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A small microfluidic platform for portable electrical biosensing towards point of care detection

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Disease diagnosis in last decade has improved tremendously with the help of increased number of research in micro and nano biosensing. However, if the goal is to make disease detection and analysis available to general people in an easier and comfortable way, plenty of works need to be done on conventional biosensing techniques. Other than the sensitivity and selectivity, such kind of biosensing demands low cost rapid measurement. Portability and simple methods of operation are two other important factors. Current most frequently used techniques (example, DNA detection) include attachment of fluorescence label to target molecules which is expensive and time consuming. Reported development of field effect transistor based devices [1, 2] operate label free but are often substantially affected by the post passivation of sensing surface. CMOS based devices [2] integrating multiple sensing in a small area, allow simultaneous sensing but reusability, disposability and fluid transport are issues with them. There are few mentions [6] of using microfluidic device with electronic sensing but mostly the uses are partial for example, using PDMS wall only to supply, incubate measurement buffer etc. Most importantly, use of these devices become limited when multiple target molecules detection are considered. In a short, a fully electronic biosensor that is really fast, robust, portable and inexpensive is a challenge yet to meet. Our aim is to develop such a tool that can be used for multiple target analyte detection and analysis.

Toward this, recently we presented label free DNA sensing [3] through surface potential measurement using simple analog circuit made of low cost discrete components and were able to achieve good sensitivity and selectivity. We also reported [4] patterned electrodes surrounded with PDMS wall used for differential measurement to increase sensitivity and selectivity. Our work [5] on continuous potential measurement of sensing surface during different steps of DNA functionalization showed the promise of making a fully portable DNA sensor for future point of care detection.

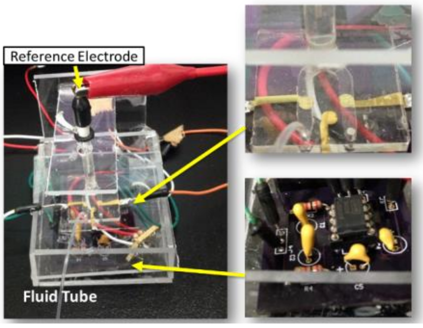

Fig 1 : Complete device for biosensing, with PDMS channel on top and circuit on the bottom.

Here we present a small microfluidic platform that provides easier way of fluid transport to the Au based sensing surface. Au/Cr has been sputtered on the glass to create sensing area which is then covered by microfluidic channels made by PDMS. A miniature analog circuit is attached to the platform for the label free electrical sensing of the surface functionalized with target molecule. Complete device that can fit inside palm is able to operate through a single cell battery giving it a complete portability in biosensing. Integration of microfluidic channels with sensing surface and circuit has added total flexibility in handling fluids such as supply of probe and target molecules and measurement buffer. We aim to use our device in different target molecules sensing (eg. DNA, RNA) therefore giving it the flavor of a true Lab-on-chip device.

[1] D. Gonc¸alves et al., “*Detection of DNA and proteins using amorphous silicon ion-sensitive thin-film field effect transistors*” Biosensors and Bioelectronics 24 (2008) 545–551
[2] K.-H. Lee et al., “*A CMOS label-free DNA sensor using electrostatic induction of molecular charges*”, Biosensors and Bioelectronics 31 (2012) 343– 348
[3] Tanzilur Rahman, Takanori Ichiki, "*Direct potential measurement for label free DNA hybridization detection using discrete electronic circuit*", 74th JSAP Autumn Meeting, 2013, Kyoto, Japan
[4] Tanzilur Rahman, Takanori Ichiki,"*DNA hybridization detection through differential potential measurement on a patterned gold multi electrode using analog circuit*", 23rd Annual Meeting of MRS-J, Yokohama, Japan
[5] Tanzilur Rahman, Takanori Ichiki ,“*Continuous potential measurement of DNA modified sensing surface using analog circuit towards point of care detection”*, 61st JSAP Spring Meeting, 2014,Kanagawa , Japan
[6] Seokheun Choi et al.,“*Microfluidic-based biosensors toward point-of-care detection of nucleic acids and proteins*”, Microfluid Nanofluid (2011) 10:231–247

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