Towards the development of a combined pH, oxygen, and cortisol implantable sensor using electrochemistry techniques

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Abstract

This study focuses on the development of an implantable biosensor that detects pH, oxygen, and cortisol levels. Oxygen and pH levels are both associated with cancer, and cortisol is associated with increased stress and a litany of related conditions. Polymer fibres, which have shown resistance to biofouling, were tested as a platform for pH and cortisol sensors, and a semi-implantable needle-based platform was used for oxygen sensor testing. Electrochemical sensing techniques were used for both fabrication of sensors, using cyclic voltammetry and chronopotentiometry, and testing of sensors, using open potentiometry (pH sensor), amperometry (oxygen sensor), and cyclic voltammetry (cortisol sensor). Two pH sensors were tested, one with the IrOx pH sensing layer, and another with IrOx pH sensing layer and intermediate and anti-biofouling layers of EDOT. pH sensing was conducted in a series of buffer solutions, while oxygen sensing was conducted in solutions of hydrogen peroxide in phosphate-buffered saline, and cortisol sensing was conducted in solutions of hydrocortisone in PBS. The sensor with EDOT yielded a lower sensitivity (-76.56mV/pH unit) and lower limit of detection (0.60pH units) than the sensor without EDOT (sensitivity=-51.07mV/pH units, LOD=0.92pH units), and the results of the sensor with EDOT more quickly stabilized into the target flat-line results than the results of the sensor without EDOT. The oxygen sensor tests indicated a sensitivity of (5.171pA/1mM H_2O_2) and an LOD of (0.0513mM H_2O_2), and the cortisol sensor yielded a sensitivity of (24.25pA per 1ng/mL hydrocortisone) and an LOD of (0.1104 ng/mL hydrocortisone).

Biography

Meera Madhavan has submitted her Master's thesis at the age of 26 from Imperial College London and completed her Bachelor's Degree at the Henry Samueli School of Engineering and Applied Sciences at the University of California, Los Angeles.