

# Development of the chemical / biological agents multi detectable biosensor and concept of the network monitoring system

Masato Saito, Hidenori Nagai, Eiichi Tamiya  
Graduate School of Engineering  
OSAKA UNIVERSITY

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# Concept of our project

We have been exposed any threat of terrorism. A personal or small groups will attack by chemical and biological agents which is called as “the poor’s bombe” at any time and any place. It will give arise to the serious damages for our life.

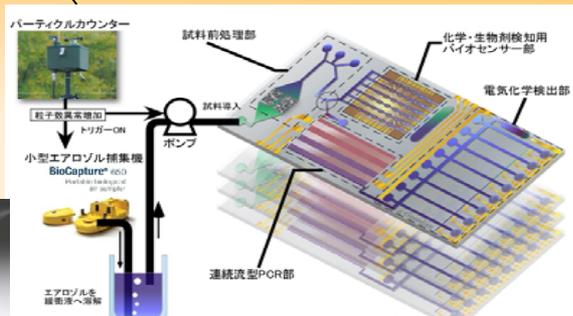
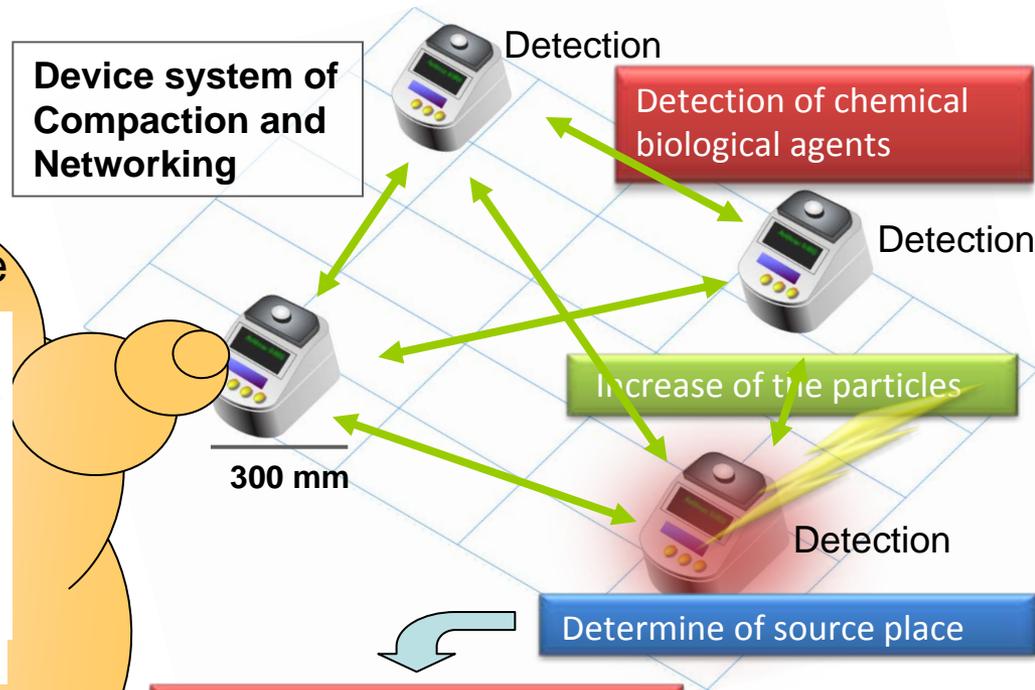


It needs the chemical and biological agents detectable real time monitoring system which is small compact and is possible to set to all over the place.

## Requirement of the system:

- Continuous monitoring of particles
- Rapid detection
- Construction of the system network
- Detect the agent and occurrence place

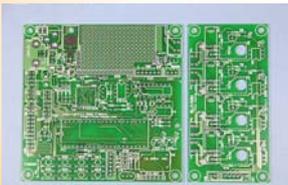
Device system of  
Compaction and  
Networking



Biosensor microchip



Capturing



Wireless network



Alert system

Alert to the first responder

evacuate, recover, initial investigation . . .

