Laser spectroscopy for the investigation of UV effects in human skin

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Introduction

Lasers are ideal instruments for investigating interactions between UV radiation and human skin in vivo because of their high spectral, spatial and time resolution. Therefore UV radiation effects on human skin, the basic mechanisms of photoinduced processes and the optical properties of the skin can be determined with high accuracy. A short overview about lasers which can be tuned over various wavelength ranges is presented. Recently, an optical parametric oscillator (OPO) which provides continuously tunable laser radiation covering the terrestrial ultraviolet range was developed.

Laser spectroscopic methods for the investigation of UV effects are based on different kinds of non-invasive interactions between laser radiation and human skin: especially absorption and scattering processes.

Future applications of tunable lasers in the field of UV effects are shortly pointed out.

Laser action spectroscopy

Some years ago, the wavelength dependencies of the erythema and pigmentation reactions in humans were determined using highly monochromatic laser irradiation in the UV-B and UV-A. These action spectra - published by the CIE in 2002 - are discussed in comparison with the current standard erythema curve as well as with other photobiological action spectra (e.g. for tumor induction).

Optoacoustics

A new approach for measuring the optical properties of human skin in vivo is the non-invasive optoacoustic tissue differentiation using short laser pulses to induce stress transients. This technique allows the determination of wavelength depend absorption coefficients with high spatial resolution and a more exact measurement of the penetration depths of UV radiation into the skin. Measurements on tissue models and on in vitro epidermal models paved the way for a study on human subjects investigating native and induced pigment and the influence of sunscreens on the optical properties of human skin in vivo. The possibilities of the optoacoustic method concerning the prediction of UV sensitivity of various skin types in vivo (Fig. 1) will be discussed with future prospects of whether this could lead to a skin typing determination method aided by instrumental measurements.

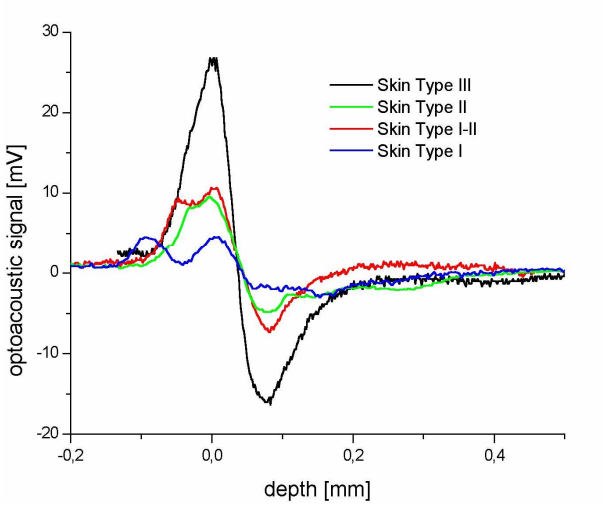

Figure 1. Optoacoustic signals for different skin types

Confocal Raman microscopy

Raman spectroscopy provides information about molecular vibrations useful for substance identification. Confocal Raman microscopy is a new promising method also for a non-destructive, spatially resolved analysis of skin samples. For example, the melanin distribution in melanocytes and melanoma cells could be measured without any sample preparation (Fig. 2).

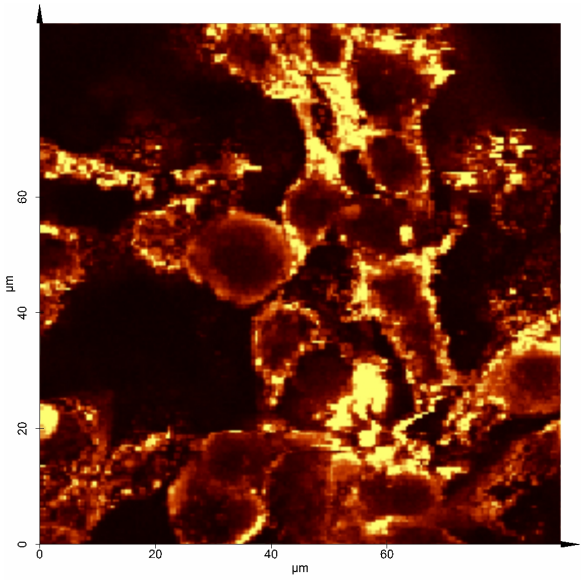

Figure 2. Melanin distribution in murine melanocytes. Higher concentration in the outer parts of the cells and along the dendrites.

The effects of UV-irradiation are also studied with this technique.

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