POPULAR SCIENTIFIC ABSTRACT

Said Ali Said El-Busaidy
Photoacoustic Sensor for Non-invasive In-Vivo Measurement of Blood Glucose

---

Abstract in English

Photoacoustic spectroscopy is proposed as an effective technique for measuring the blood glucose levels non-invasively. The technique detects an acoustic signal generated by probing glucose molecules using mid-infrared radiation. To amplify the generated photoacoustic signal, an acoustic resonator is used. One of the resonator ends is left open during the glucose measurements to prevent the build-up of humidity inside the resonator that can affect the measurements. The open resonator end deteriorates the signal and thus the sensitivity of the photoacoustic glucose measurements.

This work aims to contribute towards the development of a non-invasive glucose sensor by improving the sensitivity of the measurements. Resonance amplification is strongly dependent on the geometry of the resonator. The resonator geometry is therefore optimized for maximum signal strength and hence improved sensitivity.

The procedure for optimizing the acoustic resonator is described. Accurate simulation models that can calculate the photoacoustic signal from solid samples are developed and evaluated against experimental measurements. The ability of the models to accurately simulate the photoacoustic signal in both the open and closed resonator configuration is demonstrated. One of the models is employed in a numerical shape optimization of the resonator to maximize the detected photoacoustic signal. The optimization results show a significant signal increment that represent a step forward towards developing a non-invasive photoacoustic blood glucose sensor.

Resumé på dansk

Fotoakustisk spektroskopi foreslås som en effektiv teknik til ikke-invasiv måling af blodsukkerniveauet. Teknikken detekterer et akustisk signal genereret ved sondering af glukosemolekyler ved hjælp af melleminfrarød stråling. For at forstærke det genererede fotoakustiske signal anvendes en akustisk resonator. En af resonatorenderne er åben under glukosemålingerne for at forhindre ophobning af fugt inde i resonatoren, som kan påvirke målingerne. Den åbne resonatorende forringer signalet og dermed følsomheden af de fotoakustiske glukosemålinger. Dette arbejde sigter mod at bidrage til udviklingen af en ikke-invasiv glukosesensor ved at forbedre målingernes følsomhed. Resonansforstærkning er stærkt afhængig af resonatorens geometri. Resonatorgeometrien er derfor optimeret til maksimal signalstyrke og dermed forbedret følsomhed.

Proceduren til optimering af den akustiske resonator beskrives. Nøjagtige simuleringsmodeller, der kan beregne det fotoakustiske signal fra faste prøver, udvikles og evalueres i forhold til eksperimentelle målinger. Modellernes evne til nøjagtigt at simulere det fotoakustiske signal i både den åbne og lukkede resonatorkonfiguration demonstreres. En af modellerne anvendes i en numerisk formoptimering af resonatoren for at maksimere det detekterede fotoakustiske signal. Optimeringsresultaterne viser en signifikant signalforøgelse, der repræsenterer et skridt fremad mod udvikling af en ikke-invasiv fotoakustisk blodsukkersensor.

Zoom Link for the PhD thesis defence on 28 May at 10am:

https://syddanskuni.zoom.us/j/63698887457?pwd=QUd3a1NDK2tFYzlkYVdOME1nblZYUT09