

What is LAPS???

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문현석

Introduction

- LAPS based Biosensors became popular.
- First propose at *Science*(1988) by D.G. Hafeman and etc.
- **L**ight-**A**dressable **P**otentiometric **S**ensor
- Detection and Verification
 - *Salmonella typhimurium* (1999)
 - *Escherichia coli* O157:H7 (1998)
 - bacterial DNA (1997)
 - biological warfare (2000)

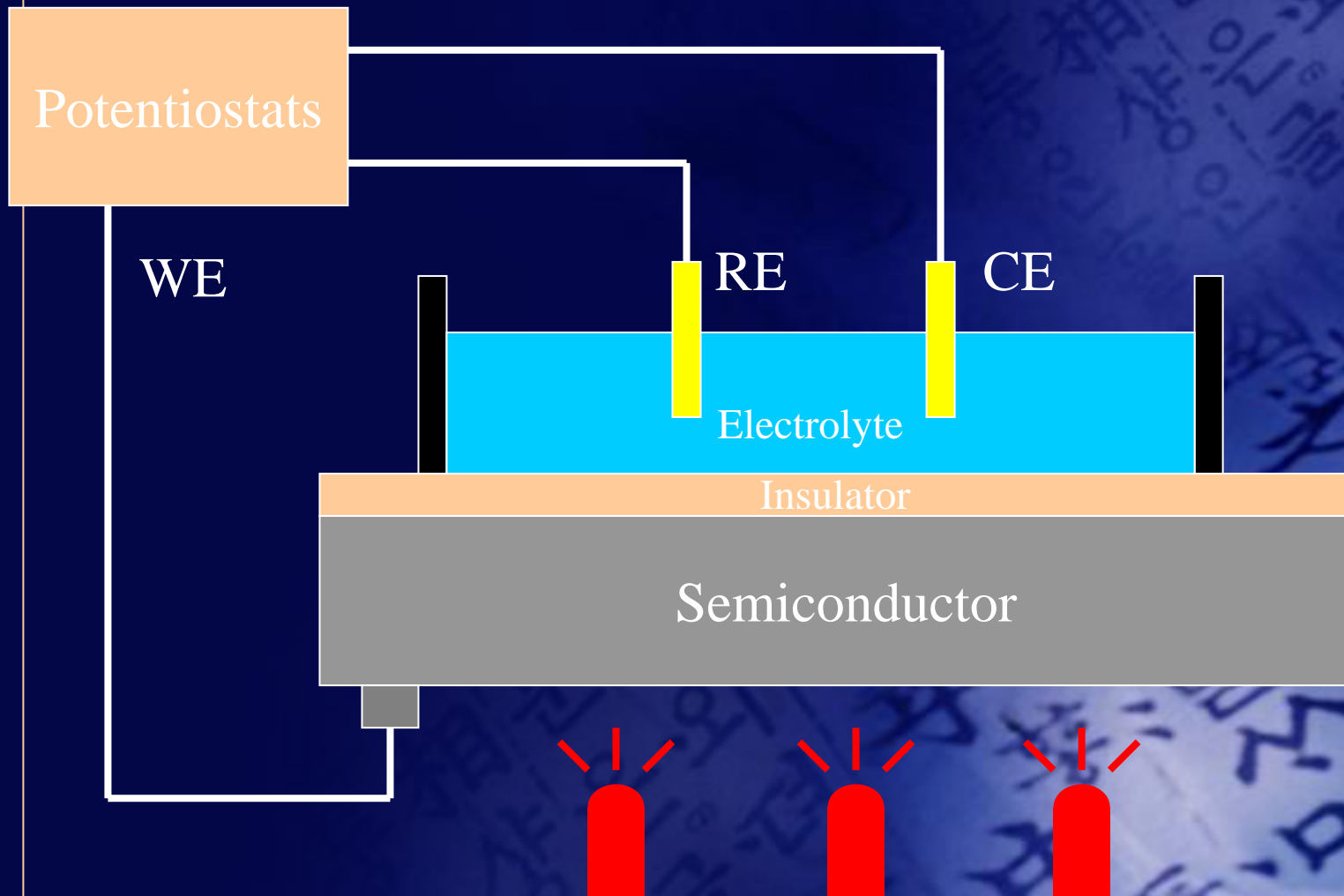
LAPS is...

- A kind of ion-sensitive FET(ISFET)
- Electrolyte / Insulator / Semiconductor structure
- Sensitive to surface potential or pH
- Light-Addressable?
 - By illuminating the part of the semiconductor surface, a photocurrent flow according to the local surface potential or the pH.

