In Situ Patterning of Neurons Using TiO_2 Photocatalysis for Fabrication and Analyses of Artificial Neuronal Circuits

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As the down-scaling of complementary metal-oxide-silicon (CMOS) technology approaches the physical limitation, not only extending the semiconductor roadmap but also exploring novel devices that derive the alternative computer architecture are demanded [1]. Neural computing that takes advantage of network-based parallel computation is a latter approach, but only a few neuronal functions have been implemented based on knowledge provided by neuroscientists, the lack of knowledge has resulted in poor performance in the computation as compared to human brain even though the arithmetic logics were mimicked preferentially.

Human brain is a longtime challenging motif among nonlinear complex systems. Although there have been a gap between electronics and neuroscience, fabrication of transducers and surface modification techniques can bridge the gap in the interdisciplinary field.

Our aim is to establish an artificial neuronal circuit, a simple *in vitro* model that mimics the *in vivo* architecture and function of neural circuits, and investigate the network properties of neurons in a brain and their computational role [2,3]. For the fabrication of neuronal circuits with predefined topology, neurons need to be immobilized on preferred sites on a template, followed by connecting their neurites individually to other cells. This approach is akin to building an electronic circuit on a stripboard and enables to design a living neuronal circuitry by guiding a selected neurite to a preferred site of any target neuron with an arbitrary pathway. To make this, we investigated the feasibility of photocatalytic lithography of self-assembled monolayers (SAMs) deposited on a TiO_2 film. Decomposition of cytophobic SAMs by ultra-violet irradiation allows neurons to attach to the decomposed surface and elongate their neurites [4-6]. Such photocatalytic lithography can be carried out not only in air but also in a culture media where neurons are being cultured. Using this technique, we intend to construct a local neuronal circuit on a glass chip and elucidate their functions with its mathematical model.

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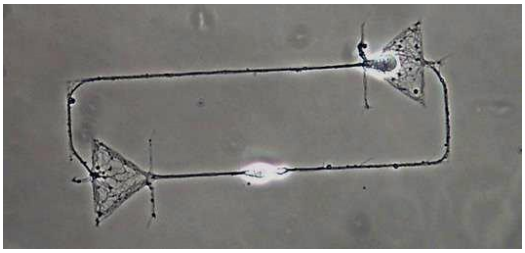

Figure 1 Two neuronal diodes connected recursively.

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