Chemical Engineering Thesis Defense

Development and Qualification of Novel Colorimetric Breath Acetone Sensors for Ketosis and Ketoacidosis Diagnostics

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Abstract

Non-invasive biosensors enable rapid, real-time measurement and quantification of biological processes, such as metabolic state. Currently, the most accurate metabolic sensors are invasive, and significant cost is required, with few exceptions, to achieve similar accuracy using non-invasive methods. This research, conducted within the Biodesign Institute Center for Bioelectronics and Biosensors, leverages the selective reactivity of a chemical sensing solution to develop a sensor which measures acetone in the breath for ketosis and ketoacidosis diagnostics, which is relevant to body weight management and type I diabetes. The sensor consists of a sensing solution encased in a polymer shell that is permeable to volatile organic compounds, such as acetone. The sensing solution displays a gradient of color changes resulting from green and blue wavelength absorbance changes, and the absorbance change is proportional to the acetone concentration in the part-per-million range, making applicable for detection ketosis and ketoacidosis in human breath samples. The colorimetric sensor response can be fitted to a Langmuir-like model for sensor calibration. The sensors best performance comes with turbulent, continuous exposure to the samples, rather than batch sample exposure. With that configuration, these novel sensors offer significant improvements to clinical and at-home measurement of ketosis and ketoacidosis.

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