A NOVEL NANOPOROUS PLATINUM ELECTRODE FOR EEG SIGNAL QUALITY ENHANCEMENT

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I. INTRODUCTION

A. Importance of the contact impedance in an EEG recording

- ◆ **High contact impedance** is a major source degrading the quality of EEG signal.
- ◆ **Conventional electrodes** use inconvenient electrolytic paste and skin preparation to lower the contact impedance.
- ◆ Therefore, a convenient and efficient way to lower the contact impedance is necessary.

B. Proposal

- ◆ Increased surface area of an L2ePt electrode increases capacitance.
- ◆ **Here, the L2ePt electrode that significantly reduces the contact impedance for recording EEG is introduced.**

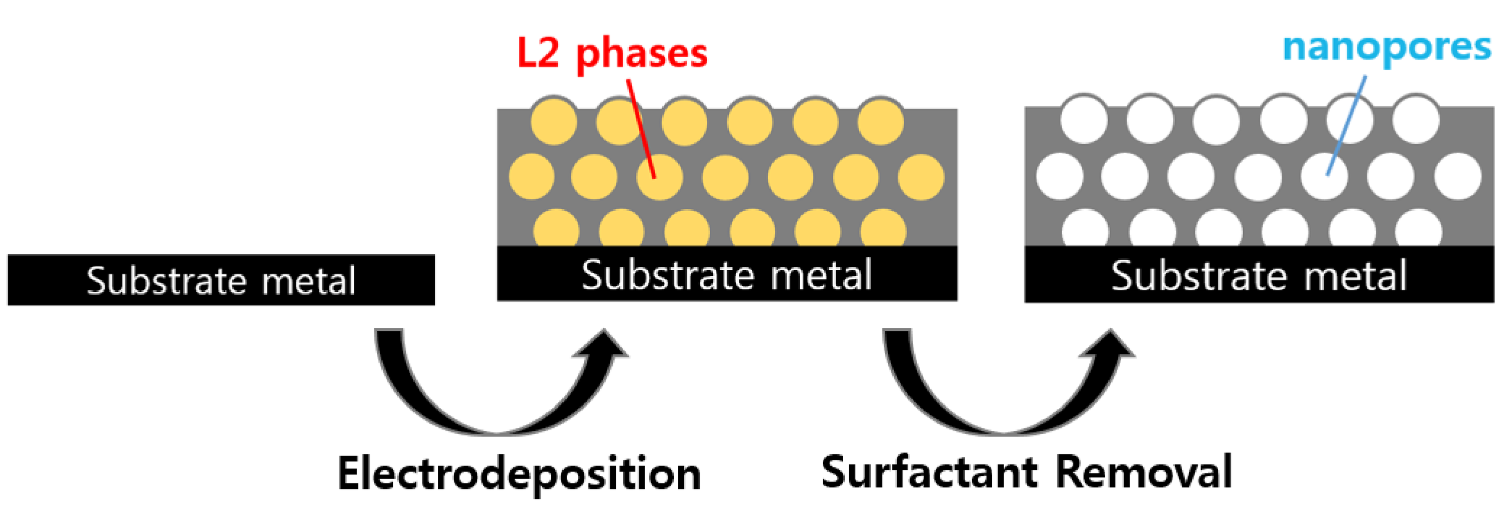

Fig. 1. The schema of the electrodeposition process for the nanoporous platinum electrode.

- ◆ **Key features of the L2ePt electrode**
- Electrochemical deposition on gold or platinum using L2 phases produces nanoporous film that increases effective surface area.
- The height of the nanoporous film can be controlled quantitatively.
- The L2ePt electrode shows lowest electrode impedance at roughness factor 200 (roughness factor=effective surface area/geometric area).
- The electrode is mechanically robust (long term storage and repeated uses are possible).

Ⅱ. MATERIALS AND METHODS

- ◆ The L2ePt electrodes (6mm x 6mm) were fabricated through electrodeposition of an electroplating Pt solution on a Pt foil [1].
- ◆ The electrode impedance was measured for an electrode in physiological saline solution (0.9% NaCl) using an impedance analyzer (20~1000Hz) [2].
- ◆ During eye-closed cycles the alpha rhythms were recorded simultaneously from Ag/AgCl, FlatPt, and L2ePt electrodes on the forehead.

