Electrochemical detection of cardiac myoglobin using microchannel with interdigitated electrodes (MCIE)

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The present study aims to solve a problem that runs rampant across North America i.e. heart attacks. Each year approximately 70,000 heart attacks occur in Canada. That means one heart attack every 7 minutes and costs the Canadian economy $20.9 billion each year[1]. In 2010-2011, there were approximately ~300,000 hospitalizations due to heart diseases[1]. This number is increasing at an alarming rate due to many reasons of life style. Most of the deaths reported are due to the lack of prior diagnosis of heart damage.

Heart attack, also known as myocardial infarction or acute myocardial infarction (AMI), is the death of heart muscles due to insufficient supply of oxygen carrying blood. It has been found that the concentration of certain proteins and/or enzymes increases in the blood serum after infarction. The cardiac proteins, such as myoglobin, troponin I, troponin T, CK-MB, fatty acid-binding protein (also known as H-FABP), and isoenzymes, appear in the blood serum after AMI. Myoglobin is one of the premature identifying cardiac protein markers whose concentration level increases from 90 pg/ml or less to over 250 ng/ml in the blood serum within the first 2–8 h after heart muscles start dying.

Early assessment of heart attacks has always posed a problem to researchers. Rapid detection and quantification of such cardiac markers from blood serum can play an important role in the early detection of heart attack. Current techniques employed in diagnosis are time consuming, expensive and intense human involved. However, much research has been done in addressing this problem, but there is no accurate and high sensitive technique for detecting cardiac markers[2].

In this work, we developed a novel electrochemical sensing technique to detect the myoglobin using microchannel with interdigitated electrodes (MCIE). This is a label-free technique, which can avoid the using of detection antibodies, and reduces the cost and improves the signal to noise ratio.

The methodology involves the fabrication of MCIE[3]; biofunctionalisation of interdigitated electrodes in the MCIE with myoglobin capture antibodies using alkanethiol self-assembled monolayer (SAM); and injecting the aqueous solution of myoglobin antigens into MCIE. Binding of myoglobin antigens with immobilized myoglobin antibodies changes the impedance of the system. Using alternating current (AC) electrochemical impedance spectroscopy (EIS), the change in impedance spectra is observed across the frequency range of 0.1 Hz to 1 MHz.

The effect of width of the electrode and gap between the electrodes on performance of the MCIE is studied.

References

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[3] N. S. K. Gunda, S. K. Mitra and V. R. Rao, Proceedings of the 7th International Conference on Nanochannels, Microchannels, and Minichannels 2009, ICNMM2009, (PART A), pp. 113-119, (2009).

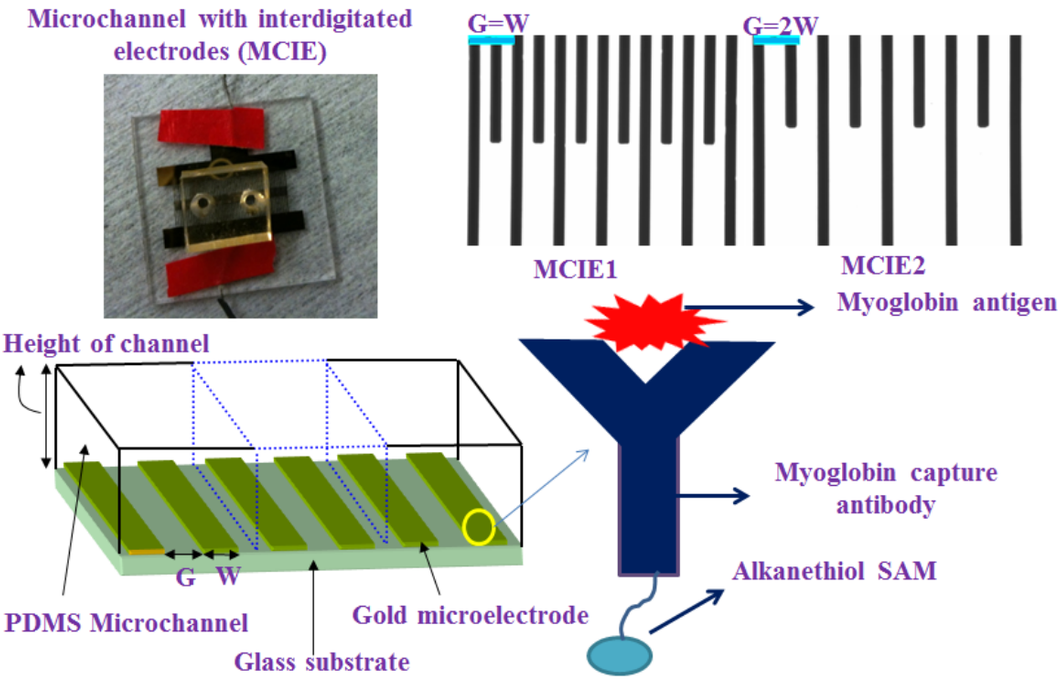

Figure 1: (Top) Picture of microchannel with interdigitated electrode (MCIE) and optical images of two different electrode configurations; (Bottom) Schematic showing the MCIE with immunoassay on interdigitated electrodes (not to scale).