

*Abstract*

# Electrochemical Current Measurement by CMOS Potentiostat Integrating Chromatography Paper Fluidic Channel and CMOS LSI Chip for Small Biosensors <sup>†</sup>

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<sup>†</sup> Presented at the 5th International Symposium on Sensor Science (I3S 2017), Barcelona, Spain, 27–29 September 2017.

Published: 6 December 2017

Biosensing using CMOS chip equipped with sensor electrodes on the surface has been studied for small biosensors [1]. The conventional method uses external pump to transport sample solution to the electrodes and hence is not suitable for miniaturization. Because of this, we have focused on using water absorbency of Chromatography Paper (ChrPr), instead of external pump, to transport solution, and already succeeded in simultaneous detection of glucose and ethanol on CMOS chip using ChrPr [2]. However, the measurement was conducted by electrochemical analyzer connected to the on-chip electrodes, not on-chip sensor circuits, since the previous work focused on transporting sample solution and setting up electrochemical cell directly on the chip.

In this work, glucose detection was conducted using CMOS chip equipped with both measurement circuits and sensor electrodes. In particular, we carried out glucose detection in sample solution by electrochemical current measurement using CMOS potentiostat composed of two operational amplifiers, supposing blood glucose measurement. The CMOS chip (0.18  $\mu\text{m}$  process) is 5 mm square and has electrodes on the surface for three electrode system. Working electrode and counter electrode are fabricated from graphene ink, and reference electrode is fabricated from Ag/AgCl ink. Solution transport is conducted as follows. Firstly, hydrophobic area is defined on ChrPr by applying silicone resin. After that, the ChrPr are laminated so that 3-D fluidic channel is formed, utilizing the fact that the solution moves spontaneously into the overlapping hydrophilic area. By setting the laminated ChrPr on the CMOS chip, dropped solution is transported to the electrodes. Glucose oxidase and potassium ferricyanide, which are chemicals for glucose detection, are immobilized in the hydrophilic area before laminating process. Thus, the sample solution intermingles with the chemicals in the process of being transported to electrodes. The voltage is applied so that the potential between the working electrode and the reference electrode is +0.5 V which is an adequate voltage to conduct glucose detection.

As a result, the observed current was found to be proportional to the glucose concentration. Thus, we successfully realized small biosensor chip integrating many functions, such as sensor electrodes, solution transport without external pump, and circuits conducting electrochemical measurement, in a single small chip.

**Acknowledgments:** This work was supported by JSPS KAKENHI Grant Number 26289111.

## References

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