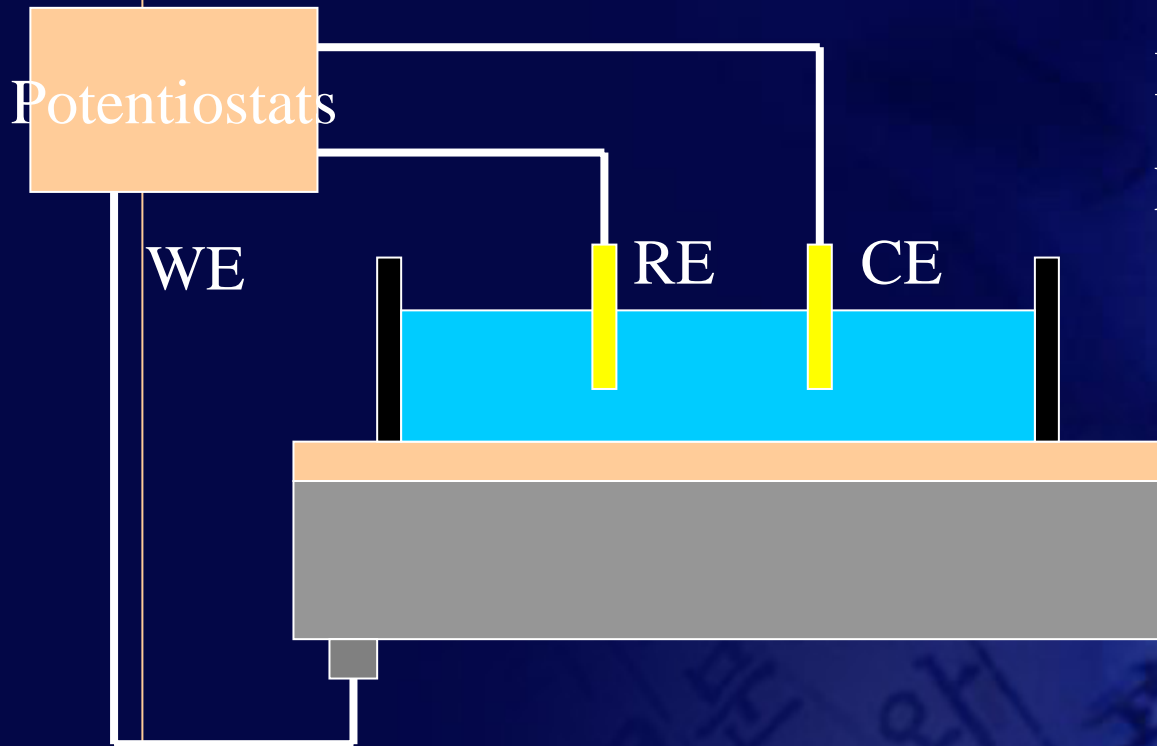
Advantage of LAPS

- Simple structure: Easy to fabricate
- Light-Addressable
 - No pre patterning is required
 - Light pointer decide sensing position
- Completely Flat surface
 - Optimization of the microchamber design
 - And hydraulics
 - Good for microfluidic system

LAPS System Schmetic is...