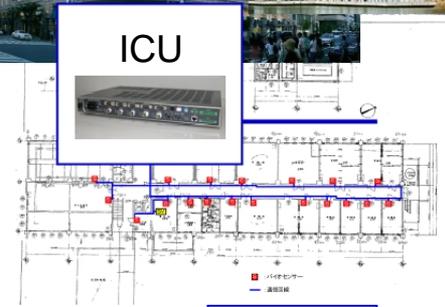
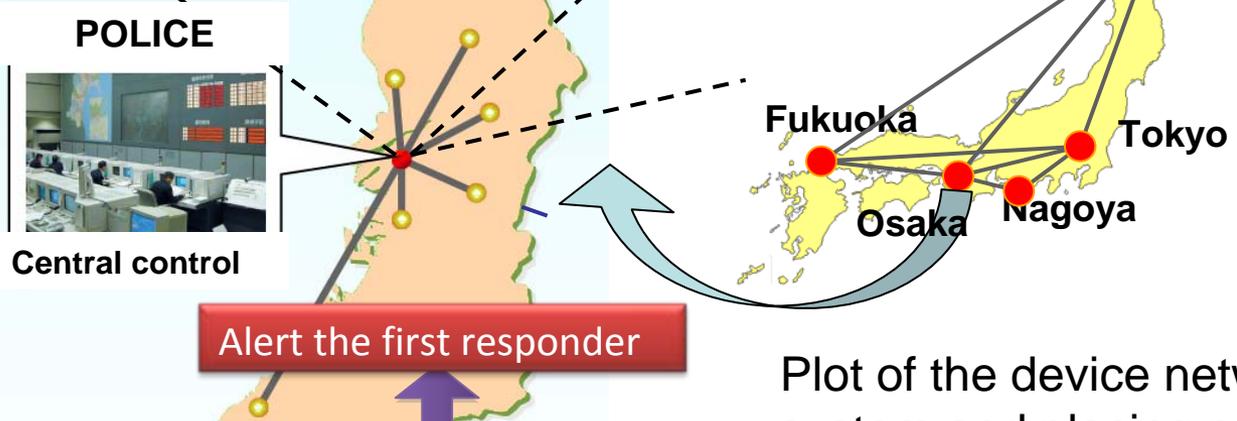
Deterrence of chemical biological terrorism, Minimize of damage, Secure and safety life for people

# Concept of our project

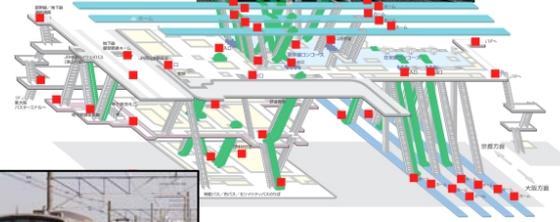
Mall • Public space

- Continuous monitoring of agents and rapid detection
- Detection of the agent and occurrence place using network compact device system

