

ABSTRACT

SELF-ASSEMBLED FLEXIBLE LACTATE SENSOR

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Lactic acid is a vital indicator for shock, trauma, stress, and exercise intolerant. It is key biomarker for increases in stress levels and is the primary enzyme of metabolically produced acid which is responsible for tissue acidosis that can lead to muscle fatigue and weakness. Lactate can be an excellent biomarker for monitoring lactate threshold in individuals as well as tissue and organ health. During intensive exercise, the muscles go through anaerobic metabolism to produce energy. This leads to decreases in the flow of nutrients and oxygen and increases in lactate production, which in turns causes lactic acidosis. Currently these problems are monitored by sensors that can be invasive via blood or wearable based sensors that use the enzyme lactate oxidase and produces hydrogen peroxide as a byproduct. Here we present the developments of noninvasive wearable electrochemical lactate biosensor for the detection of lactic acid. The bioelectrode was designed with multiwalled carbon nanotubes (MWCNTs). This material was chosen due to low cost, high conductivity, flexible, high active surface area and easy to functionalize. D-Lactate dehydrogenase (D-LDH) was immobilized on the surface of the MWCNTs to facilitate the oxidation of lactic acid. The biosensor was then integrated into a polydimethylsiloxane (PDMS) flexible substrate platform. PDMS was chosen because it is lightweight, flexibility, biocompatibility, and conformal properties. The sensor is designed to be placed on skin in order to measure lactate in sweat. Sweat lactate concentrations have shown to be a good biomarker for evaluating the severity of peripheral occlusive arterial diseases and damage in soft tissue. Sweat has shown to be the most promising to measure lactate. The lactate biosensor exhibited a dynamic linear range of 5 mM to 45 mM lactic acid with a good sensitivity of 1.256 $\mu\text{A}/\text{mMcm}^2$. This electrochemical biosensor has the potential to be used for the real-time detection of lactic acid in the clinical, biological and sports medicine fields.