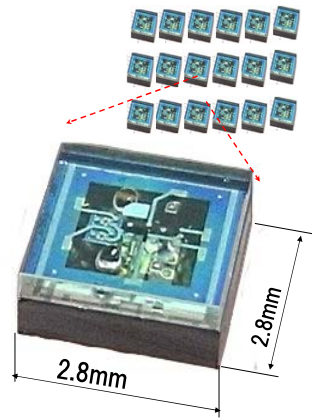
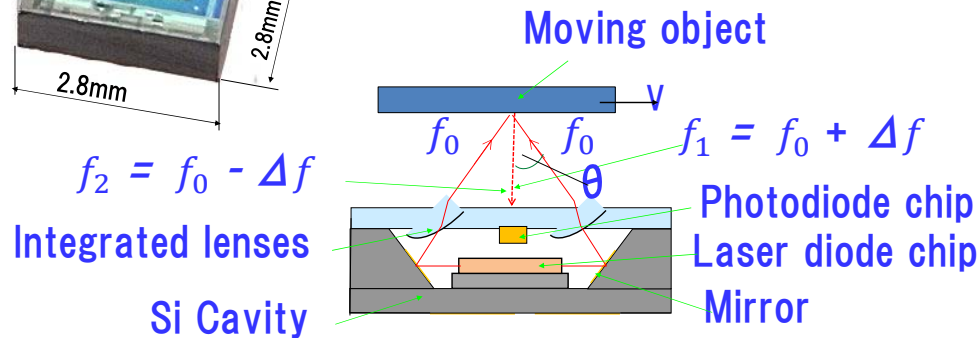


Two types of MEMS laser velocimeter

Micro Laser Doppler Sensor



Based on beat signal resulting from the interference between two Doppler shifted light beams from moving objects



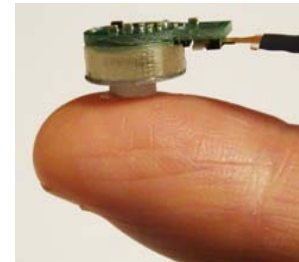
$$\text{Velocity } V = \text{Wavelength } \lambda \cdot F_{\text{beat signal}} / 2 \sin(\theta)$$

$F_{\text{beat signal}}$: Beat frequency

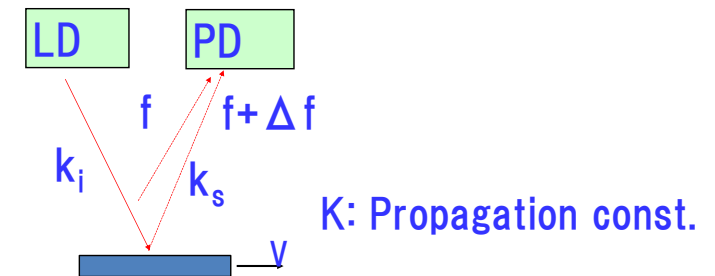
Absolute value of the velocity can be measured

Can measure the absolute value

Micro Laser blood flow sensor with a built-in contact pressure sensor



Based on the probability application to the behavior of the speckle pattern resulting from interference of scattering light



$$\int f \cdot P(\omega) d\omega \propto \text{Velocity } V, \text{ Flow } Q$$

$P(\omega)$: power spectrum
($\omega = 2\pi f$)

Use as Blood flow sensor

Immune to the vibration and the fixing

Palmens

Start-up Company of Kyushu University

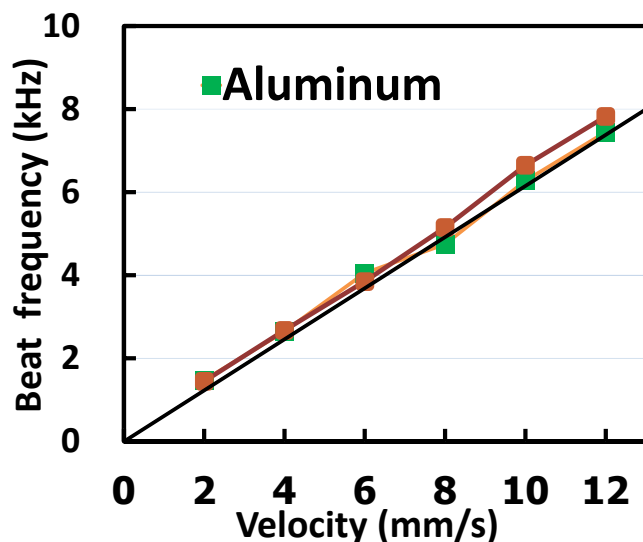
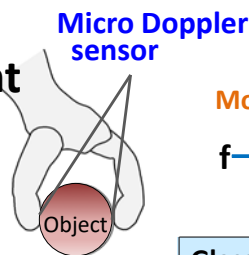
EXTCOM