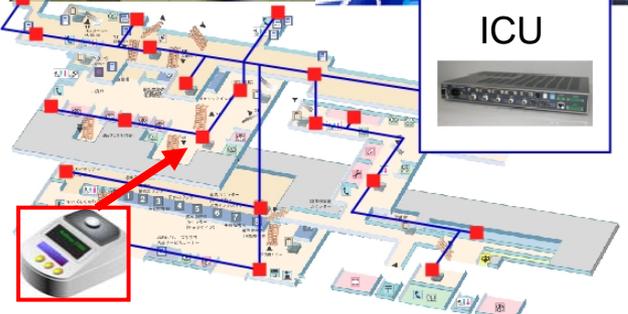
## Surveillance network system



Railroad Station



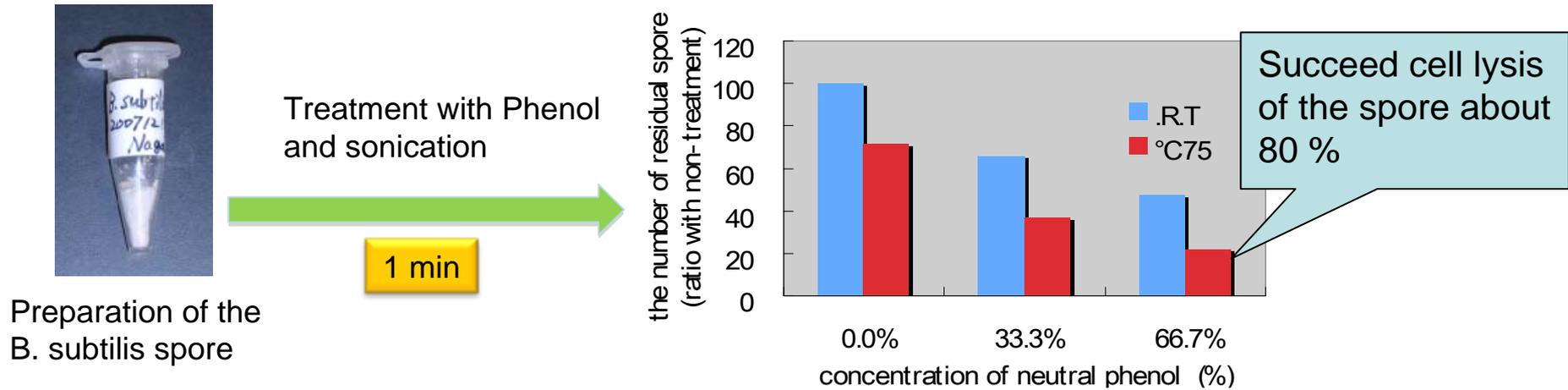
Airport



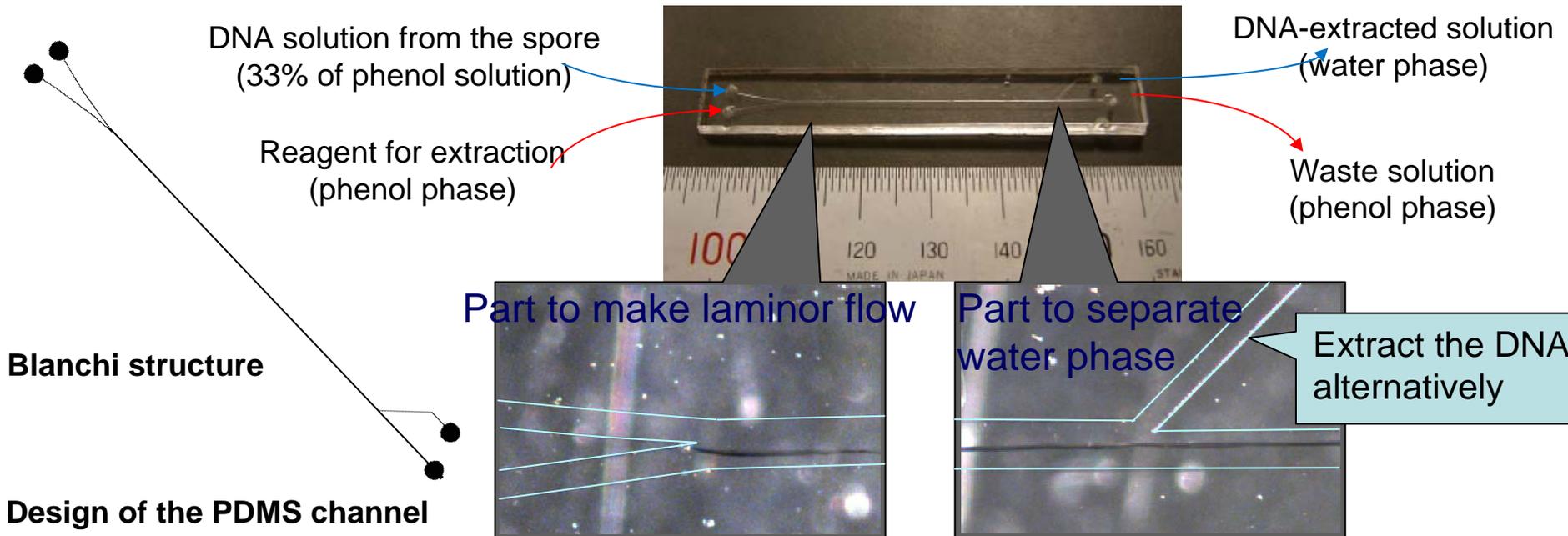
Placement of the biosensor device system for each space  
Construction of the large scale monitoring network system

# Development of the DNA extraction device chip from the aerosol captured sample

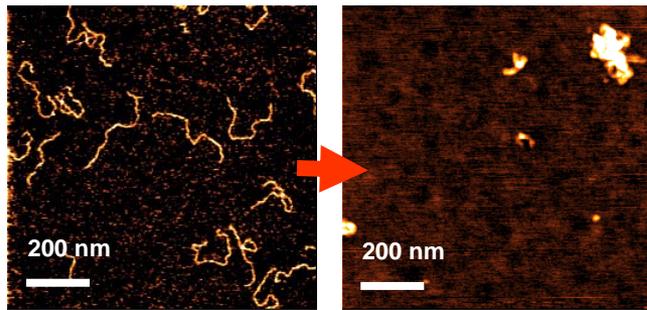
- Developed rapid cell lysis for the spores of a model biological agent