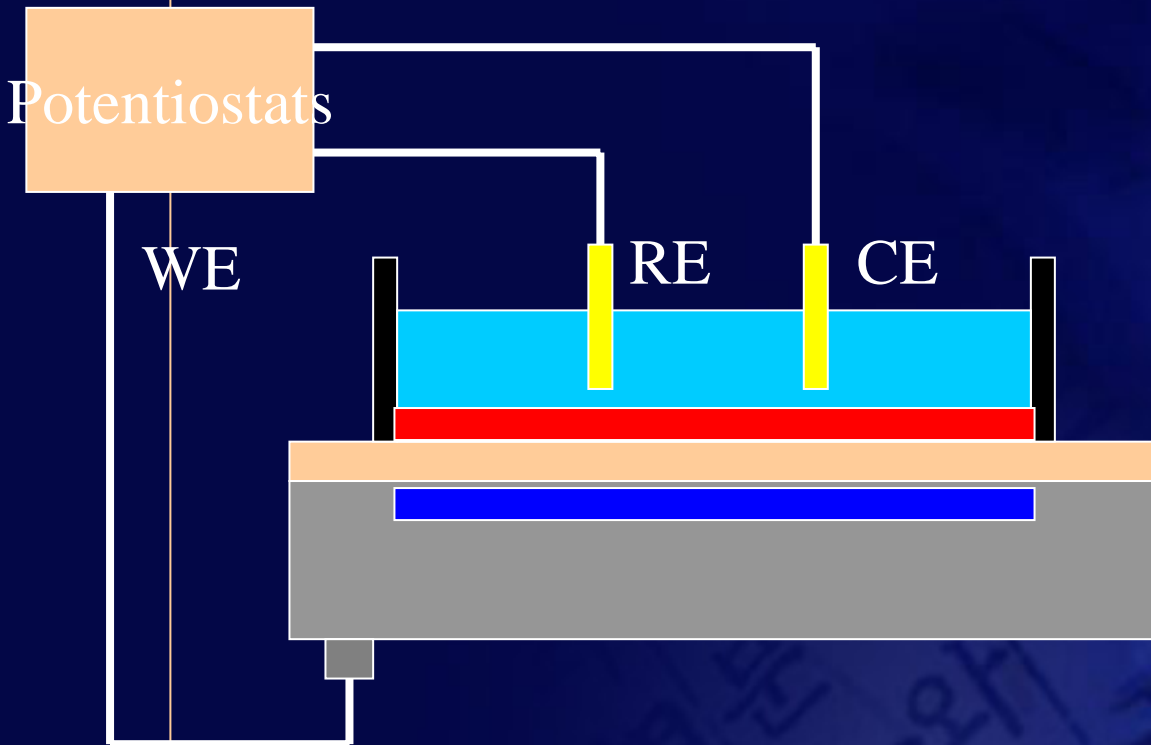


How LAPS works? (1)



In absence of illumination
Like MOS Capacitor

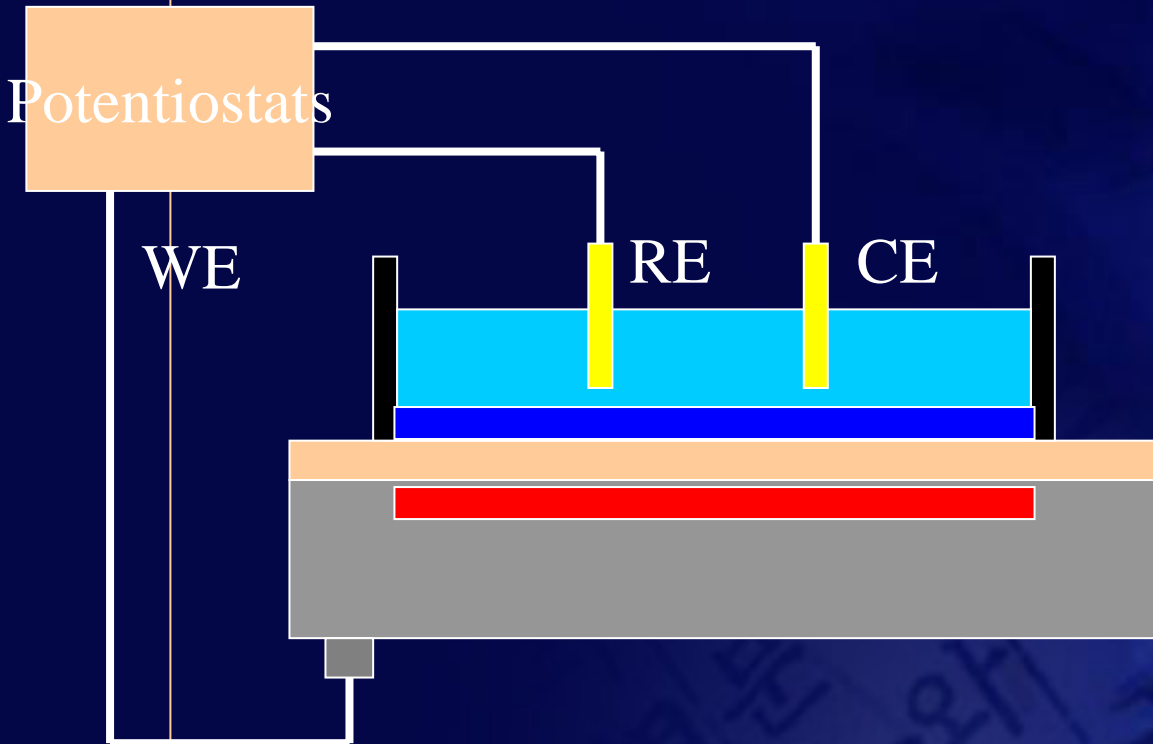
How LAPS works? (2)



Negative bias potential applied (if p-type Si)

