BIOSENOSRS

BIO 580

Electrochemical Biosensors - theory part 2

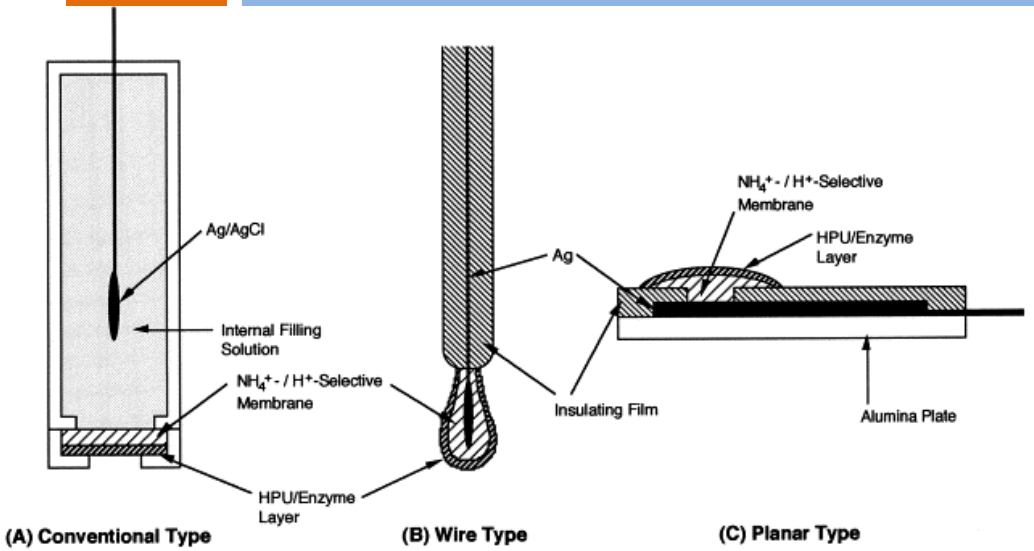
Some examples for potentiometric biosensors

Week-2

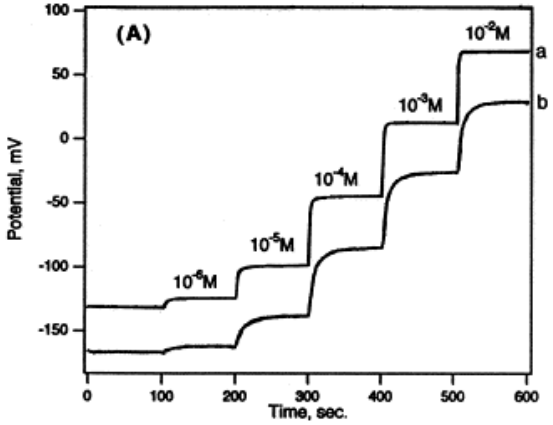
Fall Semester

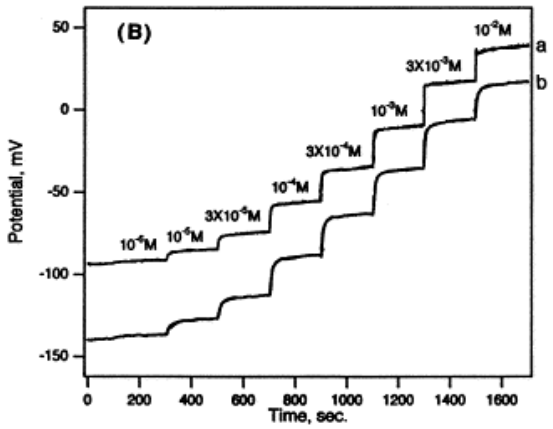
Faculty: Dr. Javed H. Niazi KM
Faculty of Engineering & Natural Sciences
Sabanci University

