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Abstract

Acetone Bio-Sniffer (Gas-Phase Biosensor) for Monitoring of Human Volatile Using Enzymatic Reaction of Secondary Alcohol Dehydrogenase †

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Abstract: We developed a highly sensitive acetone bio-sniffer (gas-phase biosensor) based on an enzyme reductive reaction to monitor breath acetone concentration. The acetone bio-sniffer device was constructed by attaching a flow-cell with nicotinamide adenine dinucleotide (NADH)-dependent secondary alcohol dehydrogenase (S-ADH) immobilized membrane onto a fiber-optic NADH measurement system. This system utilizes an ultraviolet light emitting diode as an excitation light source. Acetone vapor was measured as the fluorescence of NADH consumption by the enzymatic reaction of S-ADH. A phosphate buffer that contained oxidized NADH was circulated into the flow-cell to rinse the products and the excessive substrates from the optode; thus, the bio-sniffer enables the real-time monitoring of acetone vapor concentration. A photomultiplier tube detects the change in the fluorescence emitted from NADH. The relationship between the fluorescence intensity and acetone concentration was identified to be from 20 ppb to 5300 ppb. This encompasses the range of concentration of acetone vapor found in the breath of healthy people and of those suffering from disorders of carbohydrate metabolism. Then, the acetone bio-sniffer was used to monitor the exhaled breath acetone concentration change before and after a meal. When the sensing region was exposed to exhaled breath, the fluorescence intensity decreased and reached saturation immediately. Then, it returned to the initial state upon cessation of the exhaled breath flow. We anticipate its future use as a non-invasive analytical tool for the assessment of lipid metabolism in exercise, fasting and diabetes mellitus.

Keywords: biosensor; chemical sensor; enzyme; acetone; gas sensor

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