Accumulation layer constructed to balance the surface potential

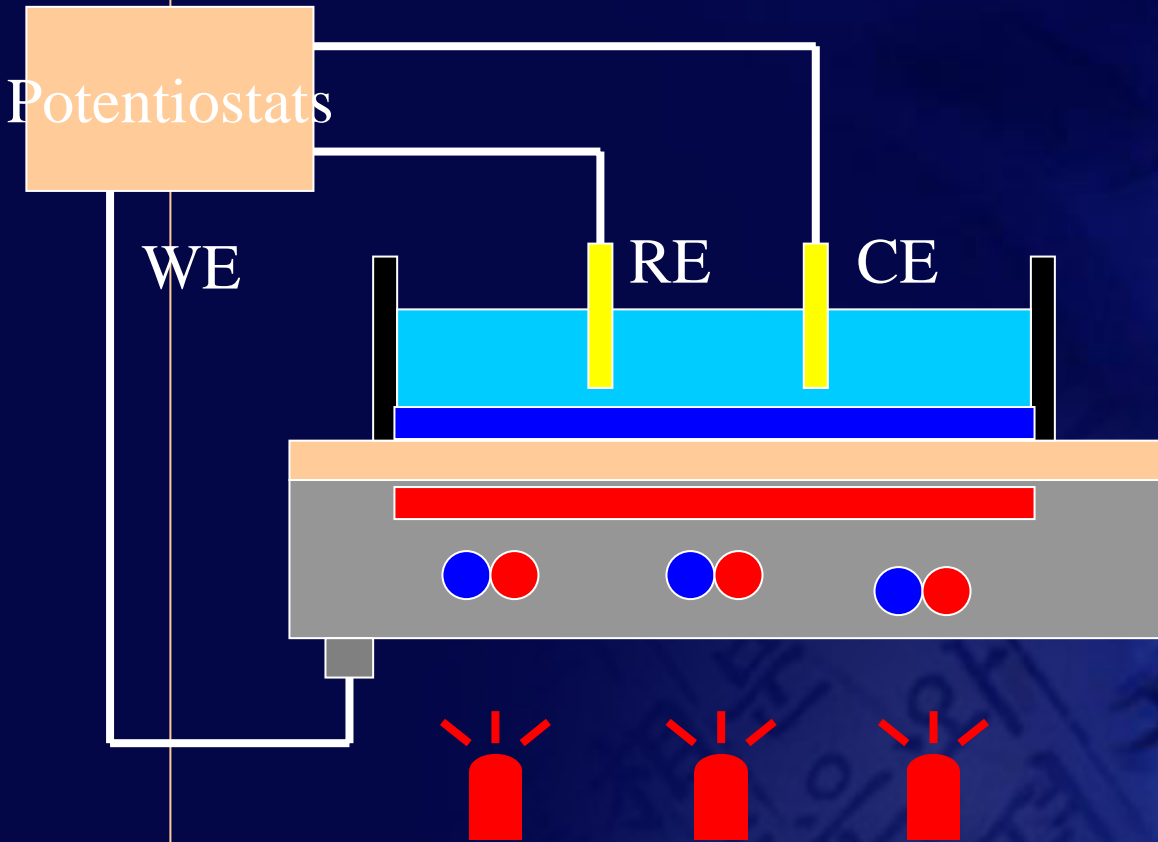
How LAPS works? (3)



If positive bias potential
($WE < RE$) applied (if p-
type Si)

