Microneedles for Creatinine Detection: Novel Prototype of Non-Invasive Portable Tool Towards Chronic Kidney Disease Risk Assessment

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Chronic kidney disease (CKD) is a condition in which the kidneys gradually lose their function and in most cases deteriorate to end-stage renal disease. Early detection helps those at risk to receive treatments and intervention that slow down the onset of the disease and prolong life expectancy. Previous studies indicated that serum creatinine can be a specific bio-marker of CKD. Since the concentration of creatinine in the interstitial fluid is also directly correlated to the concentration in the blood, our objective is therefore to develop microneedles-based electrochemical sensors for creatinine measurement in the interstitial fluid. The microneedle array containing 41 microneedles (with the height of approximately 812.5 microns) was fabricated using polymethyl methacrylate on which a thin layer of gold was sputtered for electrical conductivity. Two polymer deposition methods, spin coating and drop casting were performed to deposit molecular imprinted polymer on the microneedle sensor. The morphology differences were thoroughly characterized to ensure the selectivity of creatinine on the microneedle. The thin film layer produced by the spin coating technique is thinner and more consistent throughout the whole surface, allowing the microneedle sensor to have more sensitivity, reproducibility, and durability. The microneedle electrochemical sensors were tested in varying creatinine concentrations (0-90 mM) using cyclic voltammetry method. The relationship between the peak redox current and concentration of creatinine and the microneedle sensor's response to the creatinine concentration has been confirmed. This promising result from the microneedle-based electrochemical sensor is a proof of concept for a home-use CKD assessment in the future.

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