

# OPAMP内蔵小型変位センサ

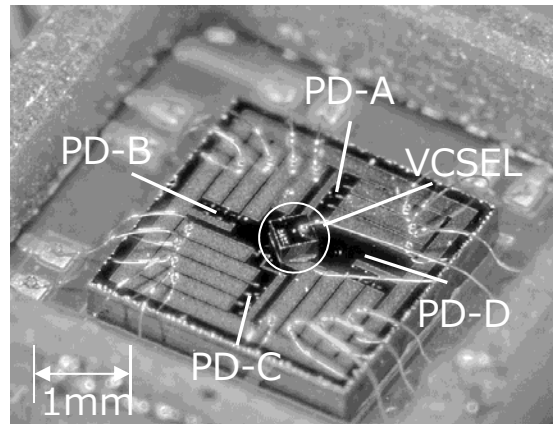
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# Micro Displacement Sensor

Micro displacement Sensor



**Structure : Small & Simple**

Sensor chip size:  $3000 \times 3000 \times 700 (\mu\text{m})$

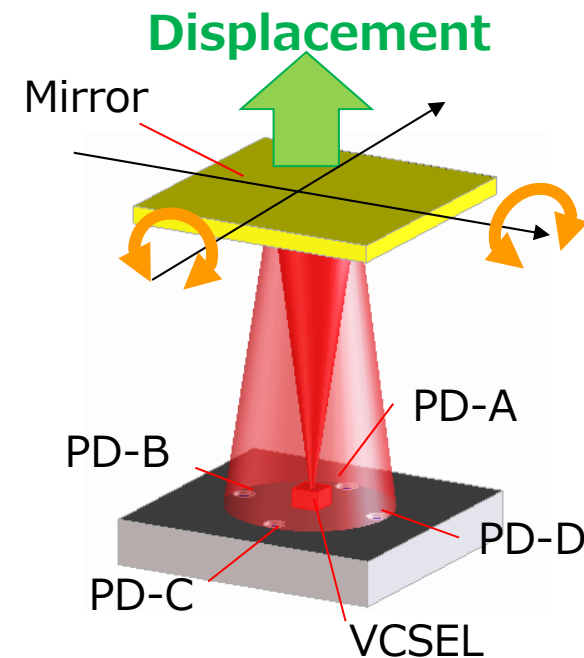
VCSEL(laser diode): 850nm, 2.5mW

Photodiodes(PDs): 3 PDs in each direction