- Development of microfluidic DNA extraction device chip with by phenol treatment



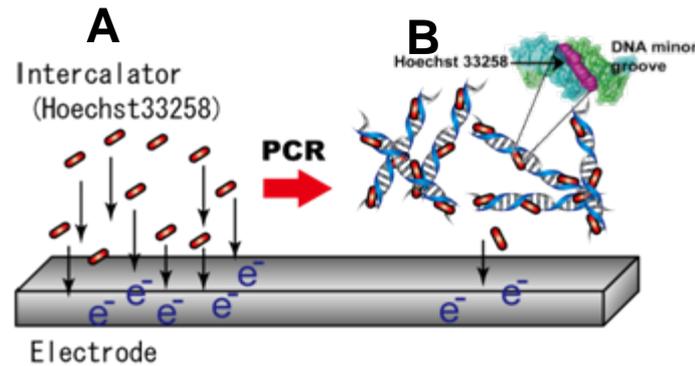
# Development of the electrochemical device chip for the detection of biological agents



PCR-amplified DNA  
without H33258

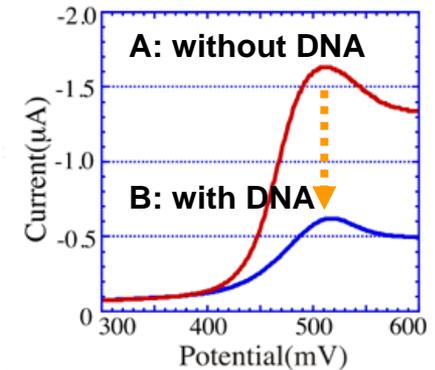
with H33258

DNA-H33258 aggregation



(Low DNA content)

(High DNA content)

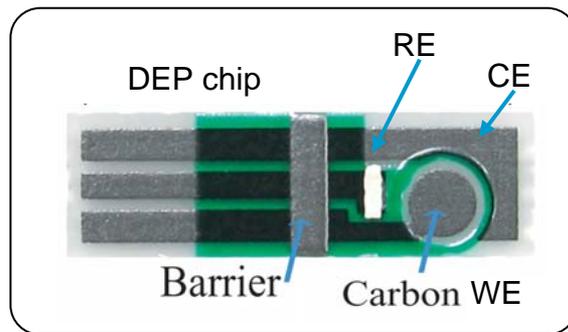


Linear sweep voltammetry

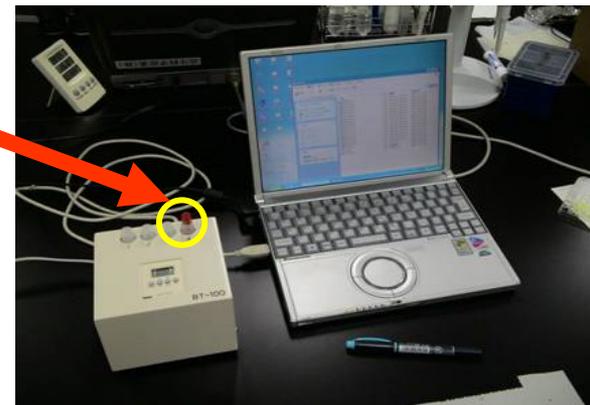
(Analyst, 2007, 132, 431–438)

