首届致远学术节
学生科研成果展示

Preparation and Characterization of First-Generation Glucose Sensors

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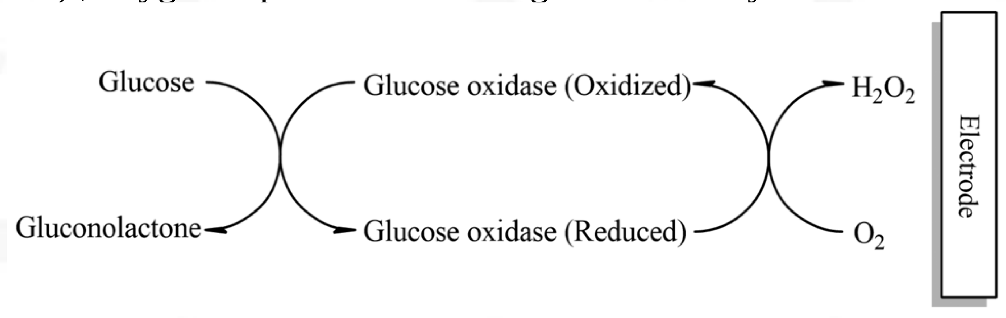
Introduction[1]

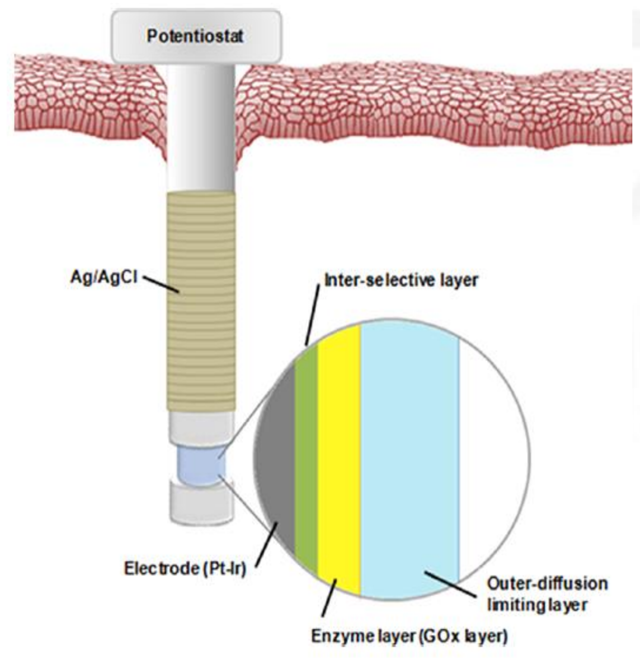
Amperometric enzyme electrodes, based on glucose oxidase (GOx), have played a leading role in the move to simple easy-to-use blood sugar testing and are expected to play a similar role in the move toward continuous glucose monitoring for a worldwide public health problem--diabetes mellitus.

First-generation glucose biosensors rely on the use of the natural oxygen cosubstrate and generation and detection of hydrogen peroxide. The major focuses are glucose linearity, electroactive interferences (like AA: Ascorbic Acid and APAP: Acetaminophen), oxygen dependence and long-term stability.



Keyword: Diabetes, Biosensors, Amperometry

Design[2]



- Inter-selective layer
1. PAA: Polyacrylic Acid
2. CAB: Cellulose Acetate Butyrate

- Enzyme layer
i. GOx: Glucose Oxidase Enzyme
ii. BSA: Bovine Serum Albumin
iii. GA : Glutaraldehyde
iv. PVP: Polyvinylpyrrolidone

- Outer limiting layer
i. Carbosil: Polyurethane and Silicone
ii. PVP: Polyvinylpyrrolidone

Test with +0.6V vs. Ag/AgCl , in 0.1M PBS (Phosphate Buffered Saline)