Micro Laser Doppler Velocimeter (μ -LDV)

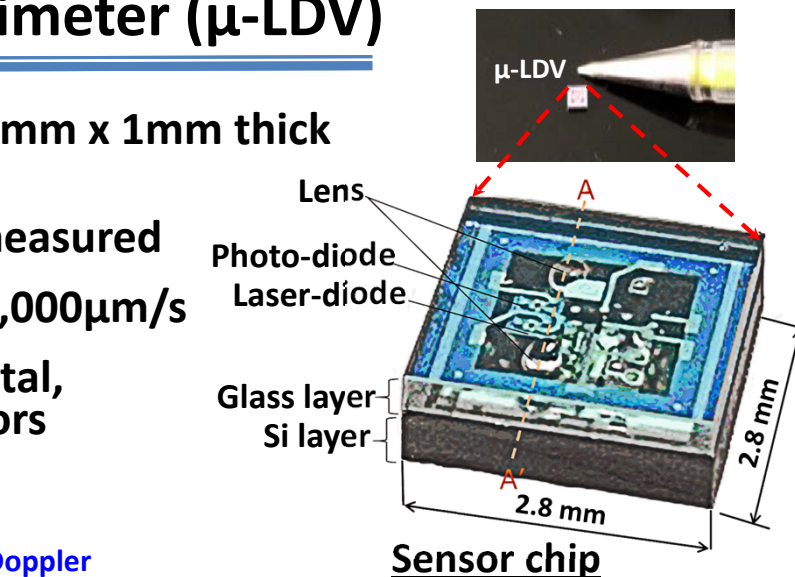
- Extremely small size: 2.8mm x 2.8mm x 1mm thick
- Non-contact velocity (speed) parallel to the sensor surface is measured
- Measurement speed range : 10-20,000 μ m/s
- Measurable materials : Plastic, metal, paper, liquid, etc., except for mirrors and colorless transparent objects

Applications

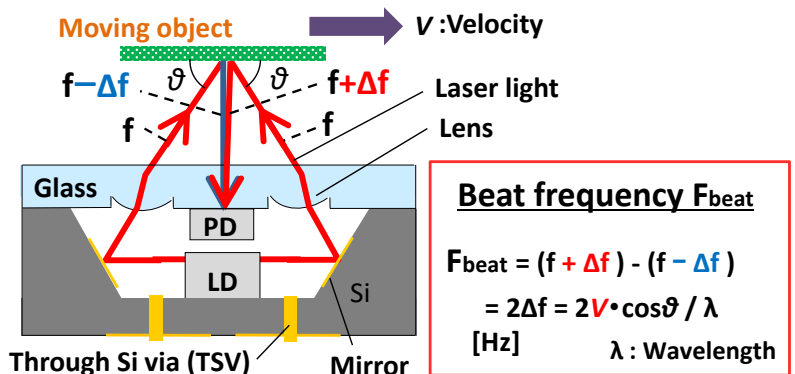
Speed measurement in tight spaces, e.g. Robotic hand slippage detection