## Electrochemical detection method which based on the DNA-H33258 aggregation

→easy to downsize the device and simplify the measurement



Miniturized, Mass productive, Low-cost



Disposable-typed screen printed electrode and detection device

# Electrochemical measurement of the model agent (*B. subtilis* 168)

## Model bacterium as a biological agent and target DNA

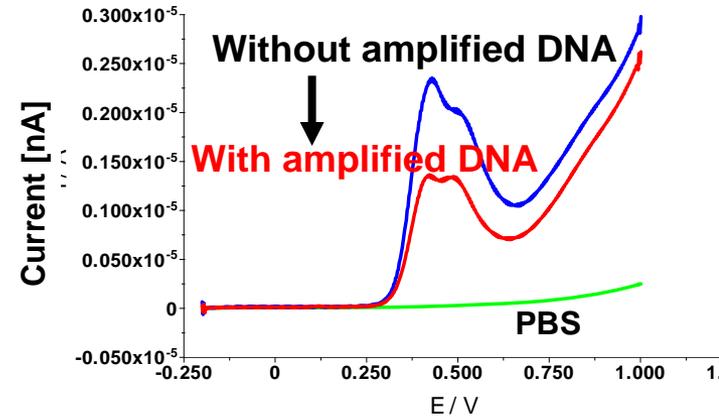
Model bacterium: *B. subtilis* 168

## PCR amplification

template: *B. subtilis* 168 genomic DNA

amplified region: 16S rRNA

DNA length: 381 bp



Electrochemical measurement of *B. subtilis* 168 using Screen printed electrode  
→succeed the detection of the initial copy number of  $10^3$  genomic DNA

## Development of the microfluidic PCR device chip for the detection of biological agent

### Design and fabrication of chip :

flow rate:  $15\mu\text{L}/\text{min}$

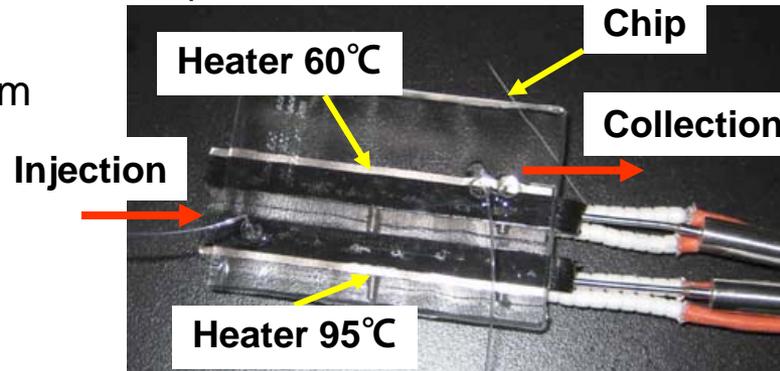
channel size:  $200\mu\text{m} \times 300\mu\text{m}$

cycle number: 30

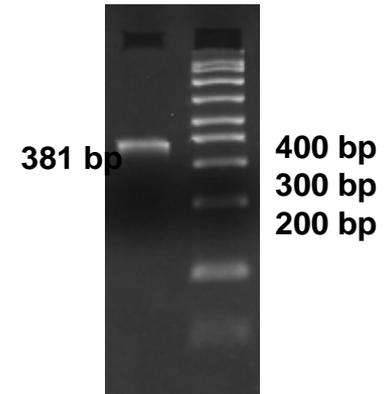
step: shuttle PCR

total time: 7min

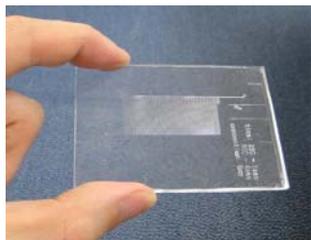
Chip size:  $52 \times 76$  mm



Setting up Microfluidic PCR chip



Gel shift assay



Fabricated microfluidic chip

- Fabricated the microfluidic PCR chip for the detection of *B. subtilis*
  - Successfully amplified the target DNA rapidly (7min)
- easy to simplify of device system, downsizing, rapid detection

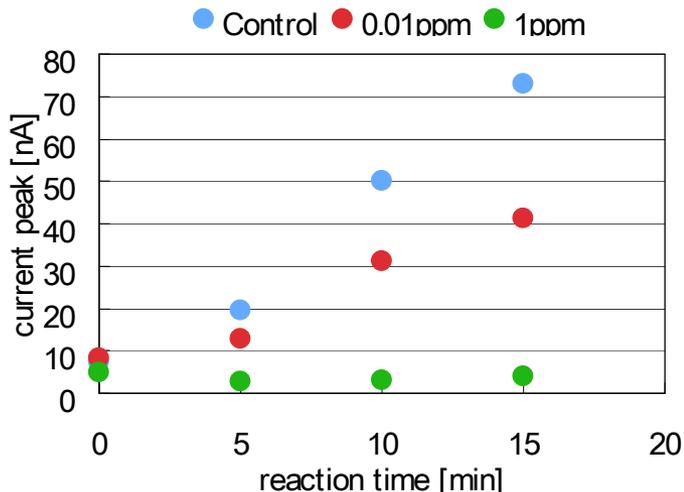
# Electrochemical detection of chemical agents

