Mid-IR Photothermal Deflection Spectroscopy Enhanced by Total Internal Reflection for Non-invasive Glucose Monitoring

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Photothermal deflection spectroscopy gives the possibility to overcome the limitations of classic transmission- and ATR-FTIR regarding the measurement of opaque samples. Due to the use of a tunable quantum cascade laser (QCL) serving a sufficient spectral range and high emission power, wavelength dependend thermal waves are established by irradiating the sample. This yields a refractive index gradient, which can be used to deflect a probe laser beam passing through the gradient. This effect offers the possibility to extract spectral information from larger penetration depths for opaque samples.

Based on this effect, we propose a mid-IR photothermal deflection spectrometer (PTDS) [1]. The experimental array can be described as an IR pump-VIS probe beam detection system. The modulated mid-IR pump laser is irradiating the sample through the optical element and generates upon absorption a thermal field in the sample and therefore via thermal diffusion also in the optical element. The probe beam passes through the optical element, which provides total internal reflection (TIR) and is deflected [2]. The deflection of the probe beam is measured by a position sensitive photodiode.

With this setup we were able to measure spectra of skin *in vivo*. They were recorded on a diabetic volunteer in order to follow the glucose concentration changes in different layers of skin. Additionally, the blood glucose levels of the volunteer were measured with a conventional clinical glucometer. The spectra were analyzed by chemometric methods to determine the glucose concentration and the sensitivity to glucose level changes of the different skin layers. The results of these measurements give a promising perspective for PTDS for further applications as sensing technique in the biomedical field.

References

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[2] German Patent: DE 10 2014 108 424.1