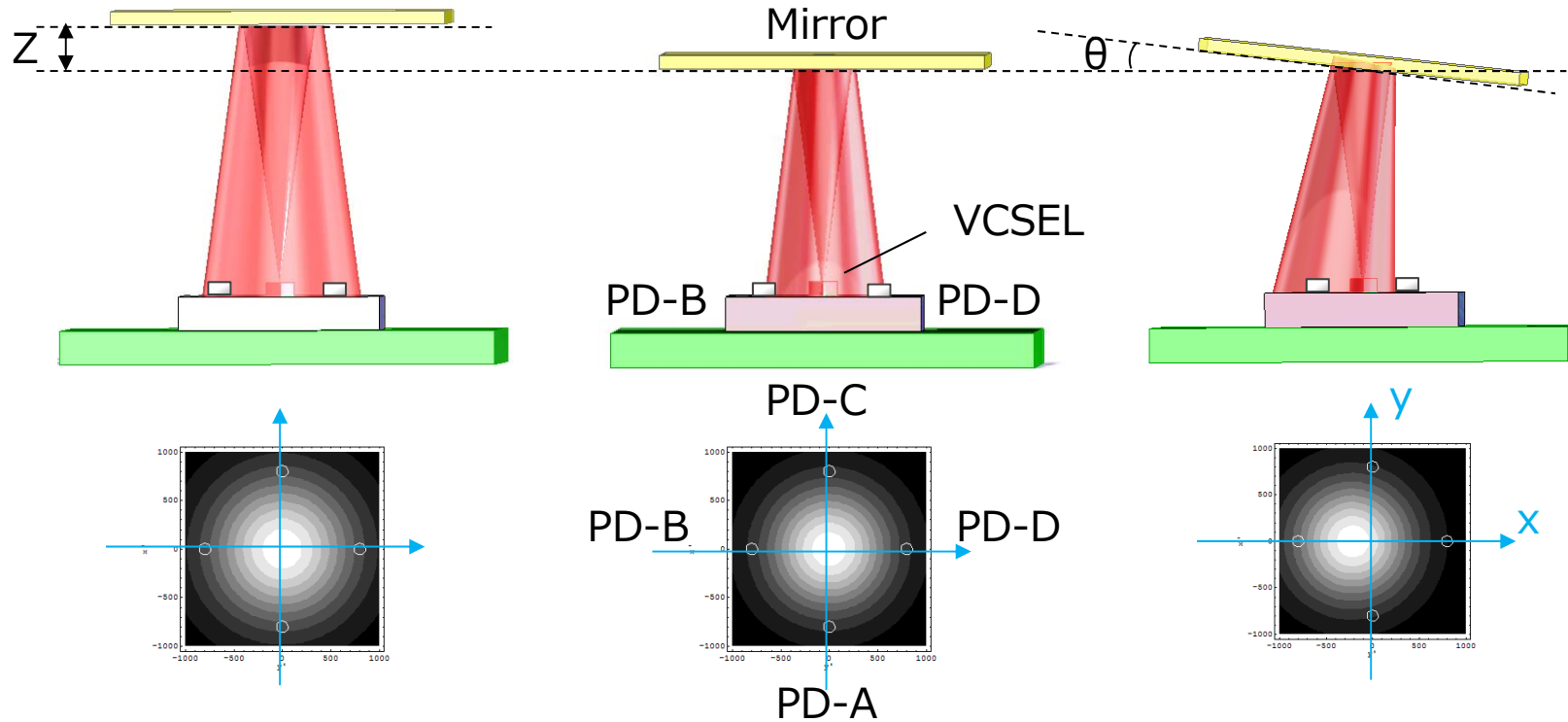
**Measurement**

**Displacement** of the mirror

**Rotation** of the mirror



# Principle



## Displacement

$$S_{in} = P_A + P_B + P_C + P_D$$

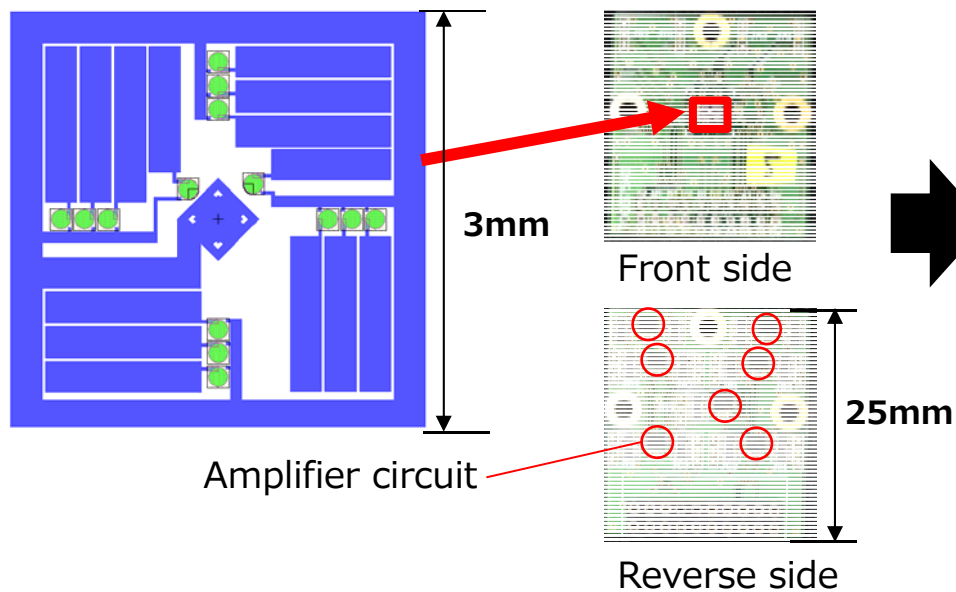
## Rotation

$$S_{rotx} = \frac{P_A - P_C}{P_A + P_C} [V/V] \quad S_{roty} = \frac{P_B - P_D}{P_B + P_D} [V/V]$$