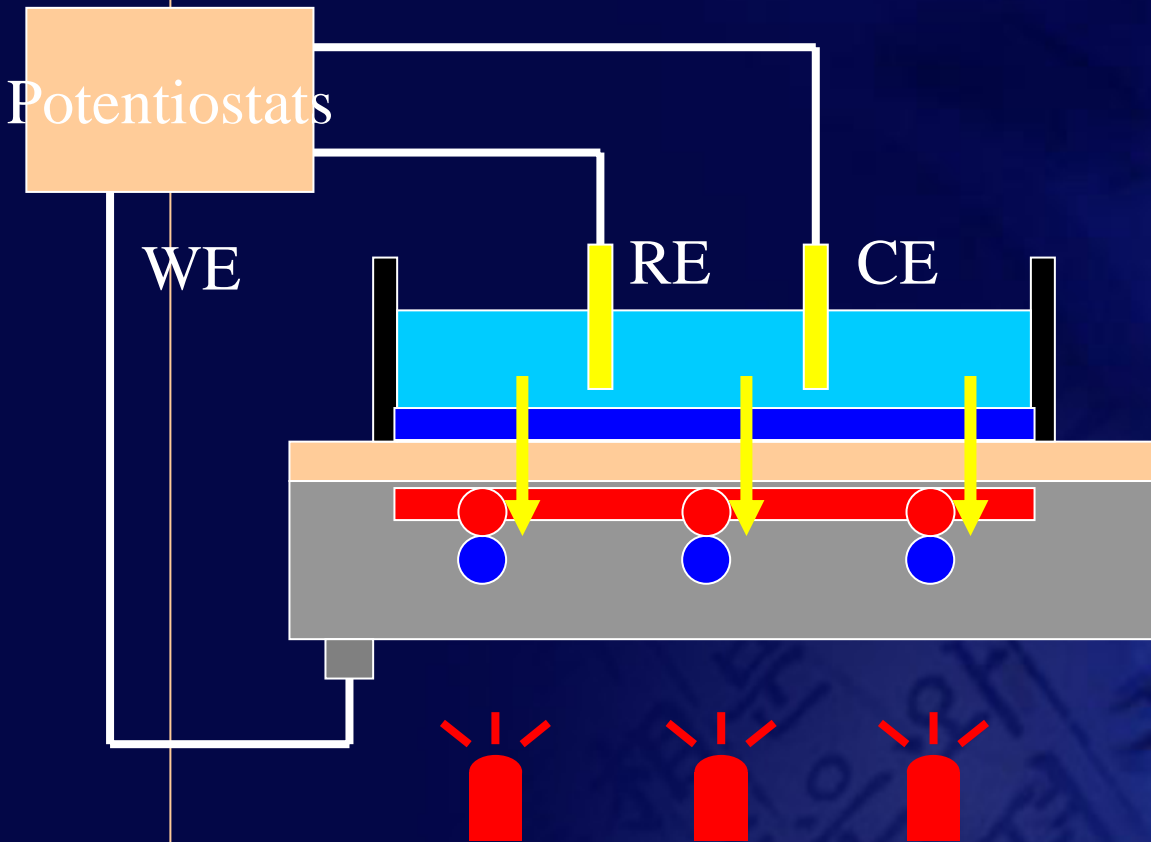
Depletion layer
constructed

How LAPS works? (4)



In presence of Illumination
Electron-Hole pair
generated in the
semiconductor

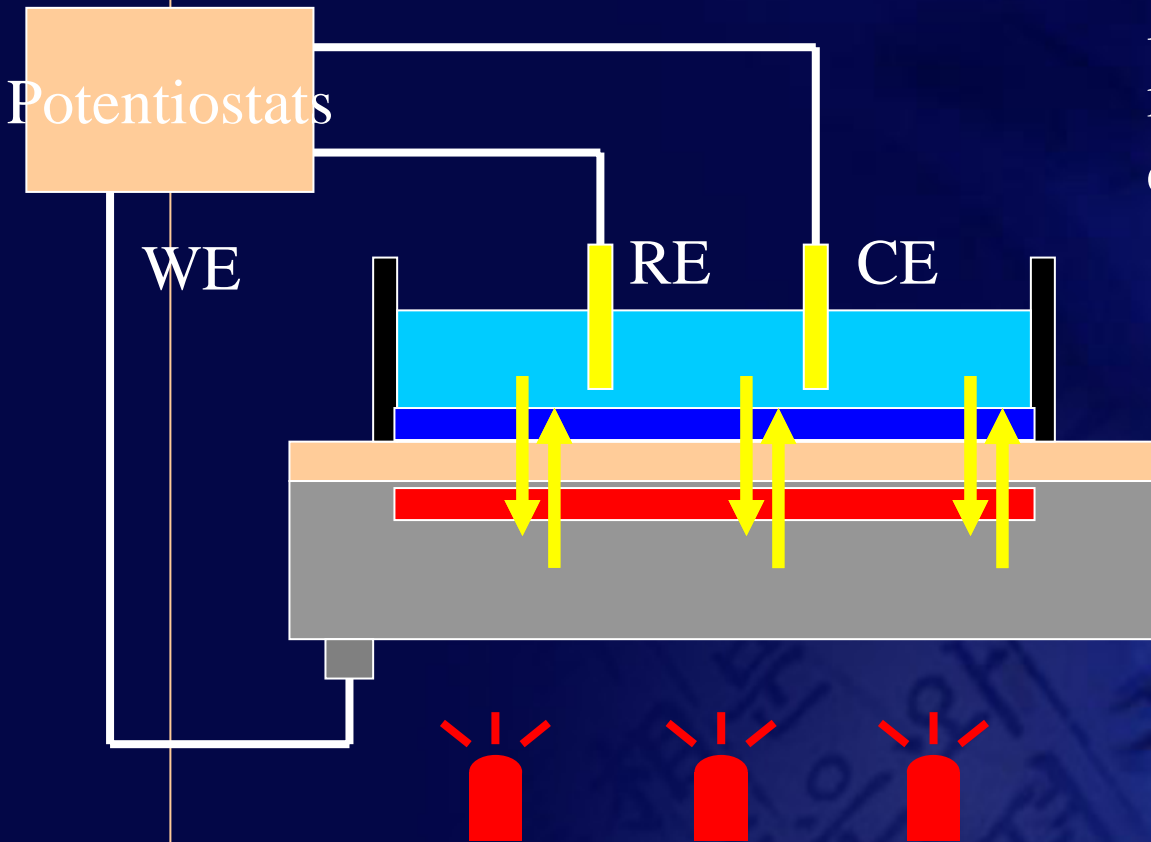
How LAPS works? (5)



