【Science and engineering（Engineering I）】

An implantable chip with integrated microprobe/tube arrays for electrical neural recording, stimulation, and drug delivery applications

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【Outline of survey】

The goal of this project is to develop technologies for integration of very fine out-of-plane silicon microprobe, silicon-dioxide microtube arrays with microelectronics using a "selective vapor-liquid-solid (VLS) growth" technique and microfabrication processes, for use in neurophysiological applications, based on multiple electrical recording/stimulation of neurons, and local drug delivery *in-vivo*.

1. Integration of a few microns diameter low-invasive probe electrode and tube arrays for simultaneous electrical recording, stimulation, and drug delivery system in cellular level
2. Realization of the microprobes/tubes with various lengths for three-dimensional electrical measurement and drug delivery in neuronal tissue
3. On-chip CMOS interface circuitry aimed for amplifications and filtering of recorded neural signals, drug flow controller and data/power wireless transmission system

Use of microelectrode technique is still useful in neurophysiological studies, compared to other techniques such as functional magnetic resonance imaging (fMRI) and electroencephalography (EEG), in terms of spatial and temporal resolutions. Recent interest in this field also includes chemical analysis of neurons with particular solutions/drugs into tissue, that has been realized by penetrating microtube based drug delivery. As know that earlier groups, University of Michigan and others, have well contributed to the developments of microelectrode/tube devices, establishing a lot of techniques, and several devices have already been commercially available. Although these devices have opened up new class of neuroscience fields, fabrication techniques of the electrodes are still developing, such as minimization of probe/tube size. Conventional fabrication technologies can realize probe/tube sizes in more than tens of microns, which are relatively large compared to a single cell body with the diameter of several microns. These probe/tube devices cause damage to neurons as well as the tissue while the probes/tubes are inserted. Additionally, the spatial separation of their probes/tubes is limited to be several hundreds of microns due to the scaling limitation of the fabrication techniques. To overcome the above device issues, we plan to develop an implantable microchip with the integrated microprobe/tube arrays by utilizing the selective VLS growth.

【Expected results】

From these advantages of the size of probe/tube, high-density probe/tube array, 3-dimensional measurements in tissue, and on-chip CMOS interface capability, the proposed device could become an effective technique for neural recording/stimulation and drug delivery *in-vivo/in-vitro*, and it could greatly assist in the problem of understanding of the nervous systems.

【References by the principal investigator】

・M. Ishida, *et.al.*, Int. conf. Transducers' 99, 1999
・T. Kawano, *et.al.*, Int. conf. IEEE-IEDM, 2004
・K. Takei, *et.al.*, Journal of Micromechanics and Microengineering, 18, 3, 501-509, 2008

【Term of project】 FY2008－2012	**【Budget allocation】** **161,900,000 yen** (direct cost)
【Homepage address】	http://www.dev.eee.tut.ac.jp/ishidalab