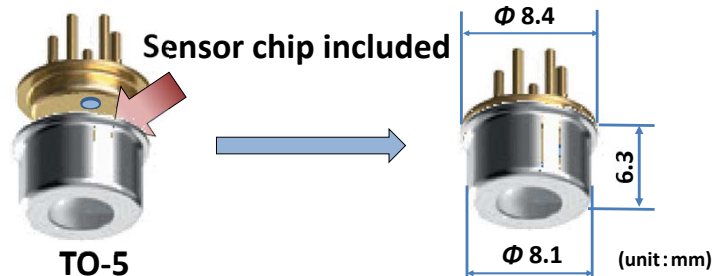
Velocities VS Peak frequencies



Sensor chip

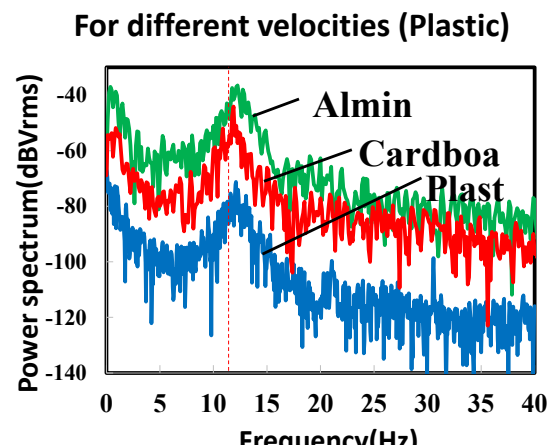
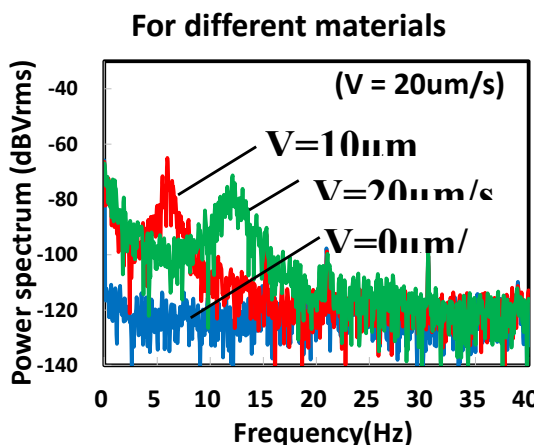
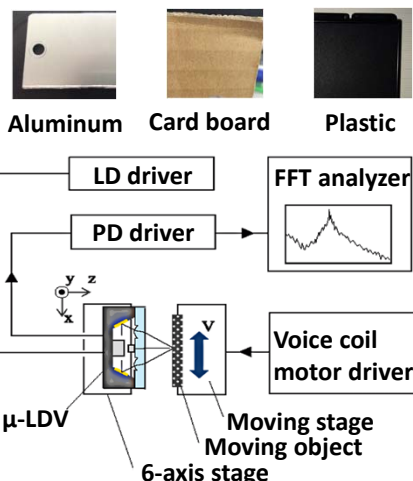


A-A' Cross section



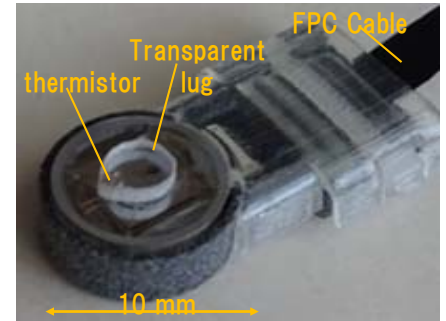
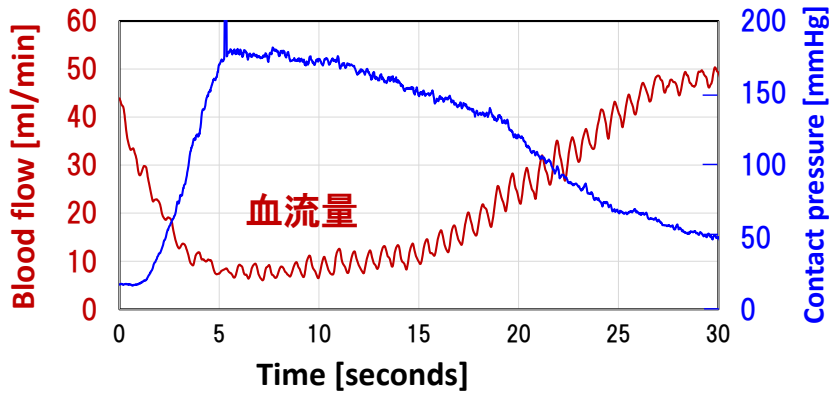
Initial product : Included in TO-5 without TSV structure

Experiment & Results



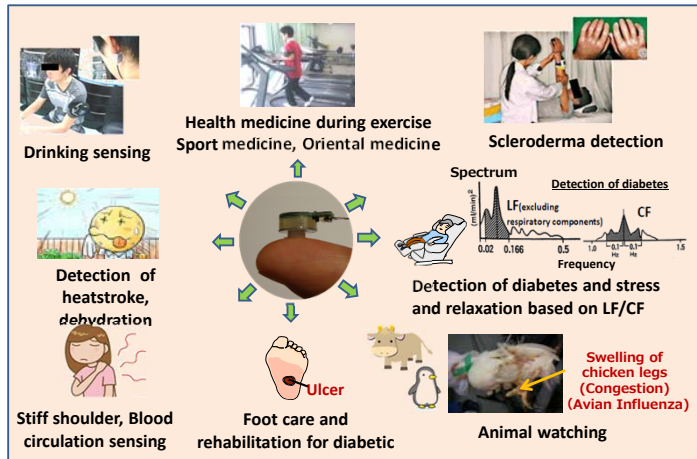
Blood flow sensor with a built-in contact pressure sensor