And Separated by electric field

Transient current generated

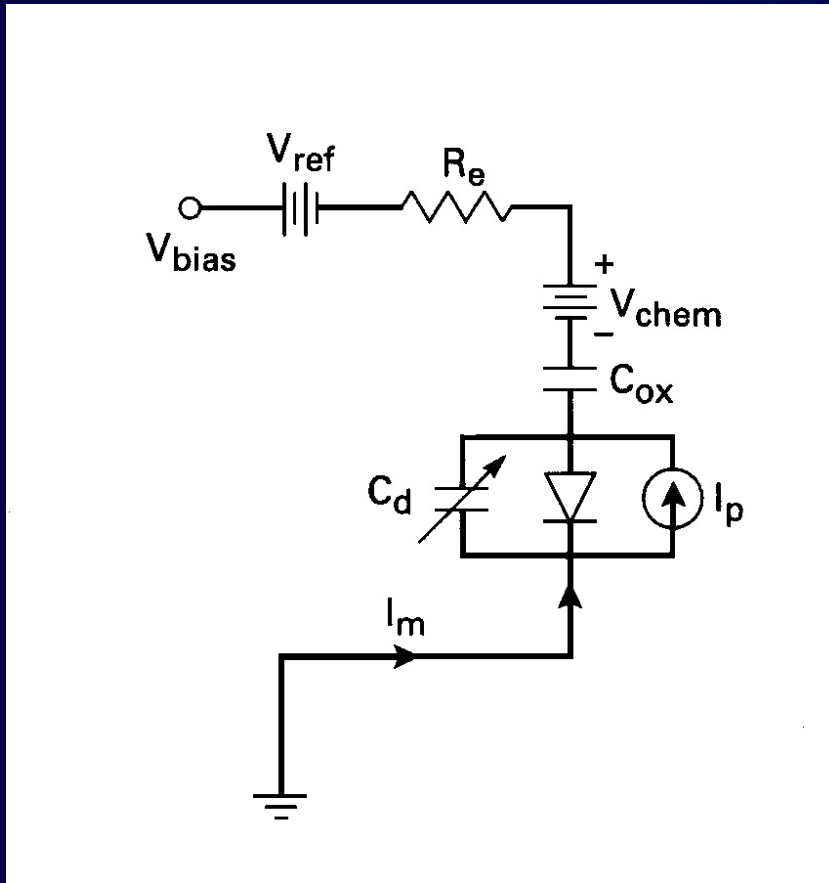
How LAPS works? (6)



If the Intensity of light is modulated, an alternating current is generated.

$$I_p = \frac{C_{ox}}{C_{ox} + C_d} |I_p|$$

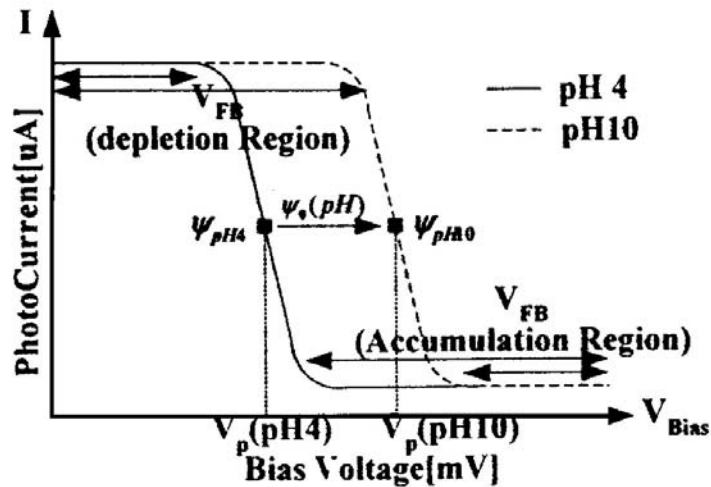
How LAPS works? (7)