Ⅲ. RESULTS

A. Electrode fabrication

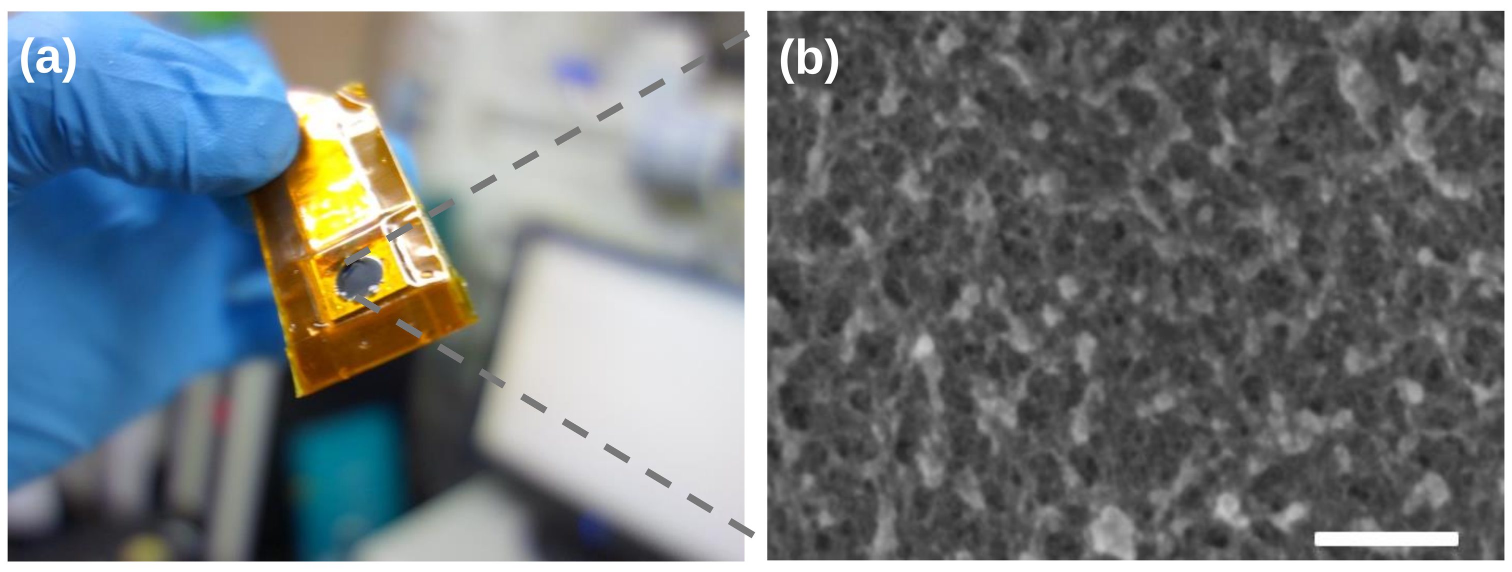

Fig. 2. (a) A sample of the L2ePt electrode. (b) SEM image (x300K) of the nanoporous surface of the L2ePt electrode (Bar indicates 100nm).

- ◆ The fabricated L2ePt electrode showed a 200-fold increase in its effective surface area compared to those of the non-electrodeposited electrodes.

