

10の6乗の計測レンジを有する 水晶振動式荷重センサ

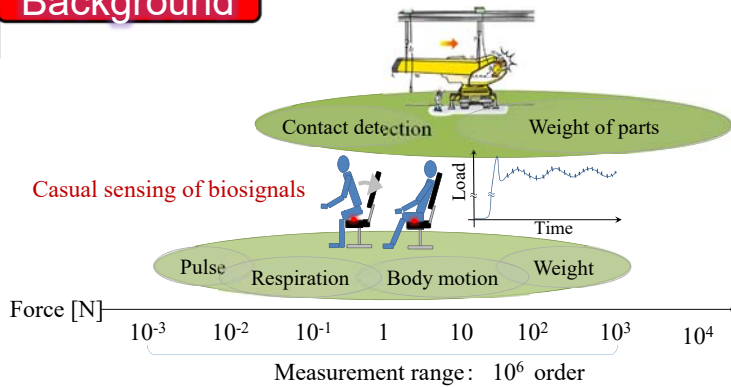
○室崎裕一 佐久間臣耶 新井史人

名古屋大学大学院工学研究科マイクロ・ナノシステム工学専攻



オール水晶により0.4 mN~600 Nの計測レンジ(10^6)を実現

Background

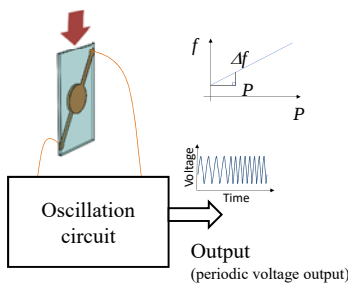


General load sensors

	Strain gauge	Electromagnetic	Piezo-electric (quartz crystal)
			
	Kyowa, LMA-A-500 N	SIMADZU, BX52KS	Kistler, 9215A
Size	$\phi 20 \times 9.5$ mm	350 mm x 355 mm x 105 mm	$\phi 6 \times 23$ mm
Measurement range	4×10^3	5×10^4	5×10^5
Max. load/Resolution	500 N/ 125 mN	530 N/ 10 mN	500 N/ 1mN
Response time (natural frequency)	44 kHz	0.3 Hz	20 kHz
Long-term stability	Good	Good	Not good (Electrical charge)

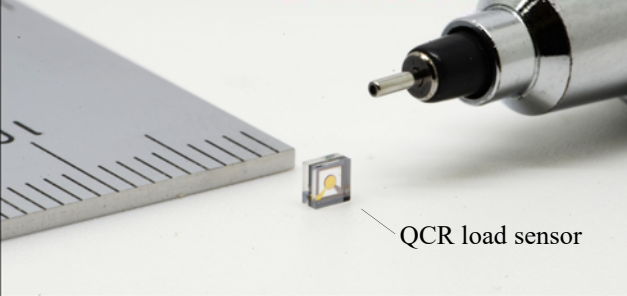
Method

Measurement principle

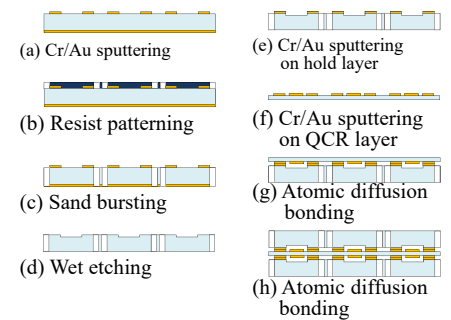


Sensor size : 2 mm x 2 mm x 1.04 mm

Measurement range : 0.4 mN to 600 N



Fabrication



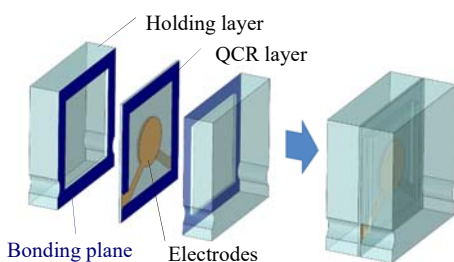
Quartz Crystal Resonator (QCR)

- High stable periodic signal
- Frequency changes linearly depending on stress.
- Quartz crystal has high Young's modulus.

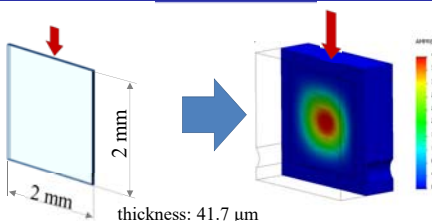
QCR load sensor

- high resolution
- wide-range
- long-term stability

Design



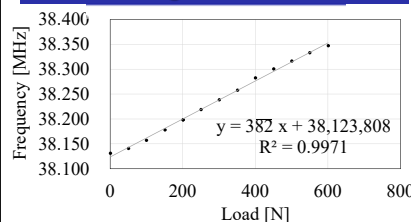
FEM analysis



Buckling stress is 10 times higher

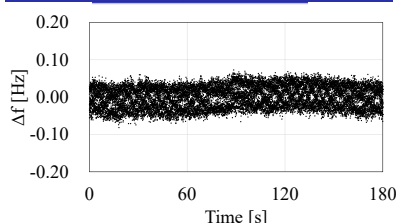
Experiment

Loading characteristics



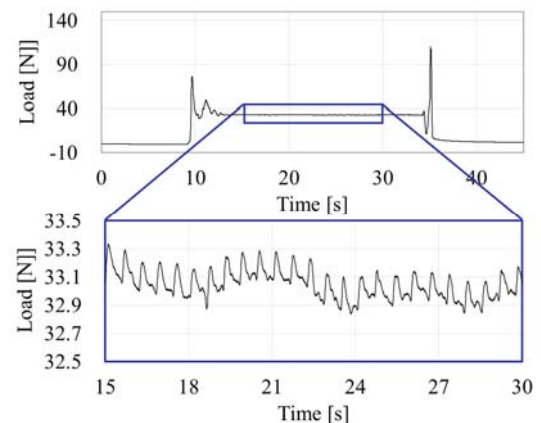
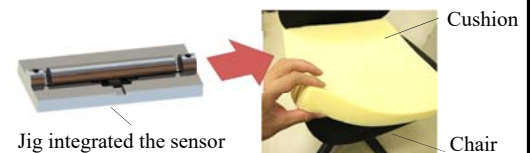
Max. load: up to 600 N

Stability of output



High stable output (0.15 Hz)

Multi-biosignal detection



Detection of pulse, respiration, body motion

Conclusions

- Measurement range of 10^6 was achieved.
- Pulse, respiration and body motion were successfully detected by a fabricated sensors