

Microfluidic chip with QCM for detection of influenza virus subtype

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New method for detection of influenza subtype

Background

Infectious disease

- Influenza
- Dengue fever etc...

Need simple and accurate Diagnosis

Previous method

- Rapid diagnosis kit

ORapidly **X**Specifically



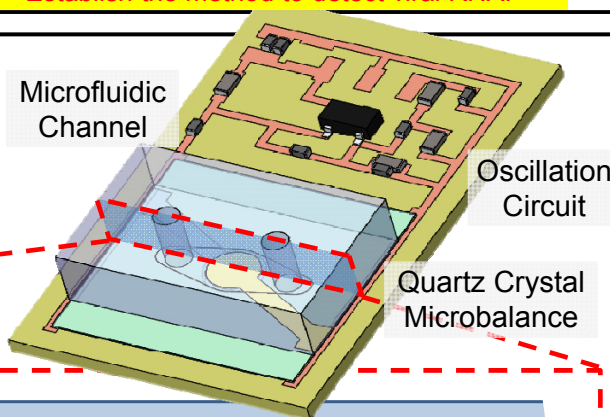
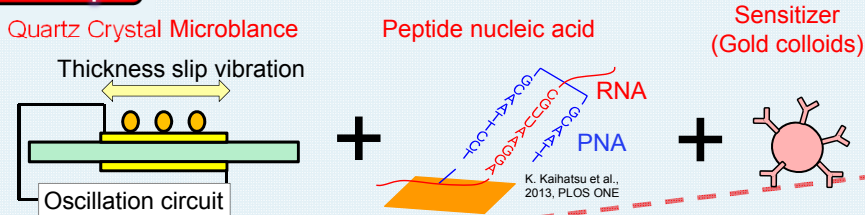
Conventional technique

- Virus purification by Hydroxyapatite
- Viral DNA/RNA extraction by Silica

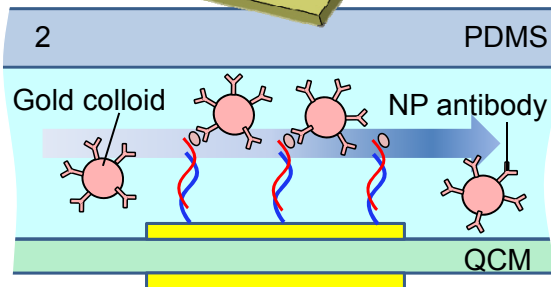
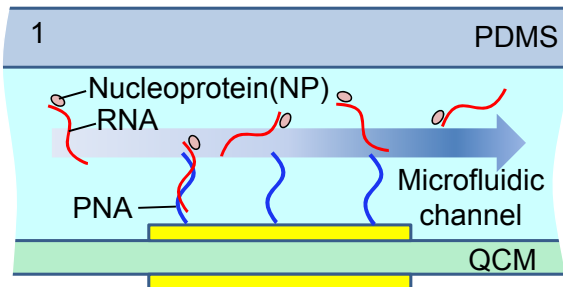
Purpose

Establish the method to detect viral RNA.

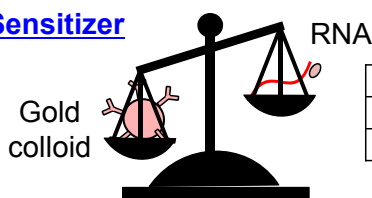
Concept



1. Viral RNA captured **specifically** by Peptide Nucleic Acid (PNA).
2. Gold colloids captured to **increase sensing mass**.



Sensitizer

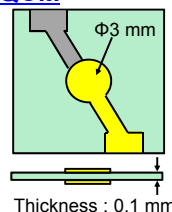


	Mass [g/piece]	Size [nm]
Viral RNA	1.2×10^{-18}	40~80
Gold colloid	6.5×10^{-16}	Φ 40

540 times heavier

Design

QCM



Fundamental frequency f_0

$$f = \frac{1.67}{\sqrt{h}} = 16.7 \text{ [MHz]}$$

Sauerbrey's Equation

$$\frac{\Delta m}{\Delta f} = -125 \text{ [pg/Hz]}$$

Thickness : 0.1 mm

Connector

Microfluidic channel

Oscillation circuit

QCM

10 mm

Height of channel : 200 μm

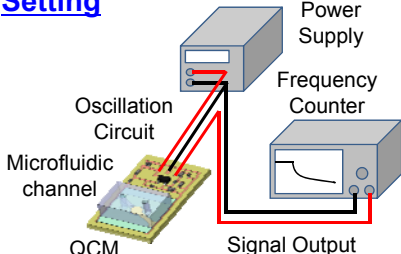
PDMS

8.4 mm

3.4 mm

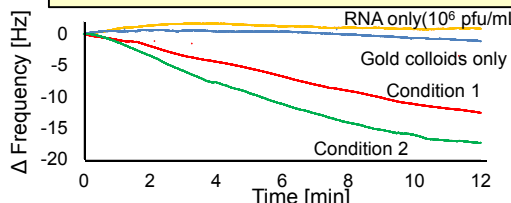
Experiment

Setting



Detection of viral RNA

- 1 : Introduced viral RNA (Condition 1, 2).
- 2 : Introduced Gold colloids.



	Viral RNA amount [pfu]
Condition 1	5×10^3
Condition 2	10^4

Conclusions

- Detected viral RNA using QCM by increasing sensing mass.
- In our future work, we will integrate all the functions in one chip.

	Rapid diagnosis kit (BD Directigen™ FluA)	Our chip
Detection limit	$10^3 \sim 10^4$	5×10^3
Detect subtype	x	○

Reference

- [1] M.Niimi et al, "Virus purification and enrichment by hydroxyapatite chromatography on a chip", volume 201, 2014, P185-190 Sensors and Actuators B
- [2] K.Kaihatsu et al, "Sequence-Specific and Visual Identification of the Influenza Virus NS Gene by Azobenzene-Tethered Bis-Peptide Nucleic Acid" 2013, PLOS ONE
- [3] S.Kagiya et al, "Detection of influenza virus subtype using quartz crystal microbalance" 2014, Micro-Nano Mechatronics and Human Science (MHS)