Flexible Impedance Biosensor for Folate Receptor Detection in Cancer Diagnostic

The majority of deaths caused by common fatal diseases are because of the late detection of the disease. If the disease is detected early, it can be treated thus reducing the chances of death. Biosensors are a promising platform for quick and cost effective cancer detection with high sensitivity. Although biosensors utilizing biomolecules (e.g., DNA, RNA, proteins) are effective, they tend to suffer from the same disadvantage; they are sensitive to environmental conditions. Thus, reducing considerably their shelf life thereby diminishing their utility and reliability. In this work, a robust, inexpensive, flexible, and effective sensor was constructed and characterized by cyclic voltammetry (CV), electrochemical impedance spectroscopy (EIS), x-ray photoelectron spectroscopy (XPS), and atomic force microscopy (AFM). The sensor was constructed using a Melinex® polymer film with gold deposited on its surface. The first step of the sensor construction was the formation of a cysteamine self-assembled monolayer (SAM) used to covalently immobilize folic acid (FA) on the electrode's surface. AFM and XPS experiments confirmed the SAM formation and the FA immobilization. A change in impedance was used to track the degree of binding between the folic acid molecules and the overexpressed folate receptor on the HeLa cell surface. A gradual increase of resistance on the electrode's surface was observed through time while exposed to the HeLa cells in solution. The electrochemical impedance of the sensor was linear from 100 cells mL^{-1} to 5000 cells mL^{-1}. As a negative control, cells that do not overexpress folate receptor were used to monitor the change in impedance and no change was found over time. Eventually, this sensor can be used as a screening tool in potentially vulnerable patients for the early detection of multiple types of cancers that overexpress folate receptors as well.