Potentiometric biosensors - Eg.,

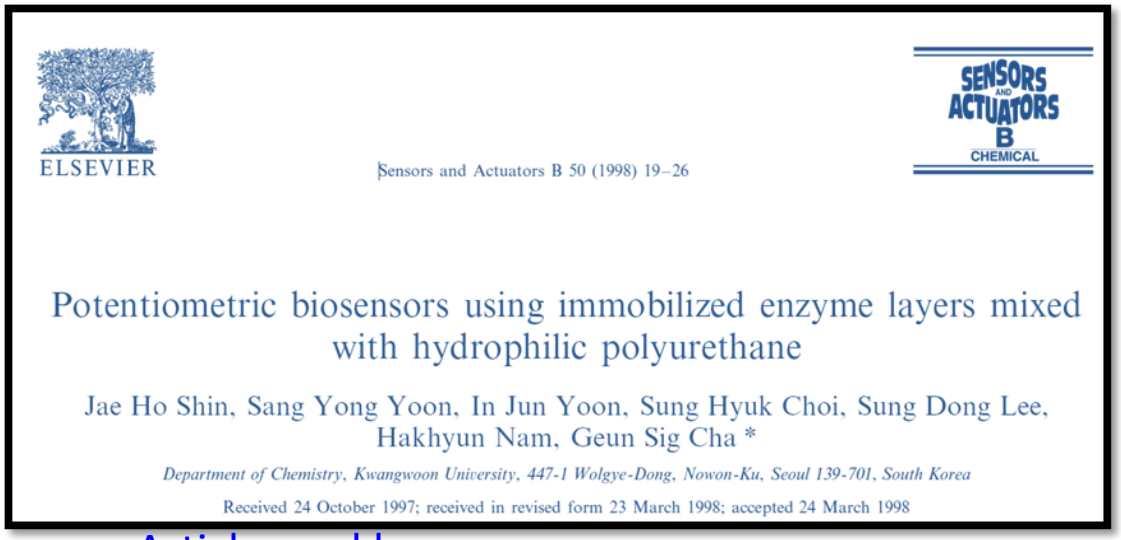


Schematic drawing of biosensors: (A) conventional type; (B) solid-state wire type; and (C) solid-state planar type.





Dynamic response toward ammonium (A) and adenosine (B) for wire type biosensors with (a) thin and (b) thick HPU/ADA films.



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Sensors and Actuators B 50 (1998) 19–26

SENSORS AND ACTUATORS B CHEMICAL

Potentiometric biosensors using immobilized enzyme layers mixed with hydrophilic polyurethane

Jae Ho Shin, Sang Yong Yoon, In Jun Yoon, Sung Hyuk Choi, Sung Dong Lee, Hakhyun Nam, Geun Sig Cha *

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Received 24 October 1997; received in revised form 23 March 1998; accepted 24 March 1998

Article read here

Example 2

Biosensors and Bioelectronics 25 (2009) 406–410

Contents lists available at ScienceDirect

Biosensors and Bioelectronics

journal homepage: www.elsevier.com/locate/bios

Regular paper

Comparison of enzyme immobilisation methods for potentiometric phosphate biosensors

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ABSTRACT

The development of two phosphate biosensors is described and compared for potentiometric detection of phosphate. Purine nucleoside phosphorylase (PNP) and xanthine oxidase (XOD) were co-immobilised

$$\text{Inosine} + \text{Orthophosphate} \xrightarrow{\text{PNP}} \text{Ribose-1-phosphate} + \text{Hypoxanthine} \quad (1)$$

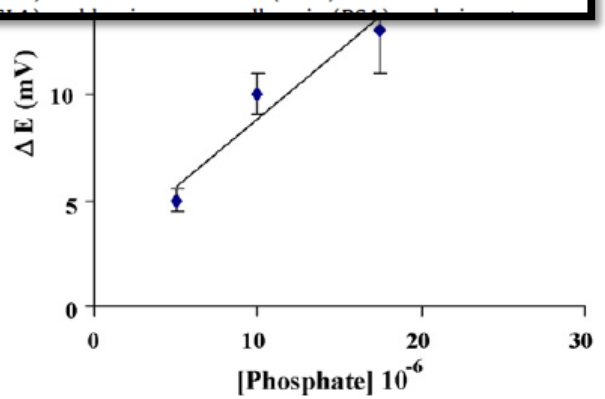
and

$$\text{Hypoxanthine} + 2H_2O + 2O_2 \xrightarrow{\text{XOD}} \text{Uric acid} + H_2O_2 \quad (2)$$