- The measure photocurrent $|I_m|$
- Generate current by electron-hole pair $|I_p|$
- has this relationship

$$|I_m| = \frac{C_{ox}}{C_{ox} + C_d} |I_p|$$

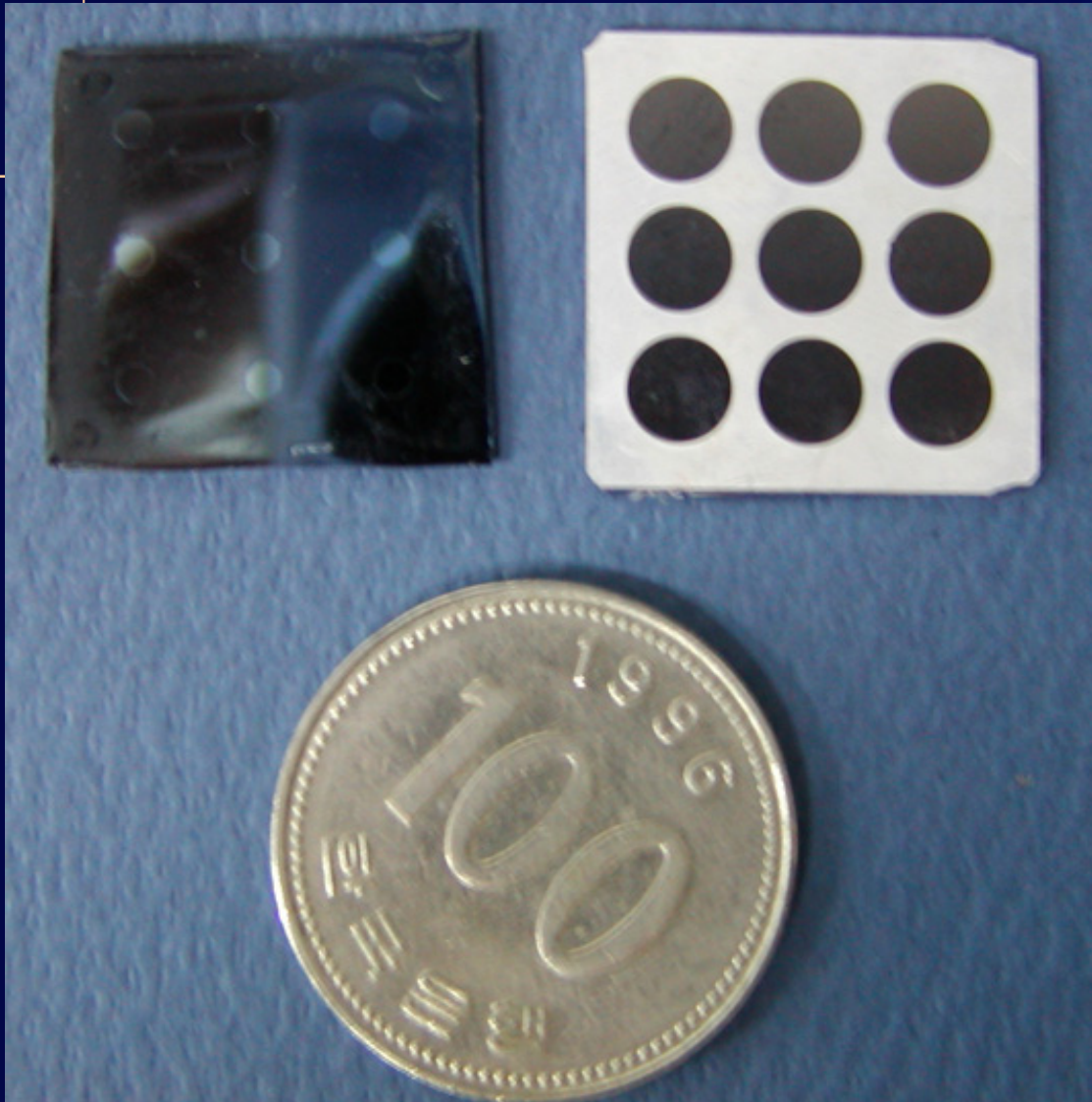
How LAPS works? (8)



- According to Bias voltage, Cd changes.
- Then $|I_m|$ make a sigmoid curve.
- If chemically sensitive surface potential V_{chem} on the insulator surface changes, Cd changes.
- So the decreasing point of sigmoid shifts.

