Improvement of Electrical Characteristics of Neural Electrode by Electroplating Process

Dong Hyun Baek, Dae Wook Kim, Seung Joon Ahn, Ho Seob Kim
Department of Physics and Information Display, College of Engineering,
Sun Moon University, 70, Sunmoon-ro 221, Tangjeong-myeon, Asan-si,
Chungcheongnam-do, Republic of Korea, 31460
E-mail: hskim3@sunmoon.ac.kr

Neural interface based on nerve stimulation and recording require microelectrodes which can be chronically interfaced to the central and peripheral nervous systems[1]. This multichannel microelectrode requires low contact impedance between the brain and electrode to be connected directly to the neuron or cortical surface. Despite of the advance in technology, Electrocorticography (ECoG) is still challengeable because of the high risky brain surgery, biocompatibility of electrode, stability and difficulty in long term recording. For the stable measurement of ECoG, the development of electrode array with low contact impedance is one of key requirements[2]. In order to pursuit this purpose, we have developed neural interface with parylene-C and evaluated its electrical performance *in-vitro*.

We designed 12 channel electrode to fit rodent brain. Figure 1 shows the arrayed Pt electrodes encapsulated by parylene-C. After fabrication process of the bare-Pt electrode, we additionally carried out Pt electro-plating for improving contact impedance between brain and electrode. Electro-plating solution contains 5g of H_2PtCl_2 (Chloroplatinic acid, Sigma-Aldrich), 71.4mg of Pb $(NO_3)_2$ (lead acetate, Sigma-Aldrich) in 357mL of DI-water. We observed the electroplated Pt surface using FE-SEM. As shown in the insert of Fig. 2, Nano-size structures were formed on the bare-Pt surface by electro-plating process, and the materials composing the nanostructures are Pt as observed by EDX analysis shown in Fig. 2.

The electrochemical impedance spectroscopy (EIS) of both electroplated and non-electroplated electrodes have been measured in 1X Phosphate Buffered Saline at room temperature using a potentiostat (EIS-300, Garmy) over frequency range from 1Hz to 100 kHz, and the results are presented in Fig. 3. The impedance of electroplated Pt electrode was observed to be much lower than that of the non-electroplated Pt electrode. The nanostructures formed after electroplating process increases the surface area, which is thought to be the origin of the impedance reduction. In this paper, the details of experiments will be described.

---

1 Stuart F. Cogan, Annu. Rev. Biomed. Eng., vol. 10, pp.275–309, 2008

2 Mikhail A. Lebedev andMiguel A.L. Nicolelis. Neurosciences, vol. 29, No 9, 2006

Figure 1: The multi-channel arrayed parylene-C based neural electrode

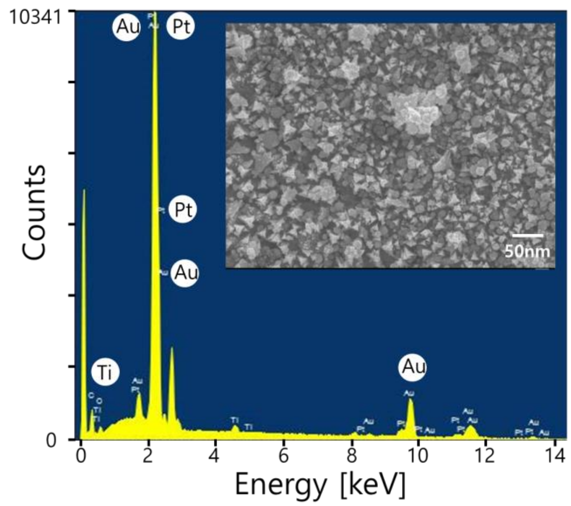

Figure 2: The SEM image at 50,000 X magnification of the electroplated Pt and EDX analysis.

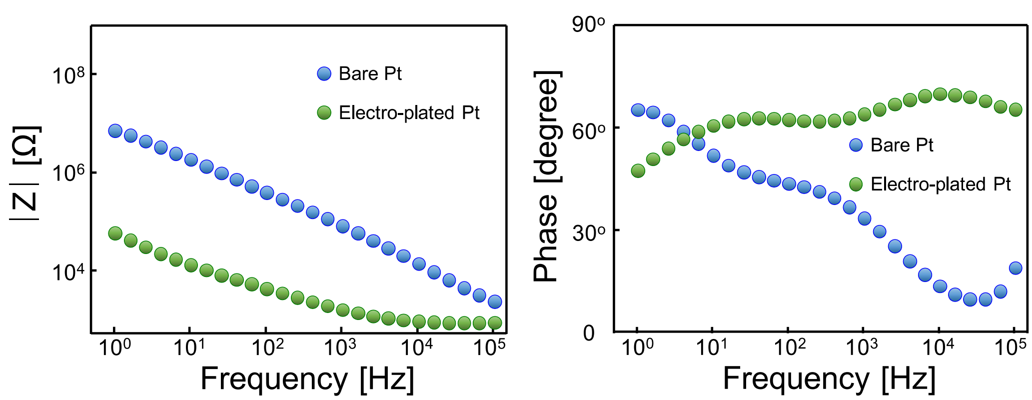

Figure 3: The results of electrochemical impedance spectra (EIS) of bare and electroplated Pt (left: Bode magnitude plot, right: Bode phase plot).