A Study of Electrical Impedance Property of an L$_2$ePt Electrode

D. Y. Kim[1], Y. S. Ku[1], H. S. Choi[1], S. W. Noh[1], J. H. Park[1] and H. C. Kim[2*]
[1]Interdisciplinary Program, Bioengineering Major, Graduate School and Department of Biomedical Engineering, Seoul National University, Seoul, Korea
[2]College of Medicine and Institute of Medical and Biological Engineering, Medical Research Center, Seoul National University, Seoul, Korea
E-mail: hckim@snu.ac.kr

Abstract— **An investigation on nanoporous electrodes is discussed in this paper. Using an electrical impedance analysis method, L$_2$ePt (a nanoporous platinum deposited electrode) impedance characteristics were compared to standard Ag/AgCl electrodes and flat platinum electrodes. The analysis revealed the impedance of flat electrodes were ten times larger than those of the nanoporous plated electrodes and Ag/AgCl electrodes.**

Keywords— **Nanoporous, Biopotential, Electrode impedance**

I. INTRODUCTION

In human-machine interface studies and clinical researches, measuring high quality biopotential signals is critical for analyzing functional status of a subject. One of the fundamental components of acquiring clean signals is an ideal electrode that detects the biopotential with low noise and low contact impedance. Here, as a possible candidate for such electrode, the nanoporous deposited electrode was fabricated and its electrical impedance property was evaluated.

II. METHODS

A. L$_2$ePt electrode fabrication

An electroplating Pt solution was prepared by mixing Triton X-100, 0.3M NaCl aqueous solution, and hexachloroplatinic acid. Then, bulk electrolysis was performed on a Pt foil, immersed under the Pt plating solution at 41˚C. After electrochemical deposition, the fabricated electrodes were immersed in distilled water for a week to eliminate the surfactant [1].

B. Electrode impedance measurement

Using an impedance analyzer, electrical impedance of the fabricated electrodes were measured. Physiological saline solution (0.9% NaCl) was used as the medium between two electrodes, a reference Ag/AgCl on one end and an electrode of interest on the other end of a measuring box. The impedance values were obtained in frequency range between 20~1000 Hz [2].

III. RESULTS

Electrode impedance in solution

Five L$_2$ePt samples were created, and they were compared to five flat platinum samples and three standard Ag/AgCl electrodes for electrode impedance. As Fig. 1 shows, the flatPt samples had significantly higher mean impedance (2.1KΩ at 20Hz) than that of other groups. On the other hand, at 20Hz the impedance of the L$_2$ePt group was between 203~215Ω, and the standard Ag/AgCl electrodes had 180Ω at the same frequency.

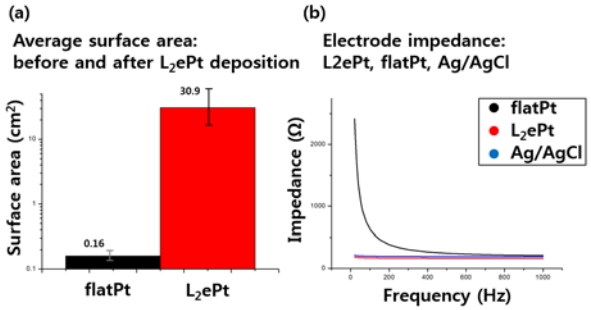

Fig. 1. (a) The average surface area of L2ePt increased nearly 200-fold. (b) Ag/AgCl and L2ePt electrode impedances show similar impedance ranges of the two groups.

IV. CONCLUSION

The impedance analysis of the three different groups of electrode revealed that L$_2$ePt electrodes with high surface area exhibited lower electrode impedance than the flat Pt electrodes. Large surface area of the nanoporous electrode reduced the impedance that nearly matched impedance of commercial Ag/AgCl electrodes.

Further considerations on the physical properties of the L$_2$ePt electrodes will be necessary for understanding and utilizing the nanoporous electrode in biopotential measuring applications.

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REFERENCES

1. S. Y. Park, S. Y. Lee, H. Boo, H.M. Kim, K.B. Kim, H.C. Kim, Y.J. Song, and T. D. Chung, "Three-Dimensional Interstitial Nanovoid of Nanoparticulate Pt film Electroplated from Reverse Micelle Solution," *Chem. Mater.*, vol. 19, pp. 3373-3375, 2007.

2. S. Myllymaa, S. Pirinen, K. Myllymaa, M. Suvanto, T.A. Pakkanen, T.T. Pakkanen, and R. Lappalainen, "Improving electrochemical performance of flexible thin film electrodes with micropillar array structures," *Meas. Sci. Technol.*, vol. 23, 2012.