Sensor Fabrication

- 2x2 cm dimension
- P-type semiconductor
- 1000Å Si_3N_4 layer and 300Å SiO_2 layer
 - Insulator on the front side
- AlO_2 for ohmic contact
- 9 sensing site



Fabricated sensor

Immobilization

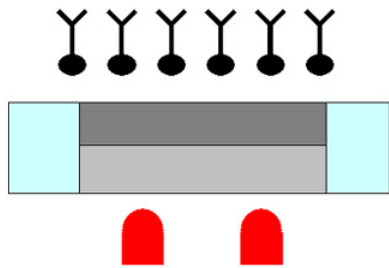
- For portable detection system
 - Based on the LAPS
 - Human pathogenic micro organism detection
- Fast and Easier method required
- =>Magnetic Bead based Bio-separation

Magnetic Bead

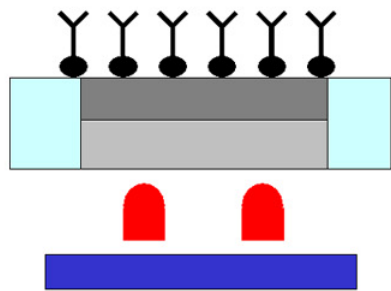
- Micro order size
 - 0.8~5.0 μm in diameter
- superparamagnetic particle
- High magnetic susceptibility
- No residual magnetization after external magnetic field is removed.

What is needed....

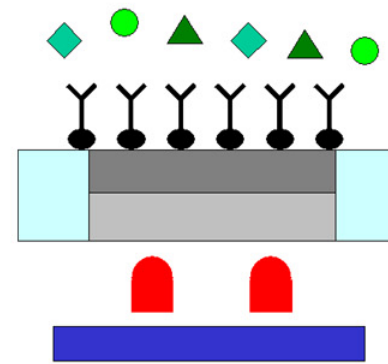
- Bead management system
 - Electromagnet or magnet control system
- Flow system
 - PDMS can be used??
- Antibody and antigen
- Need more Developement



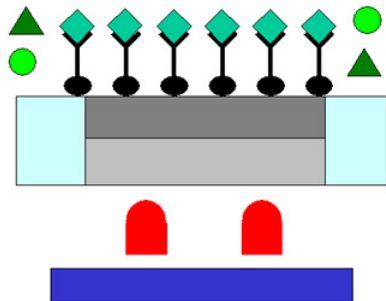
(a)



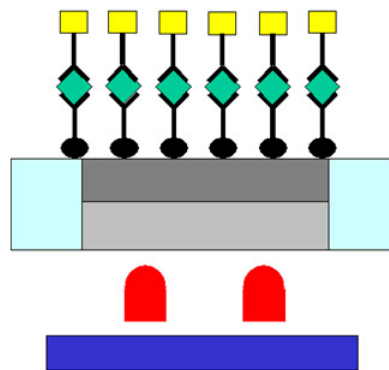
(b)



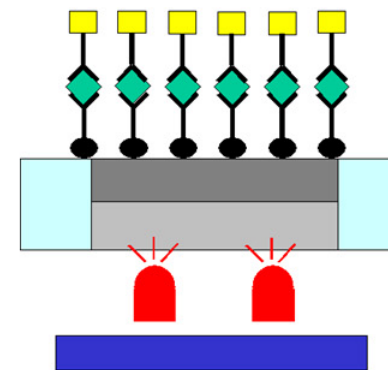
(c)



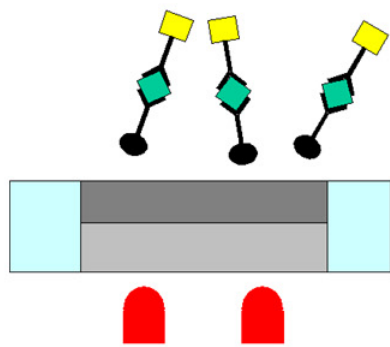
(d)



(e)



(f)



(g)



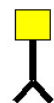
Magnetic Bead with antibody



Target Antigen



Other antigen



Urease

Simple concept

- (a) Magnetic bead injection
- (b) Holding
- (c) sample injection
- (d) Washing
- (e) urease Injection
- (f) surface potential measure by LAPS
- (g) releasing

LAPS
System
Demonstration!!!

Structure of ISFET