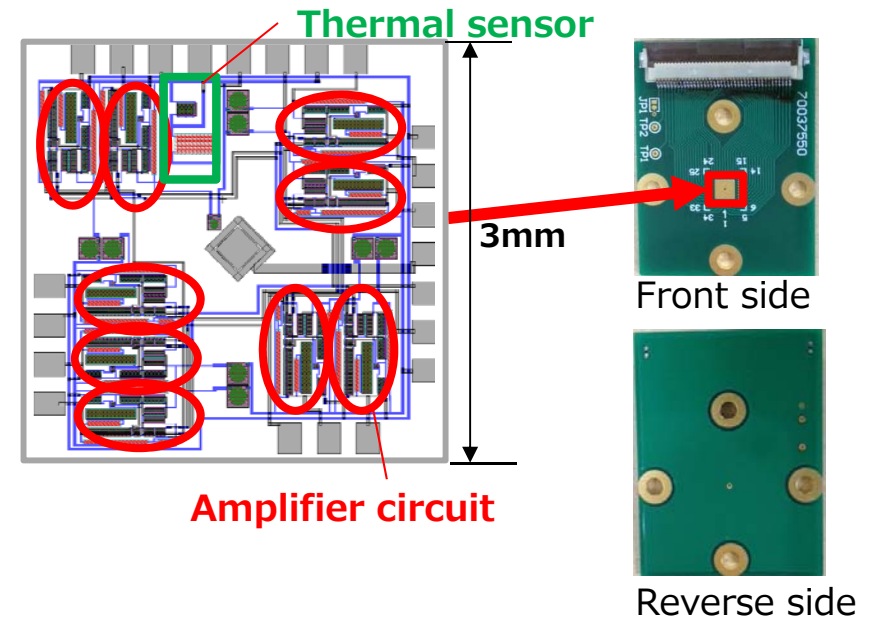
# Chip design

### Previous design



3×4 PDs + 2 Monitor PDs  
 Amplifier circuit on the substrate  
 →whole sensor size become large

