencremes zu minimieren oder gar auszuschließen. Weiterhin wird der gesamte UV-Bereich mit UV-LEDs abgebildet. 2. Zum anderen soll das einfache Photodioden-basierte Sensor-Funktionsmuster aus dem Basisprojekt weiter verbessert und miniaturisiert werden, um damit Outdoor-Messungen mit maximal zwei UV-LEDs zu ermöglichen. 3. Parallel werden Sonnencremes mit verschiedenen Eigenschaften gezielt hergestellt, um die Eignung der Methode zu untersuchen.