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Global Innovation and Sustainability for the Future of Sunscreen

Investigate the photo-induced damages, and the protection provided to skin, by different UV filters using FTIR Spectroscopy analysis.

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Background: The skin is composed of two major layers: the epidermis, unvascularized epithelial layer, and the dermis, vascularized layer with a rich supply of capillaries, nerves, hair follicles etc. The epidermis plays a key role as it is our first protective barrier from external stresses like UV exposure or exogenous contamination. Its principal cells are the keratinocytes, which differentiate as they migrate toward the stratum corneum (SC). This superficial layer of the epidermis, typically consists of ~ 10 to 20 layers of terminally differentiated anucleated corneocytes embedded in an intercellular lamellar lipids. The skin barrier function is related to both the unique lipid composition of the SC and their complex structural organization. Changes in the SC may result in significant modification of the skin barrier functions and therefore modify the actives penetration into the skin.

Aim: The objectives of the present study are 1) to assess the effects of UV exposure (10h-100h) on isolated SC from pig and human skin and 2) to investigate the penetration of different UV filters Avobenzon and Octocrylene (free and encapsulate in a gel sol silica capsule) inside skin samples.

Methods: Both FTIR Spectroscopy and ATR-FTIR Spectroscopy Imaging were used to address these questions. FTIR spectrometer (Nicolet 6700 Thermo Scientific) equipped with temperature controlled transmission cell was used for studying SC lipids conformation and packing transition by analyzing the CH₂ peaks position between 2800 cm⁻¹ and 3000 cm⁻¹. The accessory is able to create a gradual heating of the SC samples. The whole instrument was constantly purged with Nitrogen in order to remove water vapor. In all the experiments the FTIR spectra were acquired as a function of temperature from 5°C to 95°C and recorded every 2 to 3°C. All spectra were collected with a spectral resolution of 4 cm⁻¹ and 64 scans accumulation. During the data collection the sample temperature remained constant within +/- 1°C. Each experiments were triplicated. By studying the frequency variation as a function of the temperature, the phase transitions in which the system goes from an ordered to a disordered conformation were observed.

FTIR images were acquired with a Spectrum Spotlight 400 imaging system (Perkin Elmer Instruments, Shelton, Conn., USA) using a MCT (mercury-cadmium-telluride) focal plane array detector placed at the image focal plane of an IR microscope. FTIR images were collected in the

reflective mode at a spectral resolution of 4 cm^{-1} in the mid-infrared (MIR) region from 4000 cm^{-1} to 850 cm^{-1} with a spatial resolution of $6.25 \times 6.25\text{ }\mu\text{m}$.

Results: Our data show that progressive UV exposure and UV filter application may cause changes in the SC. these changes could significantly alter the skin barrier proprieties. The FTIR images have highlighted significant UV filter penetrations inside the SC after sunscreen applications. The encapsulation technology provides for a reduction in these unwanted penetrations.