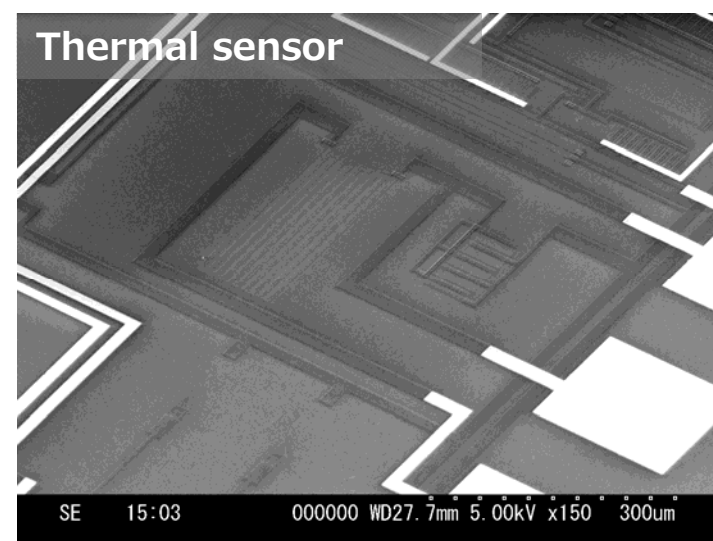
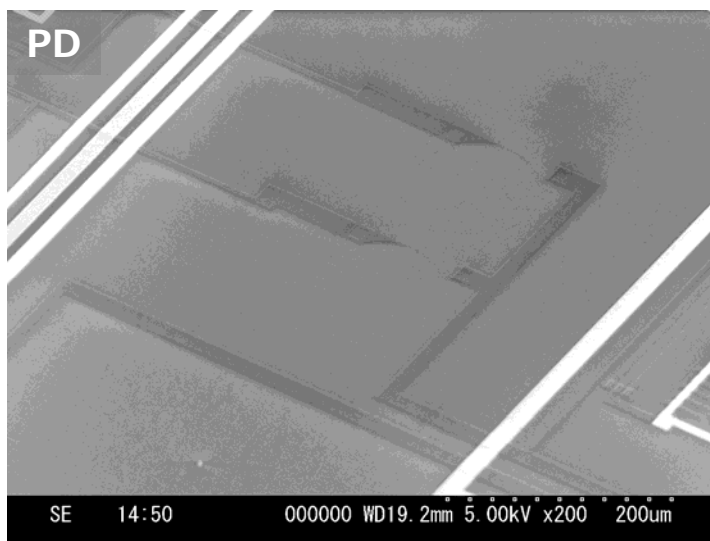
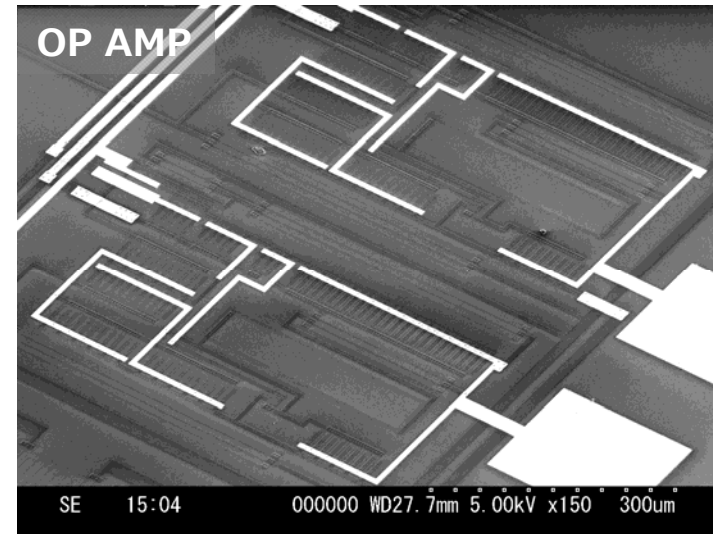
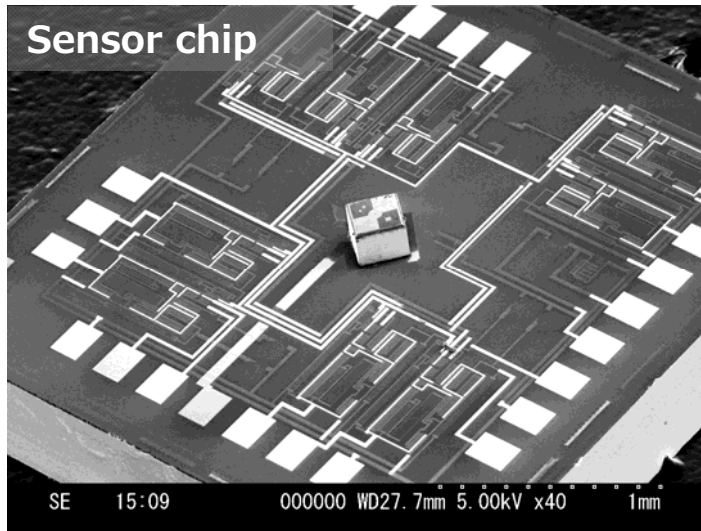
### New design



