【Grant-in-Aid for Scientific Research(S)】
Science and Engineering (Engineering)

Title of Project : Chemistry Integrated Circuit for Biomedical Equipment

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Research Area : Engineering : Electronic devices and equipment
Keyword : Electronic devices : Semiconductor Integrated Circuit

【Purpose and Background of the Research】

The purpose of this research is to realize chemistry integrated circuits where several chemical reactions occur on a chip, which are controlled and detected electrically. This type of device is mainly expected for the use of biomedical applications.

In view of the growing concern about such issues as food security, health care, evidence-based care, infectious disease, and tailor-made medicine, a portable gene-based point-of-care testing (POCT) system is needed. For a system that anyone can operate anywhere and obtain immediate results, a new biosensor chip must be developed. Electrical detection using complementary metal-oxide semiconductor (CMOS) integrated circuits has great potential since it eliminates the labeling process, achieves high accuracy and real-time detection, and offers the important advantages of low-cost, compact equipment.

Our main target is the realization of chemical integrate circuit to detect very small amount of target molecules by amplifying them on a chip.

【Research Methods】

Chemical reactions occur in parallel and sequence on a semiconductor chip. To detect very small amount of target molecules, the following research will be conducted.

1. Real time amplification and detection of biomolecules: Systematic research will be carried on the detection of biomolecules during the amplification. Optimization of chemical reactions, multi-well structure, and electrical control methods to the amplification of the molecules are pursued.
2. Electric detection of the distribution of single molecule: Monolithically integrated sensor array will be developed to observe the time evolution of the spatial distribution of biomolecular interactions. In the first year basic technology will be established to detect viruses and bacteria with dimension between 0.05μm and 5μm. From second year, this technology will be developed to detect nm-size molecules such as DNA and peptide.
3. CMOS biosensor circuit: In addition to static sensor circuits, dynamic sensor circuits will be developed for electric cytometry.
4. Microfluidics optimized to chemistry integrated circuit: To isolate and interconnect chemical elements on a LSI chip, microfluidics will be investigated.

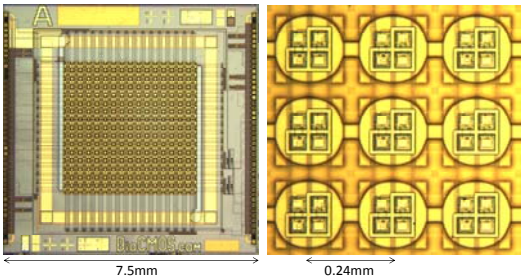

Figure 1 Chemistry Integrated Circuit

【Expected Research Achievements and Scientific Significance】

This research may mark the starting point of the "chemistry integrated circuit" where two completely different fields, material chemistry and semiconductor technology, are merged. In this research program, semiconductor integrated circuits will find wide applications on medical, pharmacy, food, agriculture, and envelopment.

【Publications Relevant to the Project】

・K. Nakazato, Potentiometric, Amperometric, and Impedimetric CMOS Biosensor Array, in *State of the Art in Biosensors/Book* 1, pp. 163-178, ISBN 980-953-307-669-5, ed. by T. Rinken, InTech, 2012 doi:10.5772/53319
・K. Nakazato, Integrated ISFET Sensor Array, Sensors 9, 8831-8851, 2009; doi:10.3390/s91108831

【Term of Project】 FY2013-2017

【Budget Allocation】 131, 700 Thousand Yen

【Homepage Address and Other Contact Information】

http://biocmos.com
http://www.nuee.nagoya-u.ac.jp/labs/nakazatolab/