0.05 M

XOD:PN

4.5 %, c



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Example 3 - Cell based potentiometric biosensor

Available online at www.sciencedirect.com
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ELSEVIER
Biosensors and Bioelectronics 20 (2005) 1757–1763
BIOSENSORS & BIOELECTRONICS
www.elsevier.com/locate/bios

Cell-based biosensors based on light-addressable potentiometric sensors for single cell monitoring

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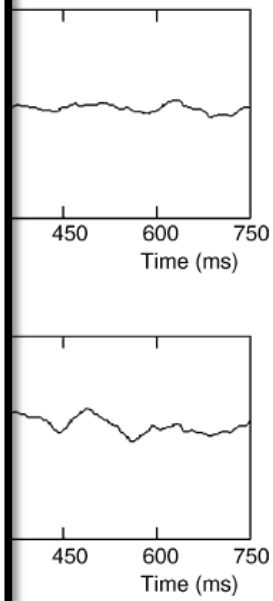
Biosensor National Special Laboratory, Key Laboratory of Biomedical Engineering of the Ministry of Education, Department of Biomedical Engineering, P.O. Box 1590, Zhejiang University, Hangzhou 310027, China

Received 3 March 2004; received in revised form 22 June 2004; accepted 29 June 2004
Available online 7 August 2004

Abstract

Cell-based biosensors incorporate cells as sensing elements that convert changes in immediate environment to signals for processing. This paper reports an investigation on light-addressable potentiometric sensor (LAPS) to be used as a possible cell-base biosensor that will enable us to monitor extracellular action potential of single living cell under stimulant. In order to modify chip surface and immobilize cells, we coat a layer of poly-L-ornithine and laminin on surface of LAPS chip on which rat cortical cells are grown well. When 10 μg/ml acetylcholine solution is administrated, the light pointer is focused on a single neuronal cell and the extracellular action potential of the targeted cell is recorded with cell-based biosensor based on LAPS. The results demonstrate that this kind of biosensor has potential to monitor electrophysiology of living cell non-invasive for a long term, and to evaluate drugs primarily.



sensor under the effect of acetyl-
effect of culture medium. (b) Ex-
ased biosensor under effect of Ach
rp rise in the peak represents about
of the second part of the peak (the
itude about 10.025 μV.

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Suggested reading

Recent developments in potentiometric biosensors for biomedical analysis (click here to read the article)

Label type: Bioca
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Analytica Chimica Acta 599 (2007) 7–15
ANALYTICA CHIMICA ACTA
www.elsevier.com/locate/aca

ox, pH and
chemical
bserved shift

Review

Recent developments in potentiometric biosensors for biomedical analysis

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Received 19 June 2007; received in revised form 30 July 2007; accepted 2 August 2007
Available online 6 August 2007

Abstract

A large variety of potentiometric biosensors is developed using biocatalytic and bioaffinity-based biosensing schemes. However, only few of them could be applied for the biomedical analysis. The most promising are those for the detection of main products of protein metabolism, namely urea and creatinine. A novel group of potentiometric biosensors is constituted by bioaffinity-based devices that could be used for immunoassays or genoanalysis. This paper reviews the recent trends in these fields as well as discusses advantages, limitations and pitfalls of the developed biosensors. Some potentiometric biosensors useful for real biomedical analysis are reported in detail.

Keywords: Clinical analysis; Potentiometry; Biosensors; Biocatalysis; Bioaffinity

Contents

Ion Selective Electrodes - eg., type 1

Silver nanoparticles as redox markers- Nanotechnology

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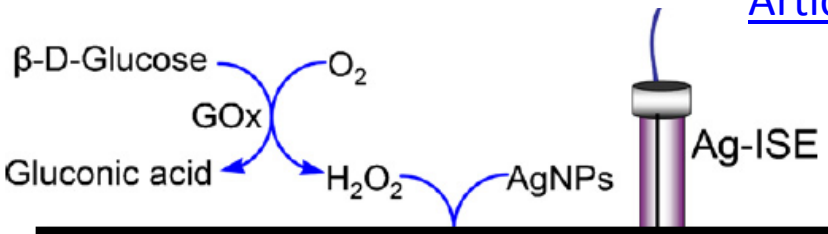