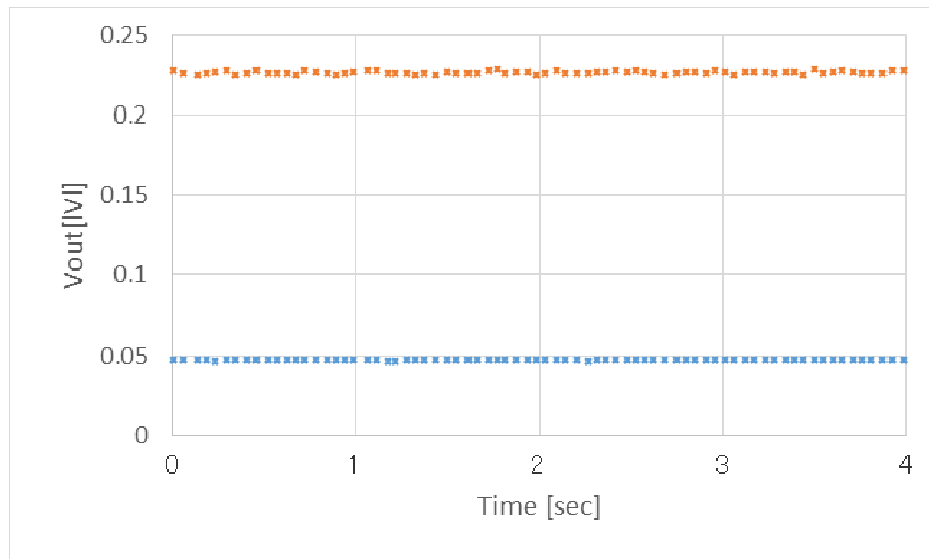
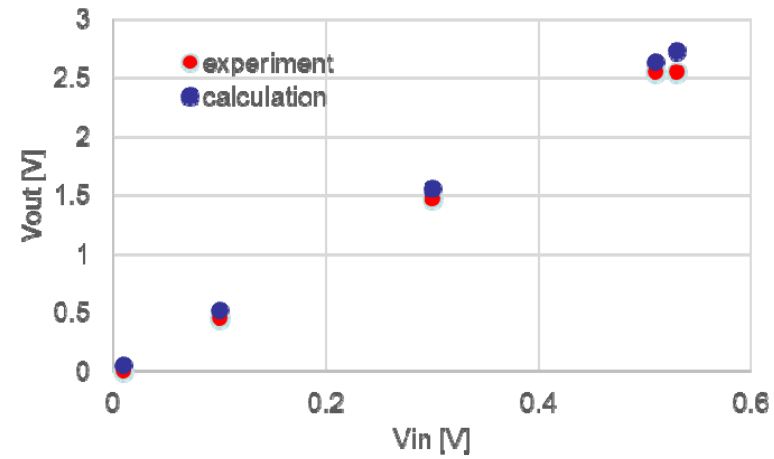
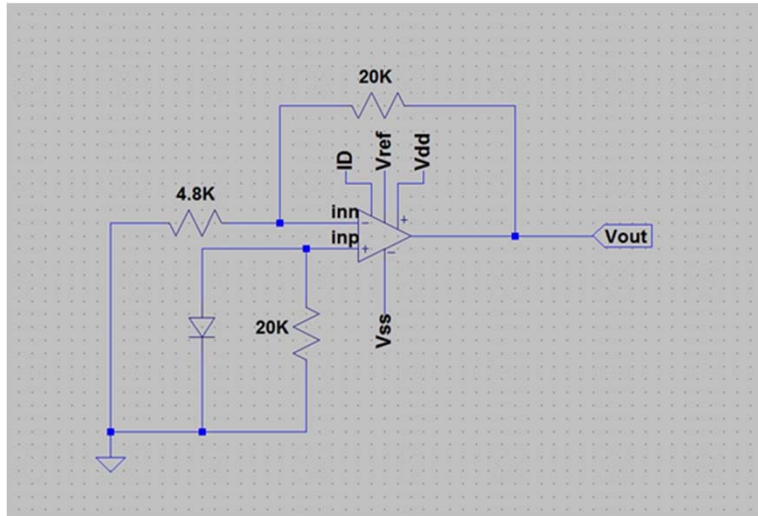
2×4 PDs + 1 Monitor PD  
 Amplifier circuit in the chip  
 →whole sensor size can be smaller  
 →improve the noise



