Biomedical vibrational spectroscopy for glucose monitoring in vivo?

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Clinical investigations have shown that the continuous surveillance of the concentration of blood glucose helps to improve the insulin therapy of people with diabetes mellitus. Unfortunately, up to now none of the presently available continuous glucose monitoring systems (which are based on electrochemical sensing) has received approval for therapeutic decisions, i.e. insulin dosage. One of the reasons may rest in the fundamental principle of these sensors in which an enzymatic reaction enables the generation of a detector current by allowing for the local consumption of glucose rather than the mere observation the concentration of glucose.

Mid-infrared spectroscopy may offer a reagent-free approach towards the continuous monitoring of glucose which avoids any glucose consumption. However, the omnipresence of water in biological samples often hampers the application of this type of spectroscopy to biological samples or tissue. Usual approaches such as drying the sample or using ultrathin cuvettes (together with high pressure pumps) are not feasible in an in vivo environment. Although the signal-to-noise ratio would conceptually benefit from the high intensity of synchrotron radiation, such a device is of course also not applicable under day-to-day conditions.

At the Kirchhoff-Institute for Physics we have recently combined the small absorption length of a miniaturized, diffusion-based cuvette within a fibre-sensor with the high intensity of a quantum cascade laser [1]. In a series of in-vitro experiments we have obtained appreciable sensitivity, which may be evaluated in terms of the noise equivalent concentration (NEC). Within an integration time of as little as 5s a NEC below 1 mg/dl was achieved, which corresponds to as little as 1% of the average glucose concentration. Potentially interfering substances were investigated, too. First steps towards enhancing the biocompatibility of the sensor were taken in preparation for an application in vivo.

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References

[1] C. Vrancic et al., *Analyst* 136, 1192-1198 (2011).