Toward non-invasive diagnostics and imaging of human skin disentangling xerosis of HIV and atopic dermatitis patients and due to ageing, of physicochemical changes in skin due to plasma treatment, and of human sweat ducts with technologies in the terahertz region and beyond

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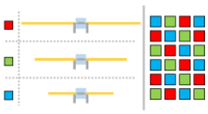
1. Non-invasive and non-destructive imaging for diagnostics and bio-medical applications

Electromagnetic waves have a high potential for diagnostics, understanding and treatment of illnesses, e.g. elevated skin temperature measured by infrared (IR) cameras is an indicator of infection. Using visible, IR, and terahertz (THz) waves has given a new understanding of patient's dry skin (1), of healing processes after plasma treatment of wounds (2), and new insights into sweat ducts properties (3). A prerequisite for non-invasive imaging of skin are cameras enabling systematic medical studies with high statistical value. Our research tackles the *challenge* to correlate spectral fingerprints in the visible, IR, and THz region of heterogeneous complex biocompatible materials, cells, tissue, and skin. Our *strategy* is to measure additional modalities by providing the imaging technologies for discoveries. Our *research* concentrates on the development of the required technology and THz spectral fingerprints/resonances.

2. Research result during FY2019 Cooperative Research Project



During project No. 2032 at the Research Center of Biomedical Engineering and the MOU between KIT and Shizuoka University, the technology has progressed by identifying suitable materials (4). A single pixel usable at 10times higher (500 Hz) than typical camera framerates of 50 Hz and illuminated with a few nW at 1 THz showed about 1000times lower noise level (5). A multi-spectral camera concept for imaging and high throughput applications with detector antennas, resonant at 3 different THz frequencies (pixel arrangement symbolized by color), was presented at ISBE (6).

3. References

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6) **E. Bruendermann**, **S. R. Tripathi**, **N. Hiromoto**, **H. Inokawa**, Non-invasive and non-destructive terahertz imaging for diagnostics and bio-medical applications, 4th Int. Symp. Biomed. Eng. (ISBE), Hamamatsu, Nov. 14-15, (2019)