# Fabricated sensor chip



# Evaluation of Op amp

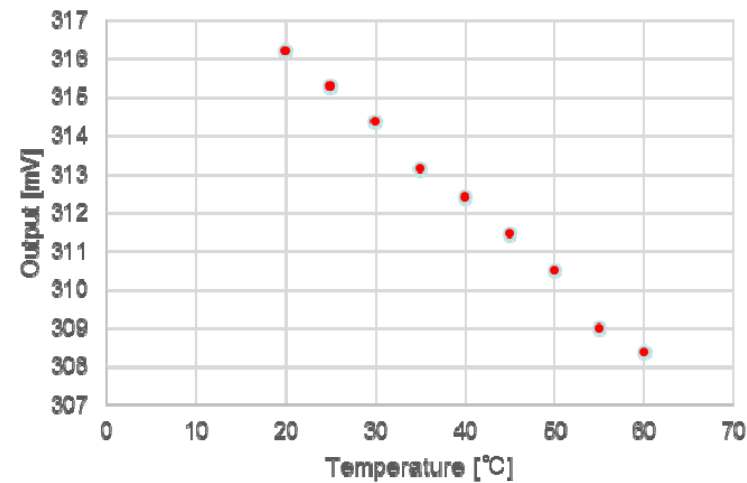
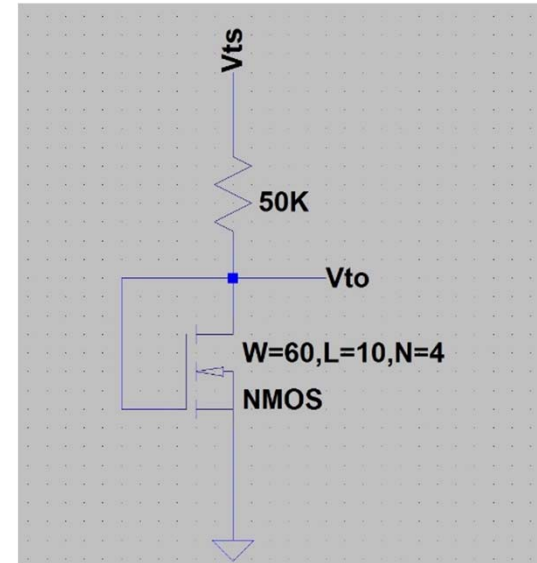
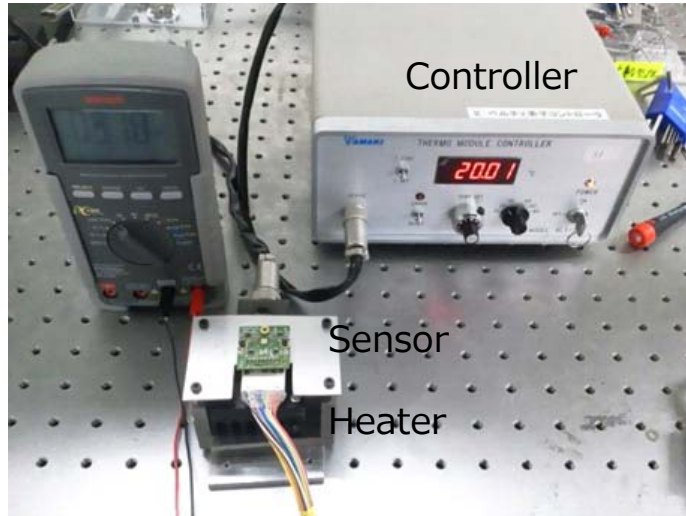


Output voltage of PD is amplified by OPAMP!