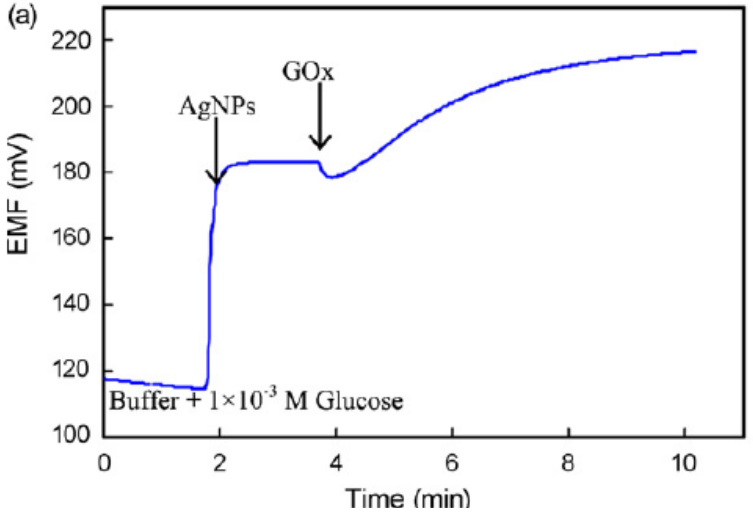

Sensors and Actuators B 137 (2009) 320–326

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Sensors and Actuators B: Chemical

journal homepage: www.elsevier.com/locate/snb

Novel potentiometric approach in glucose biosensor using silver nanoparticles as redox marker

Wittaya Ngeontae[a,b], Wanwisa Janrungroatsakul[a], Pattwat Maneewattanapinyo[a], Sanong Ekgasit[a], Wanlapa Aeungmaitrepirom[a], Thawatchai Tuntulani[a,*]

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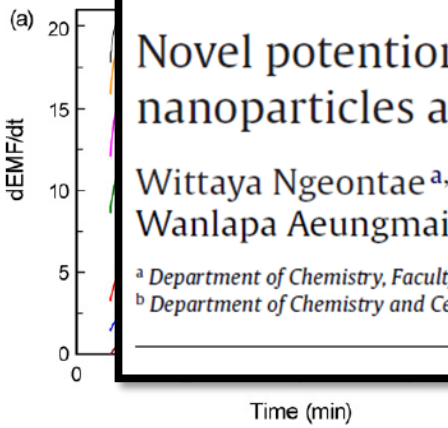
[b] Department of Chemistry and Center of Excellence for Innovation in Chemistry, Faculty of Science, Khon Kaen University, Khon Kaen 40002, Thailand



Ion Selective Electrodes- type 2

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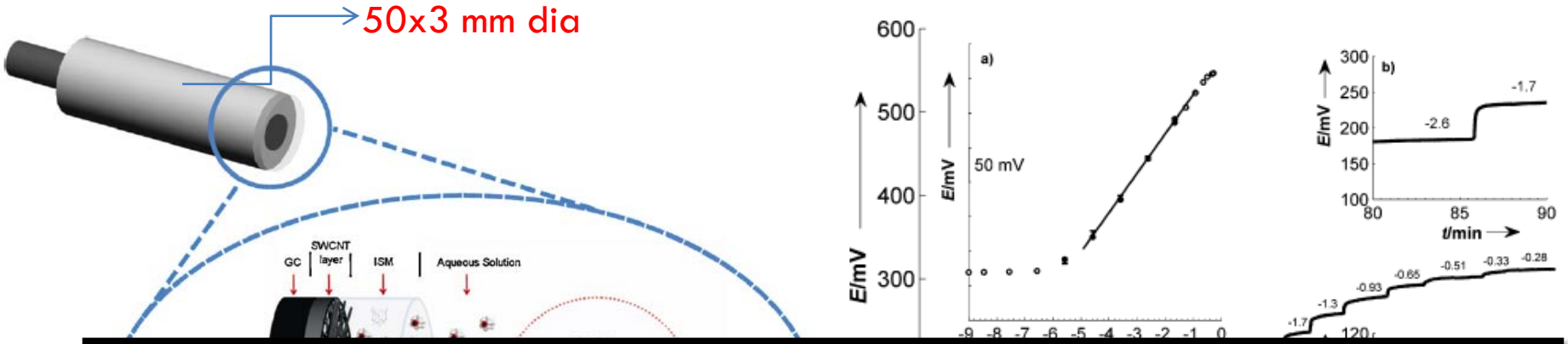