Results

a) PAA—Hydrophilic—Stable Signal

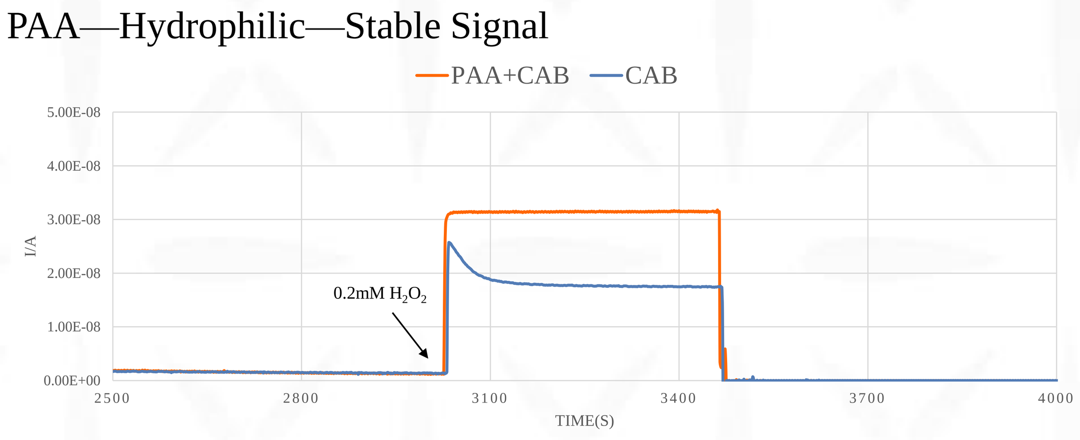


Figure 1. Detect H_2O_2 response from sensors with or without PAA

Conclusions
- PAA could get rid of the sensor signal drift phenomenon effectively
- PAA makes the electrical current more stable and increases sensor sensitivity

b) CAB plus Nafion—Crosslink—Better Selectivity

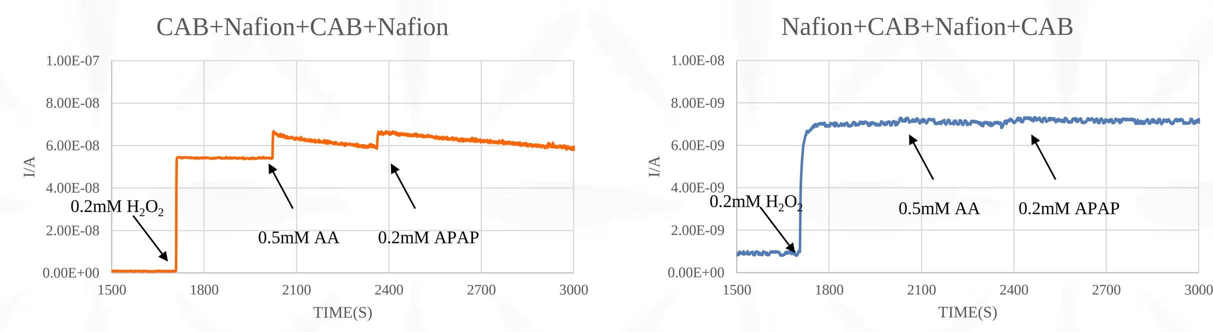


Figure 2. Detect interference response from sensors by coating selective layers in different sequence. Nafion is a sulfonated tetrafluoroethylene based fluoropolymer, which is commonly used polymer to diminish AA interference.

Conclusions
- The combining polymers of CAB and Nafion could improve the sensor selectivity
- The coating sequence of CAB and Nafion contributes to different anti-interference

c) PVP—High O_2 Solubility—Influence O_2 Dependence

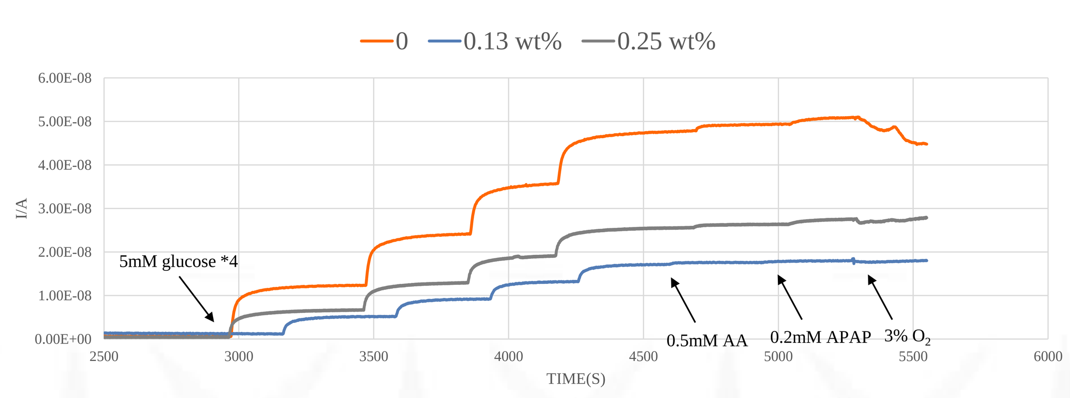


Figure 3. Compare O_2 dependence extent from sensors with different concentration of PVP (in enzyme layer)