- Since blood flow carries oxygen, nutrients, heat and information related to the physiological state of the body and autonomic nerves to the tissues in every corner of the body, measurement of the blood flow is very important.
- Since blood flow is greatly affected by contact pressure, measurement of blood flow taking into account contact pressure is essential

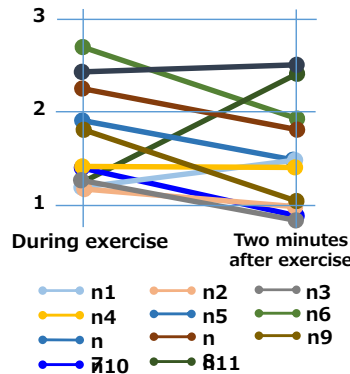


Blood flow sensor with built-in contact pressure sensor and temperature sensor

Applications



Detecting exercise effects



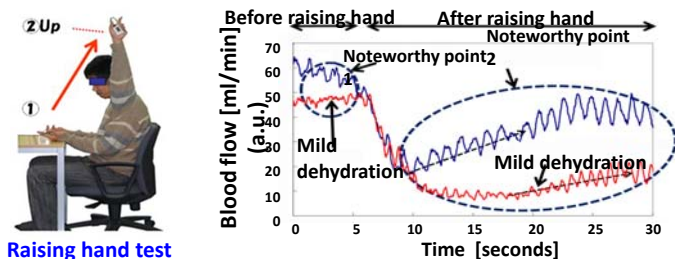
■ Even if the average blood pressure and average heart rate return to pre-exercise levels two minutes after exercise, blood flow (stroke volume) does not necessarily return to pre-exercise levels, and there are individual differences.

■ Just like blood flow, individual differences can be seen in the stroke volume calculated by measuring the volume of the left ventricle at expansion and contraction after exercise using ultrasound echo.

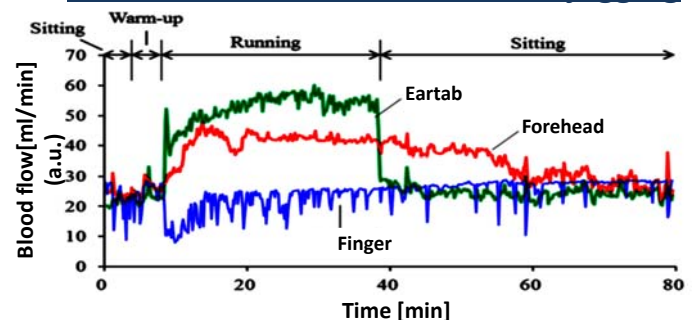
Stroke volume
= the amount of blood pumped by the heart per beat
= diastolic volume of the left ventricle - the systolic volume
∝ Blood flow measured by blood flow sensor Q (ml/min) / Heart rate HR (/min)

※※ Article: Watanabe K et al., Individual differences in the heart rate response to activation of the muscle metaboreflex in humans, AmJ Physiol Heart Circ Physiol, 299, 2010, H1708-H1714.

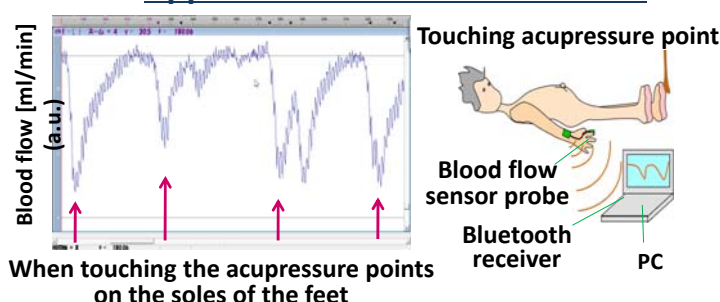
Detecting dehydration and heat stroke



Measurement blood flow while jogging



Application to oriental medicine



Simultaneous measurement of blood flow and contact pressure