Biosensors and Bioelectronics 25 (2009) 344–349

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Biosensors and Bioelectronics

journal homepage: www.elsevier.com/locate/bios

Schemat
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electron
SWCNT

Determination of choline and derivatives with a solid-contact ion-selective electrode based on octaamide cavitand and carbon nanotubes

Jordi Ampurdanés[a], Gastón A. Crespo[a], Alicia Maroto[a], M. Angeles Sarmentero[b], Pablo Ballester[b,c,**], F. Xavier Rius[a,*]

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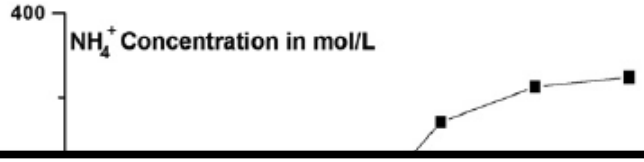
[b] Institute of Chemical Research of Catalonia (ICIQ) Av. Països Catalans, 16 43007 Tarragona, Spain
[c] Catalan Institution for Research and Advanced Studies (ICREA), Pg. Lluís Companys 23, 08010 Barcelona, Spain

[Article here]

Ion Selective Electrodes- type 3



Urease/PCS+PEI

Sensors and Actuators B 140 (2009) 260–266

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Sensors and Actuators B: Chemical

journal homepage: www.elsevier.com/locate/snb

Potentiometric biosensor for urea determination in milk

U.B. Trivedi[a], D. Lakshminarayana[a], I.L. Kothari[b], N.G. Patel[c], H.N. Kapse[d], K.K. Makhija[a], P.B. Patel[a], C.J. Panchal[e,*]

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Example of the three-electrode screen-printed sensor produced by BVT (Brno, Czech Rep.). The sensor body is made from ceramics. A gold working electrode (a) is surrounded by an Ag/AgCl reference electrode (b) and gold auxiliary electrode (c). Letter d means silver output contacts. The ruler in the bottom is in millimeter scale.

[www.zsf.jcu.cz/jab/6_2/pohanka.html]

