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Optical Methods of Imaging in the Skin

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The skin is the biggest organ of the body, representing its barrier to the environment. It provides protection against water loss, keeps microorganisms from invading our body, and responds sensitively to external stimuli. The skin barrier is formed by the uppermost cell layer, i.e., the stratum corneum, consisting of dead horny cells. Underlying the stratum corneum are various layers of living cells. The capillary structures of the blood vessels appear from a depth of approximately 150 μm beneath the skin surface. The homogeneous structure of the skin surface is interrupted by hair follicles and sweat glands. As a sensory organ the skin is an essential means of interpersonal communication. This is why we devote particular attention to skin care and dermal treatment. In this context, diagnostics and therapy control play a decisive role. Easily accessible, the skin is an ideal object to be investigated by noninvasive optical and spectroscopic methods. An ample range of such methods is available for dermal analysis, including fluorescence, reflectance, Raman, and CARS measurements. Laser scanning microscopy has proven to be specifically suitable for investigating the skin barrier and the underlying living cell layers up to a depth of 200 μm depending on the wavelength applied, imaging both cellular and molecular structures. The primary purpose of these investigations is to analyze the integrity of the skin barrier, which is characterized by the organization of the cellular structures and by the composition of the lipid layers surrounding the cells. The application both of laser scanning microscopy and optical coherence tomography is focused mainly on the detection of dermal lesions, in particular of skin tumors, and their response to different therapies.

Optical imaging methods are also becoming increasingly popular in the field of pharmacology, specifically for investigating the penetration of topically applied substances into and through the skin barrier.

Due to the rapid development of optical techniques, both in terms of excitation by lasers and light-emitting diodes, and in terms of detection using capacitive sensors, optical and spectroscopic methods are increasingly applied in medicine, cosmetics, and cutaneous physiology. The articles published in this special section provide some impressive examples.

In this special section, 31 papers describe the broad application of optical methods for skin imaging. Laser scanning microscopy and multiphoton tomography are often used techniques in skin research and clinical diagnostics [Guojin et al., *J. Biomed. Opt.* **18**(6), 061207; Ulrich et al., *J. Biomed. Opt.* **18**(6), 061211; *J.Biomed. Opt.* **18**(6), 061229; Hoffman et al., *J. Biomed. Opt.* **18**(6), 061216; Sanchez et al., *J. Biomed. Opt.* **18**(6), 061217; Abeytunge et al., *J. Biomed. Opt.* **18**(6), 061227; Tanaka et al., *J. Biomed. Opt.* **18**(6), 061231; and Lai et al., *J. Biomed. Opt.* **18**(6), 061225].

Several papers are related to the application of Raman spectroscopy for the analysis of human skin tissue [Syed et al., *J. Biomed. Opt.* **18**(6), 061202; Franzen et al., *J. Biomed. Opt.* **18**(6), 061210; Darvin et al., *J. Biomed. Opt.* **18**(6), 061230] and of nickel allergy [Alda et al., *J. Biomed. Opt.* **18**(6), 061206].

The application of optical coherence tomography in dermatology is discussed by Liew et al., *J. Biomed. Opt.* **18**(6), 061213 and Sattler et al., *J. Biomed. Opt.* **18**(6), 061224. The application of optical methods permits distinguishing between different types of skin cancer and is helpful for therapy planning [Darlenski et al., *J. Biomed. Opt.* **18**(6), 061208; Tchvialeva et al., *J. Biomed. Opt.* **18**(6), 061211; and Drakaki et al., *J. Biomed. Opt.* **18**(6), 061221].

Optical methods are also applied for blood flow imaging [Sun et al., *J. Biomed. Opt.* **18**(6), 061204; Wang et al., *J. Biomed. Opt.* **18**(6), 061209; Klein et al., *J. Biomed. Opt.* **18**(6), 061219; and Nishidate et al., *J. Biomed. Opt.* **18**(6), 061220] and for the analysis of wound healing processes [Pesqueira et al., *J. Biomed. Opt.* **18**(6), 061202; Medina-Preciado et al., *J. Biomed. Opt.* **18**(6), 061204; and Deka et al., *J. Biomed. Opt.* **18**(6), 061222].

The interaction of nanoparticles with human skin is a topic of increasing interest. Research into this specific field using optical imaging methods is presented by Yu et al., *J. Biomed. Opt.* **18**(6), 061207; Zhang et al., *J. Biomed. Opt.* **18**(6), 061214; Song et al., *J. Biomed. Opt.* **18**(6), 061215; Labouta et al., *J. Biomed. Opt.* **18**(6), 061218; and Fixler et al., *J. Biomed. Opt.* **18**(6), 061226.

Very often model calculation of skin physiological processes are based on results obtained by optical imaging techniques [Okamoto et al., *J. Biomed. Opt.* **18**(6), 061232; Liu et al., *J. Biomed. Opt.* **18**(6), 061228; and Terstappen et al., *J. Biomed. Opt.* **18**(6), 061223].

It will also be shown that a single technique suitable for all issues is not available, but that it is necessary to select the optimum technique for the specific purpose.

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