## Model compound of sarin:

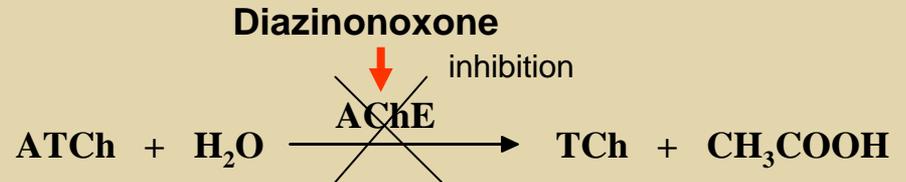
phosphorus pesticide (Diazinonoxone)

## Principle of measurement:

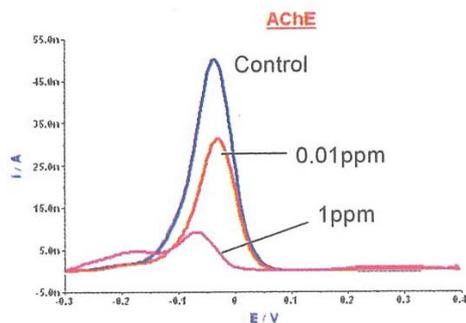
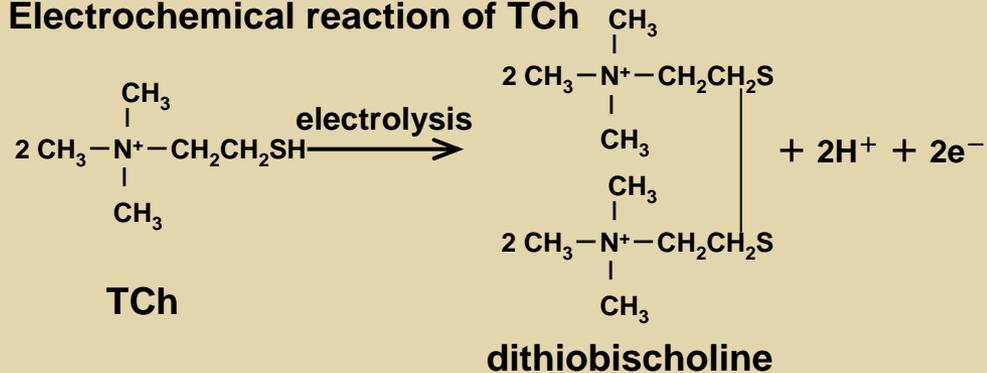
Measure the inhibition of AChE activity on the screen printed electrode. The pesticide inhibits the synthesis of TCh depending on the toxicity.



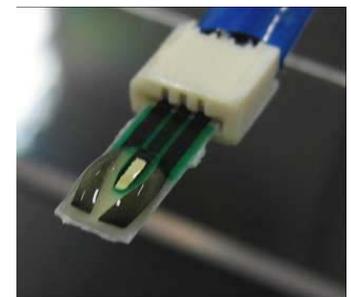
Current peak of TCh oxidation depends on the diazinonoxone concentration