B. Impedance and signal quality comparison

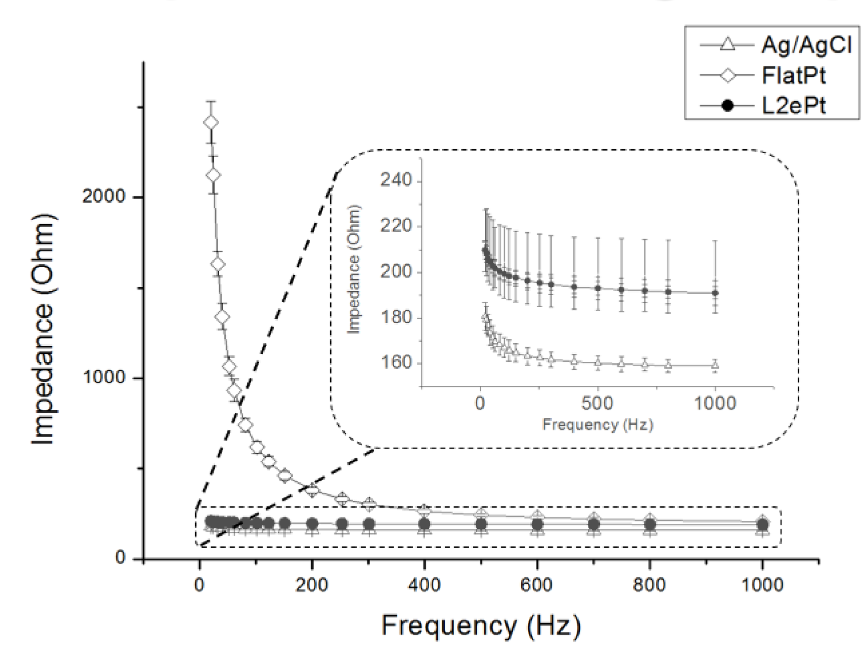

Fig. 3. The effect of the L2ePt in lowering the electrode impedance in saline

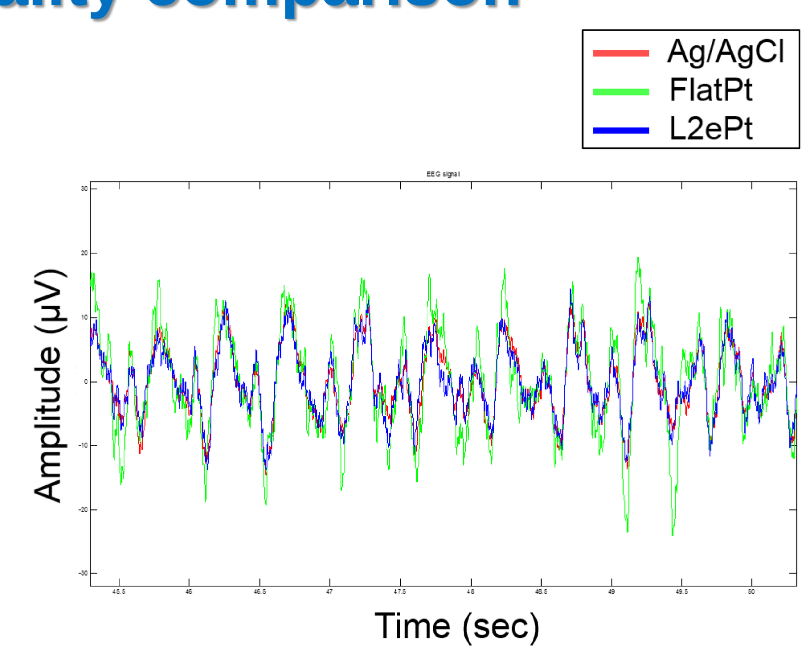

Fig. 4. Comparison of the EEG signal acquisition performance

- ◆ The electrode impedance of the L2ePt electrode was similar to that of the Ag/AgCl in 0.9% NaCl solution.
- ◆ The contact impedance of the L2ePt electrode was lower than that of the FlatPt electrode by 50%.
- ◆ The L2ePt electrode acquired alpha rhythm with correlation of 0.91 compared to that of the Ag/AgCl.

Table1. Comparison of the three electrodes

	Ag/AgCl	L2ePt	FlatPt
Electrode impedance in solution at 20Hz (Ω)	180	209	2,100
Contact impedance at 20Hz (Ω)	1,500	25,000	50,000
Correlation coefficient	1.00	0.91	0.85

IV. DISCUSSION AND CONCLUSION

- ◆ The developed nanoporous surface effectively and conveniently lowers the contact impedance (50% lower than that of FlatPt).
- ◆ We demonstrated the feasibility of using the L2ePt electrode in EEG recording applications (0.91 correlation compared to Ag/AgCl).
- ◆ For future work, the L2ePt electrode needs to be tested in more BCI applications, such as auditory evoked potential or steady state visually evoked potential. These further investigations, using more user friendly electrode structure, will validate the practicality of the L2ePt electrode in actual BCI applications.

V. REFERENCES

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