Continuous glucose monitoring system with non enzymatic sensor

Inhyun Park[1], Hee Chan Kim[3], and Taek Dong Chung[2]

[1]Interdisciplinary Program, Biomedical Engineering Major, Graduate School, Seoul National University, Seoul, Korea
[2]Department of Chemistry, Seoul National University, Seoul, Korea
[3]Department of Biomedical Engineering, College of Medicine and Institute of Medical and Biological Engineering, Medical Research Center, Seoul National University, Seoul, Korea

I. Introduction

- Continuous glucose monitoring and corresponding insulin treatment is proved to be an effective method for both type1 and 2 diabetes.
- Hypoglycemic shock caused by aggressive insulin treatment can be avoidable by continuous glucose monitoring.
- Non enzymatic glucose sensor can enhance conventional method using glucose oxidase.
  - –O2 independent
  - –Robust to sterilization process

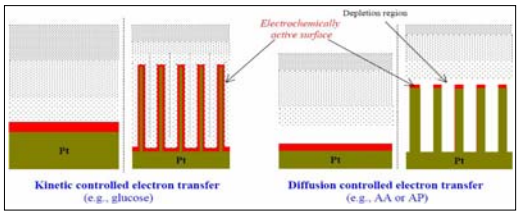
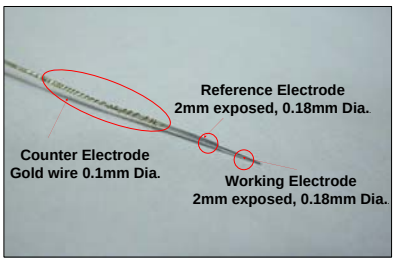


Figure 1. The working principle of non enzymatic glucose sensor. Relatively slow glucose oxidation process is kinetic controlled electron transfer while the oxidation process of AA or AP is diffusion controlled electron transfer. Thus the electrochemically active surface area of glucose oxidation is way broader than that of AA or AP oxidation.
–Anal. Chem. , 75, 2003, Page 3046–3049

II. Fabrication

A. Fabrication of wire type electrode



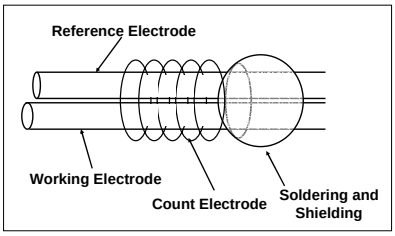


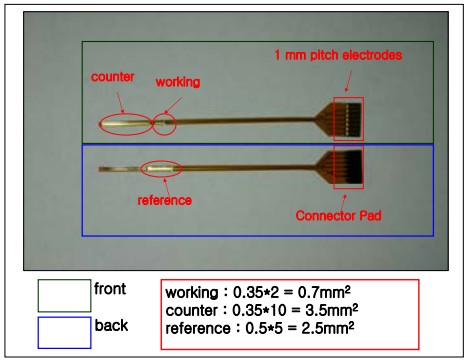
Figure 2. Schematic and image of fabricated wire type electrode

- Reference Electrode
  - –Nanoporous Pt on Pt iridium wire
  - –180μm diameter, 2mm tip exposed
  - –Poly mPD membrane
- Working Electrode
  - –Nanoporous Pt on Pt iridium wire
  - –180μm diameter, 2mm tip exposed
  - –Outer membrane
- Counter Electrode
  - –Nanoporous Pt on Gold wire
  - –0.1mm diameter, long enough to dissipate charge difference

B. Outer membrane

- Poly(mPD) electropolymerization and preconditioning
- Polyelectrolyte layer (alginate and Chitosan)
- PTFE
- Nafion

C. Fabrication of film type sensor



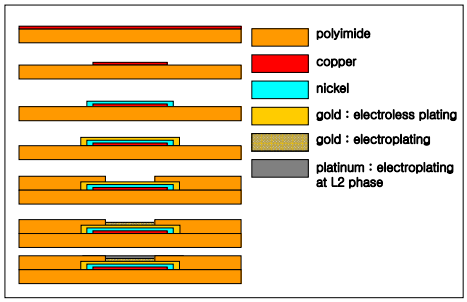


Figure 4. Image of film type electrode.

- Polyimide f-PCB (flexible printed circuit board) was used.
- Nanoporous platinum thin film was electroplated onto the gold electrode.
- After 3 day in Deionized water, the copper electrode was dissolved.

III. Results

A. Sensitivity and selectivity to glucose

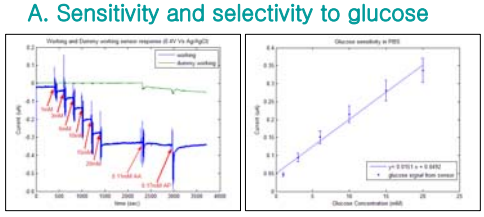


Figure 5. Working electrode responded to glucose selectively. 5 independent sensor response was collected and plotted. The R^2 was 0.98.

B. O2 independency

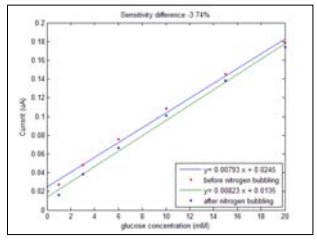


Figure 6. Sensor was not affected by the O_2 concentration. Difference between sensitivity in N_2 saturated solution and O_2 resolved solution was less than 4 percent.

C. Hysteresis characteristic

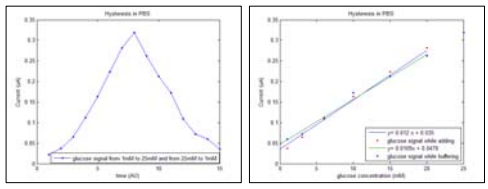


Figure 7. Hysteresis characteristic of the sensor was applicable. Difference between sensitivity in glucose adding and PBS dilution signal was less than 10 percent.

D. Glucose sensitivity test in human serum

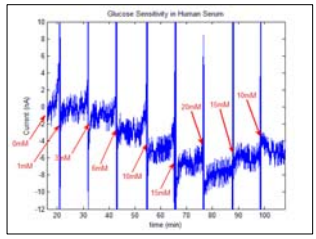


Figure 8. Sensor sensitivity for glucose in human serum. Whole blood was sampled and leaved in autoclave to drop the glucose concentration to zero then centrifuged.

IV. Conclusion

- Continuous glucose sensor system with non enzymatic glucose sensor was developed.
- Wire type and Film type sensor was fabricated.
  - –3 electrode system
  - –Commercial fPCB was used in film type sensor but the copper layer was found to be dissolved after 3 days of water contact.
- Selectivity and sensitivity to glucose, hysteresis characteristic, and O_2 independency of fabricated sensor was applicable.
- Glucose sensitivity in human serum for several hours was observed.
- In-Vivo test is in progress.