## Electrochemical reaction of TCh



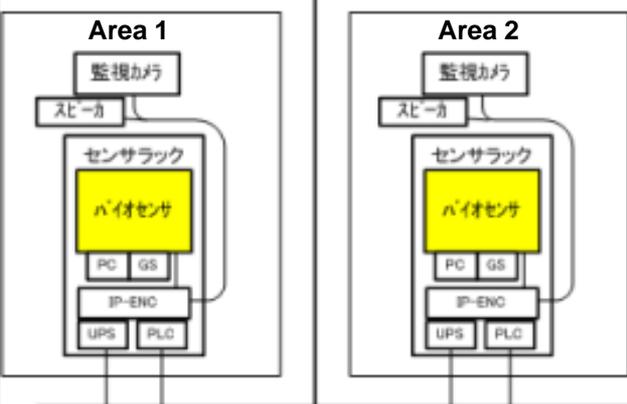
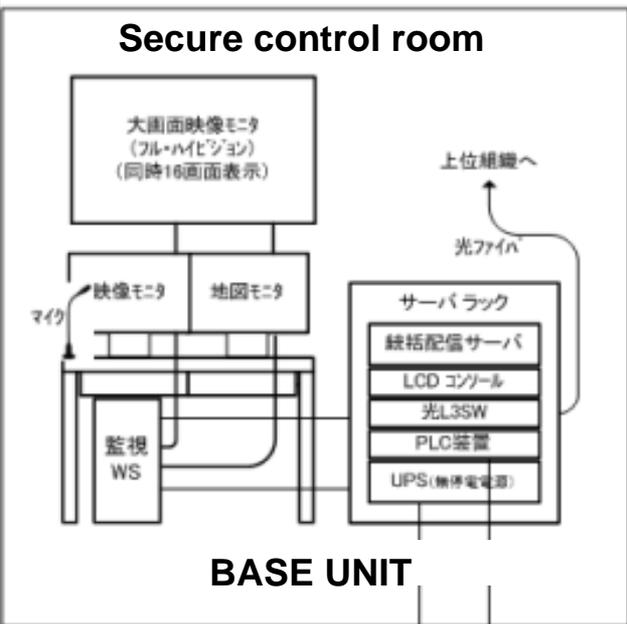
Differential pulse voltammetry



Screen printed electrode

Successfully detects 0.01 ppm diazinoneoxone using miniaturized electrode

# Design of the biosensor monitoring network system



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**UNIT1**

PC : パーティクルカウンタ  
GS : 溶剤ガスセンサ  
PLC : 電力線通信装置

**UNIT2**

**UNIT3**

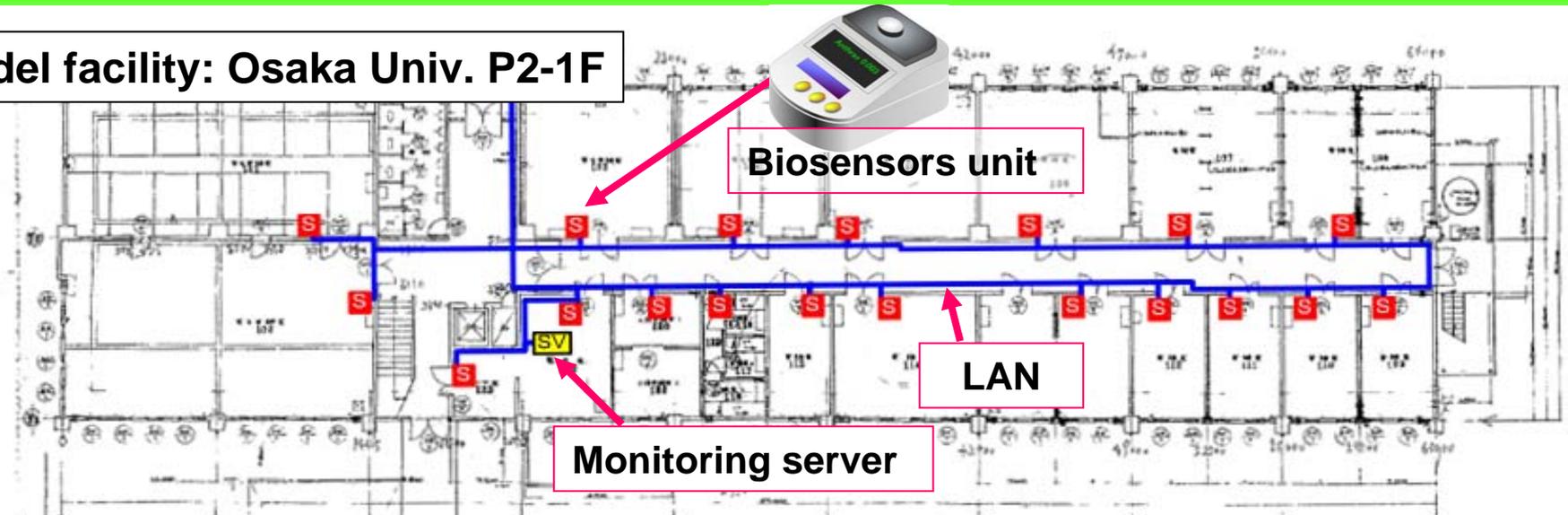
**UNIT4**

AC100V 商用電源

**UNIT X**

# Simulation of the monitoring network system

Model facility: Osaka Univ. P2-1F



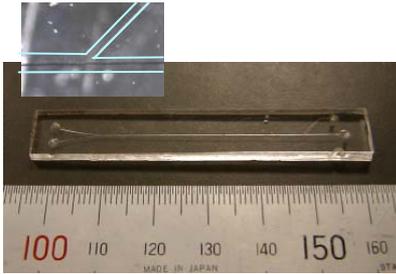
Biosensors located at each room and monitored at intensive control unit (ICU) through LAN