Conclusion
- The PVP in the enzyme layer influences the sensor O_2 dependence, low concentration of PVP results to O_2 decreasing dependence while high concentration of PVP results to O_2 increasing dependence

d) Carbosil-PVP—Diffusion Limit and Unexpected Selectivity

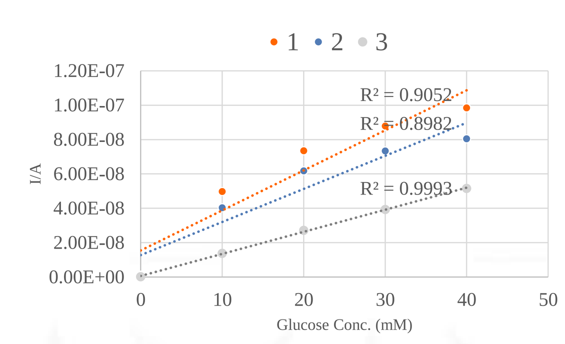


Figure 4. The glucose linearity of regular sensors with 1/2/3 layers of Carbosil-PVP

Conclusion
- Certain numbers of Carbosil-PVP layers could improve the glucose linearity

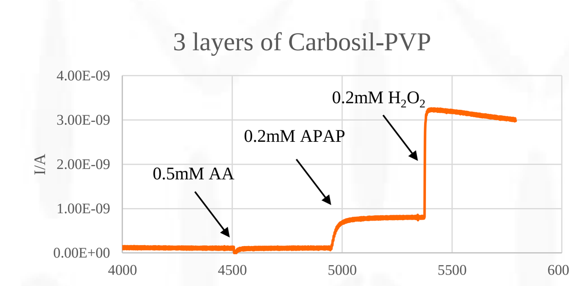
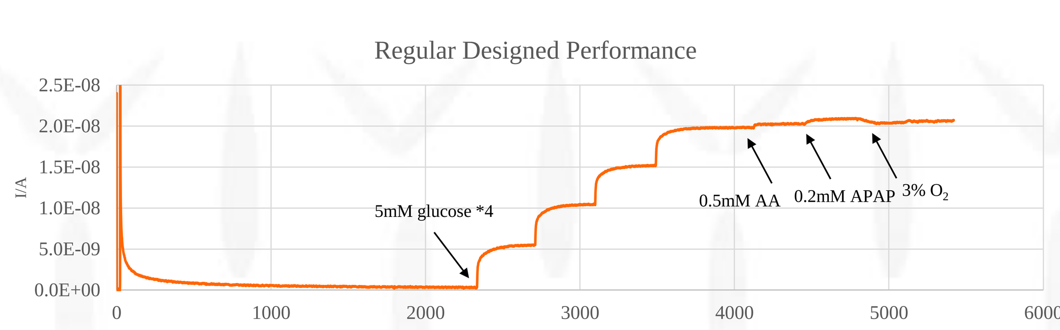


Figure 5. Detect interference response from sensors with only 3 layers of Carbosil-PVP

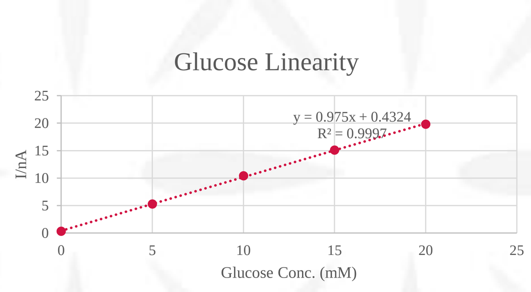
Conclusion
- Carbosil-PVP layers have special ability of preventing AA

Performance

a)



b)



c) Selectivity and O_2 Dependence

0.2mM AA / 5mM Glucose	0.106383
0.5mM APAP / 5mM Glucose	0.12766
3% O_2 / 5mM Glucose	-0.10638

Figure 6. The performance of regular well-designed sensors

Others

Future works
- Optimize the fabrication and coating method
- Characterize the polymers by Atomic Force Microscopy (AFM)
- More sensors for blood and *in vivo* test
- Combine with NO release and insulin cannula

References

[1] Wang, Joseph. "Electrochemical Glucose Biosensors." Chemical Reviews 108.2 (2008): 814-825.
[2] Nichols, Scott P., et al. "Biocompatible Materials for Continuous Glucose Monitoring devices." Chemical Reviews 113.4 (2013): 2528-2549.

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