Fabrication of various carbon electrode arrays for enhancing electrochemical signals using redox cycling

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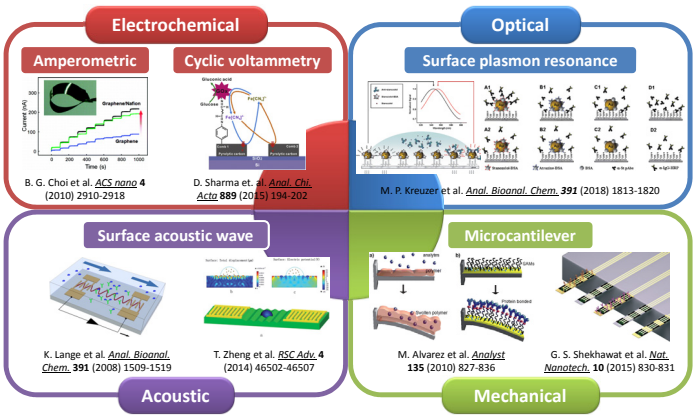
Introduction

❑ Sensing schemes commonly used in biosensors



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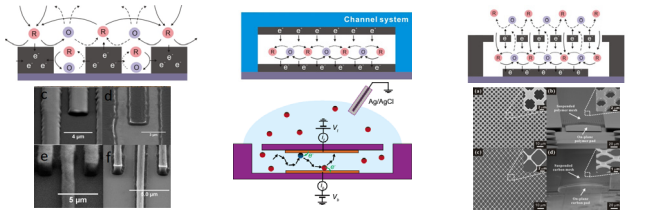
❑ Redox cycling based bio-sensing platforms



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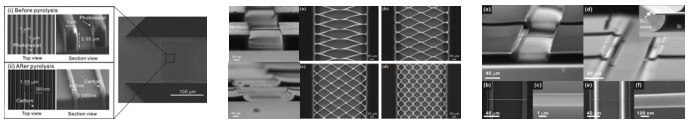
❑ Carbon-MEMS



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Computational Methods

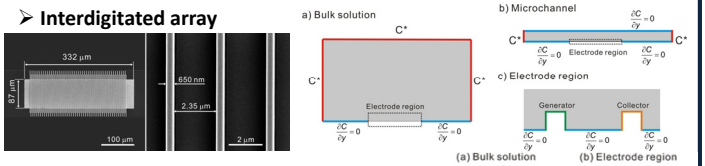
❑ Simulation of concentration profiles (w/ redox cycling)

$$\frac{\partial C}{\partial t} = \nabla \cdot (D \nabla c)$$

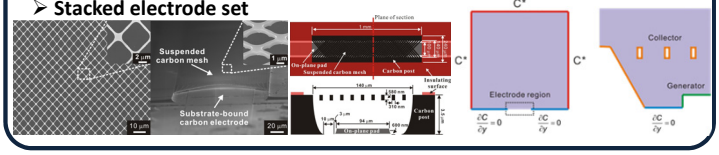
C : Concentration
D : Diffusivity of the redox species
for $Fe(CN)_6^{4-}/Fe(CN)_6^{3-}$ (6.7×10^{-6} cm²/s)

❑ Boundary conditions in the numerical simulation

➢ Interdigitated array



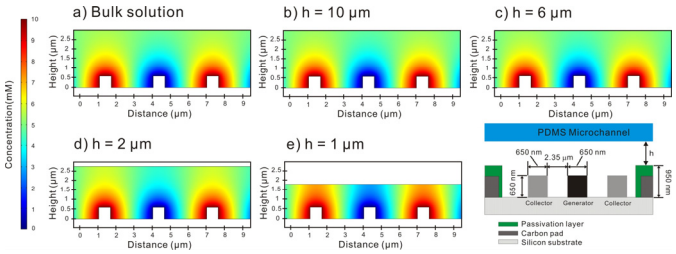
➢ Stacked electrode set



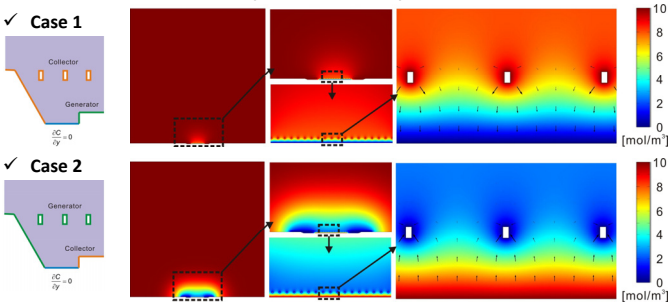
Results & Discussion

❑ Concentration profiles at the nanoelectrodes

➢ Interdigitated array

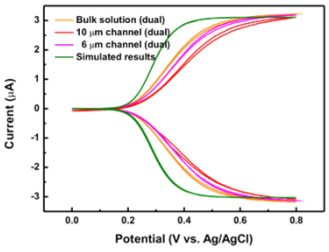


➢ Stacked electrode set (Suspended mesh + planar electrode)



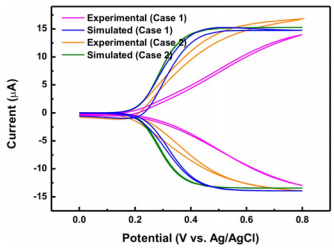
❑ Cyclic voltammetry

➢ Interdigitated array



	A. F.	C. E. (E)	C. E. (S)	Error
Bulk	10.8	96.8 %	96.2 %	3.9 %
10 mm	139	98.1%	99.4 %	0.3 %
6 mm	230	99.0%	100 %	3.0 %

➢ Stacked electrode set



	A. F.	C. E. (E)	C. E. (S)	Error
Case 1	34.7	94.7 %	92.9 %	6.4 %
Case 2	39.6	90.8 %	96.4 %	14.5 %

❖ A.F. : Amplification Factor
❖ C.E. : Collection Efficiency

Conclusion

➢ Development of carbon IDA nanoelectrode and stacked electrode set enabling the amplification of electrochemical current signals up to ~40 times.
➢ Good agreement between simulation and experimental results in the redox cycling effect.
➢ These carbon electrode arrays are expected to be utilized in various biosensor applications because of the high current amplification and simple fabrication methods.

Reference

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