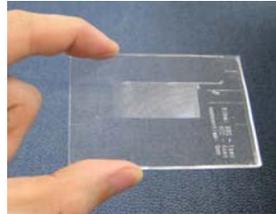
ICU analyze the place, species and concentration using the biosensor monitoring network

# Future plan

- Integrate the each parts of chip technology to the multi biosensor chip
- Develop the prototype of the biosensor monitoring network system
- Place the unit in the air port and test practically



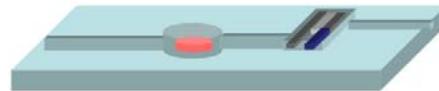
Extraction device chip



Microflow PCR device chip for biological agents

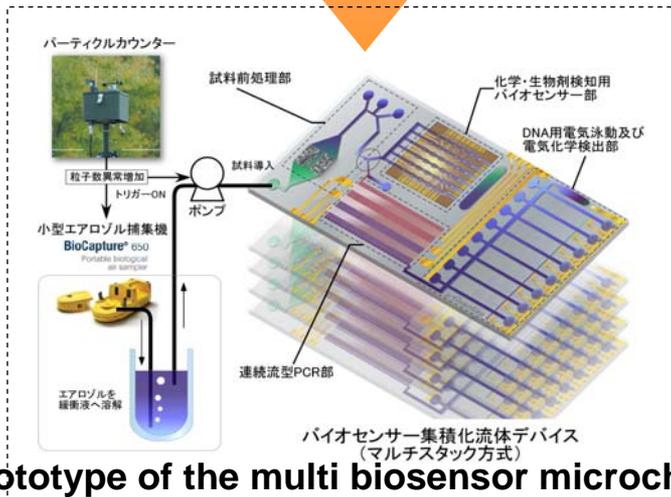


Miniaturized electrode

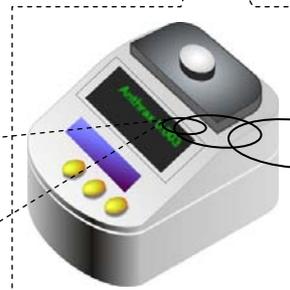


Micro-chip for chemical compounds

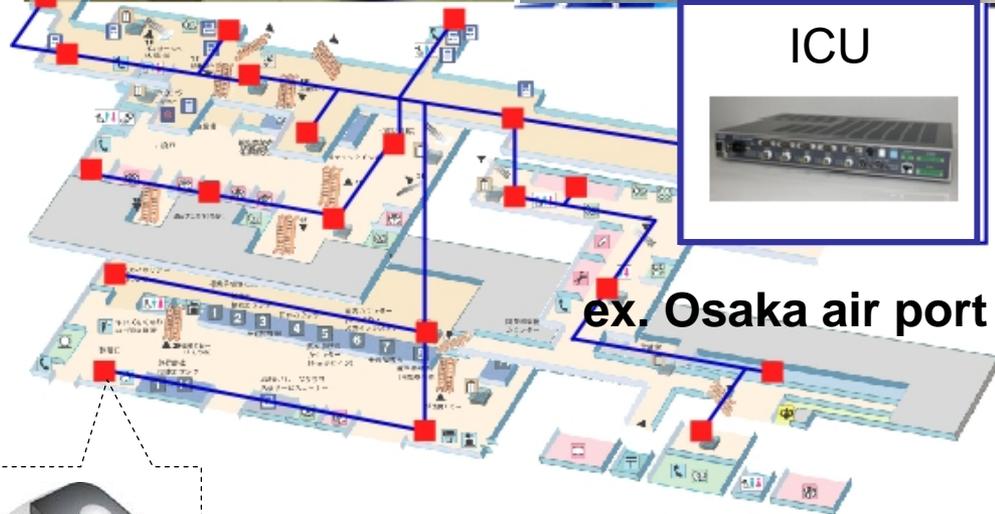
**integration**



Prototype of the multi biosensor microchip



Prototype unit



ICU

ex. Osaka air port