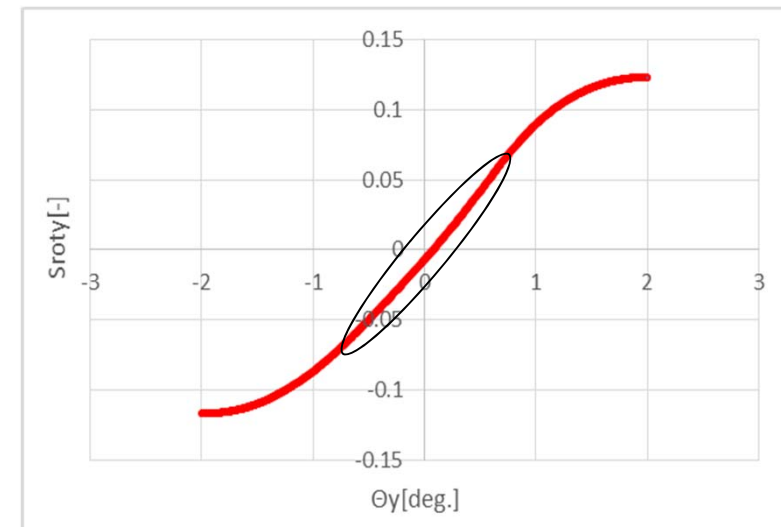
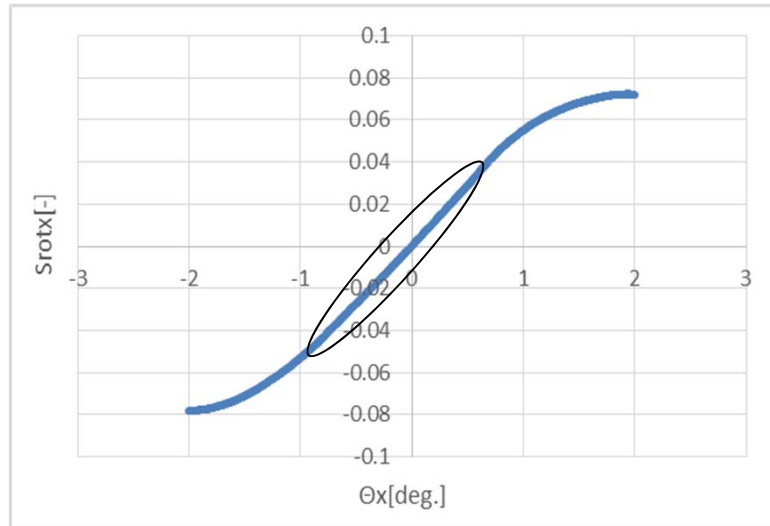
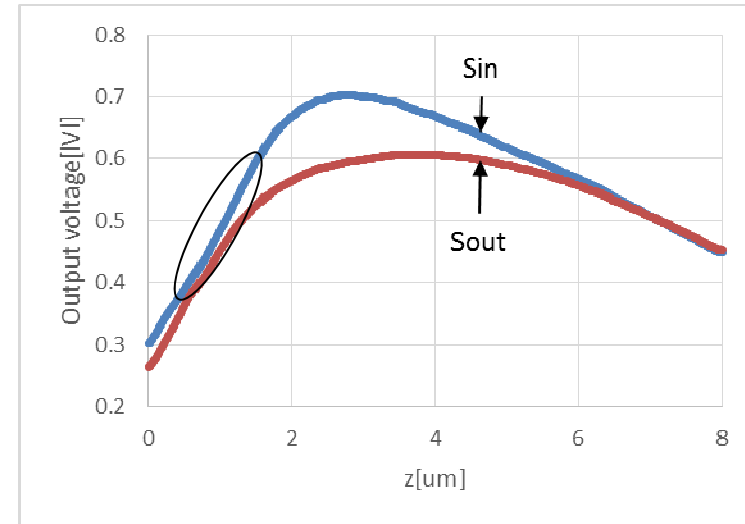
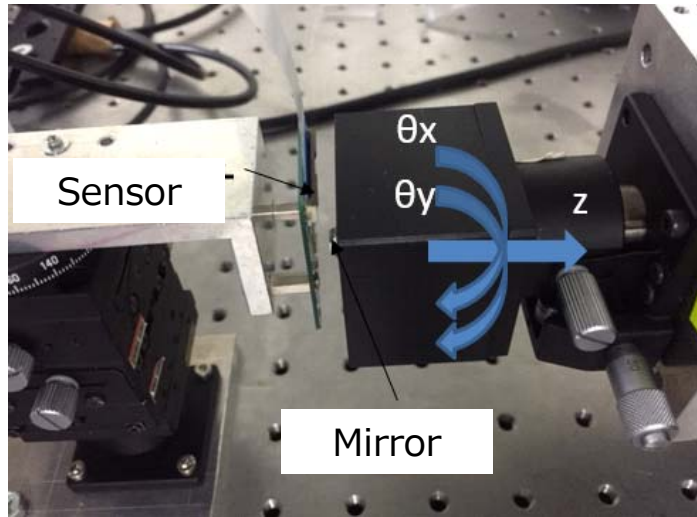
# Evaluation of temperature sensor



Thermal sensor can measure temperature of sensor chip !



# Evaluation of rotation and displacement



Sensor can measure displacement and rotation angle around two axes !





# Conclusion

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We fabricated displacement and rotation angle sensor.

- Sensor chip size is 3000 [ $\mu\text{m}$ ] $\times$ 3000 [ $\mu\text{m}$ ] and 700 [ $\mu\text{m}$ ] in thickness.
- OPAMP and Thermal sensor are integrated on this sensor chip.

Output voltage of PD is amplified using OPAMP.

- Gain is about 4.9 [-] (non-inverting amplifier circuit)

Thermal sensor can measure temperature of sensor chip.

- The output changes linearly with measuring range of 20 [deg.]  $\sim$  60 [deg.]

This Sensor can measure displacement and rotation angle around two axes.



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Thank you for your kind attention.