Article here

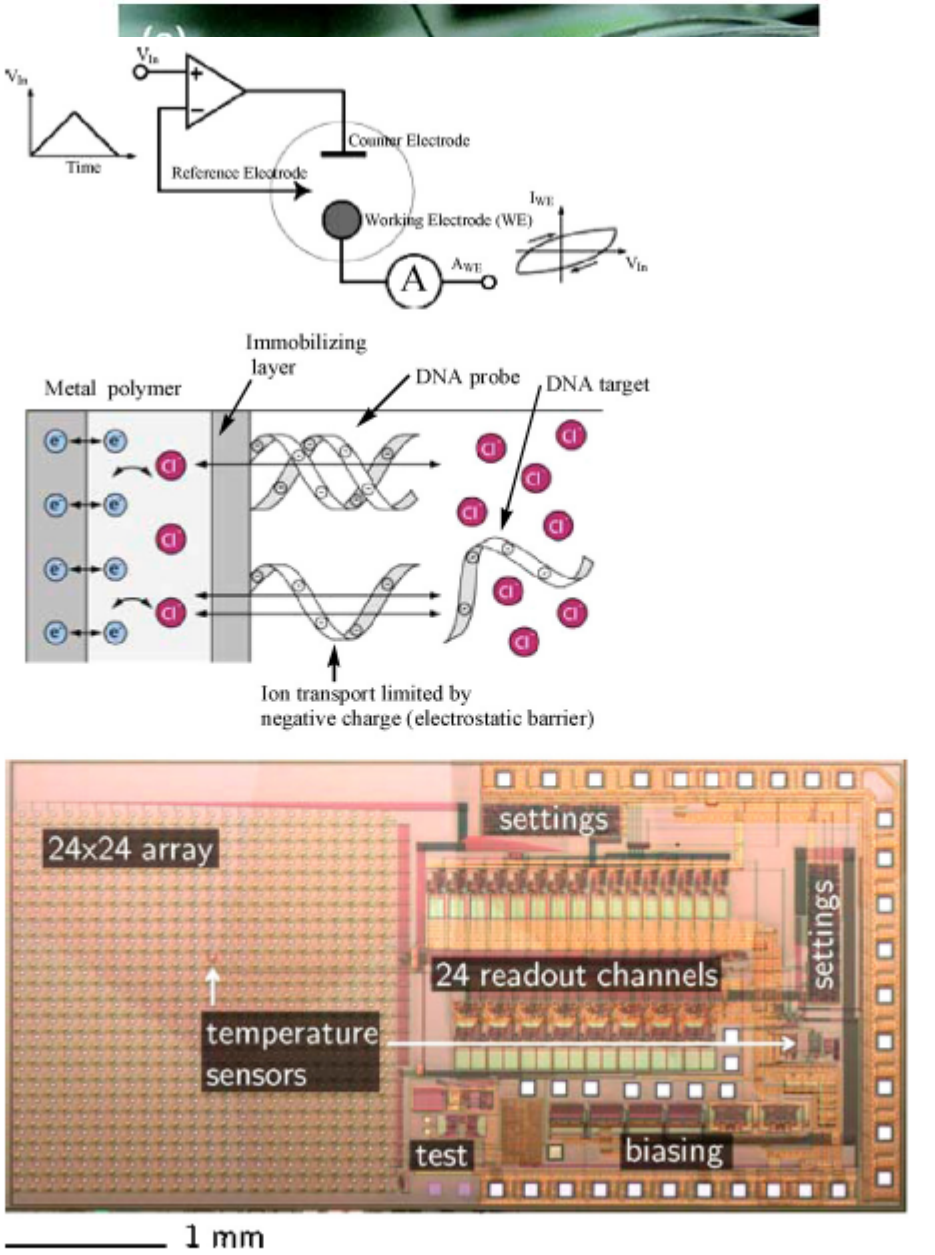

Fig. 3. Measurement principle chloride-counter ion travel kinetics are influenced by the extent of hybridization. A redox cycle is applied to the electrode and the electroactive polymer. CMOS Chip System Micrograph The chip contains electrodes, potentiostats, A/D converters and some digital circuitry units. Illustration of a cyclic voltammetry experiment and description of the label-free electrochemical DNA hybridization detection principle (TOP); The chip micrograph contains electrodes, potentiostats, A/D converters and some digital circuitry units (bottom) (reprinted with the permission from Heel, F. (2008). Copyright 2008 IEEE.

Labeled Vs Label free biosensors

Table 1
Comparing label vs. label-free electrochemical detection.

Labeled	Label-free
Utilize electroactive signal generating labels, e.g., enzymes, ferrocene, $Fe(CN)_6^{3-/4-}$; $Ru(bpy)_3^{3+/2+}$; $Os(bpy)_3^{3+/2+}$; methylene blue)	Detects a physical change in the system as a result of the biomolecular recognition
Labeled biosensors are more sensitive due to the amplification afforded by the enzymatic reaction or electroactive label	Less sensitive especially to molecular recognition involving small molecules, e.g., haptens, Ab–Ag
Requires additional steps (labeling and substrates enzymatic reaction)	Require fewer steps (no labeling step)
Additional steps increase the probability of error	More amenable to miniaturization
Electroactive label may require high redox potential, which may destroy the specificity of the biorecognition elements.	Suitable for both in-situ and ex-situ measurements (especially EIS)
	May facilitate the regeneration of the electrode surface using selected potential modulation (e.g., PAD).

Among the most valuable labels -> enzymes such as peroxidase, glucose oxidase (GOx), alkaline phosphatase, catalase or luciferase;

Electroactive compounds such as ferrocene or In^{2+} salts and a series of fluorescent labels including Cy5, ruthenium diamine complexes, phosphorescent porphyrin dyes and Alexa Fluor dyes