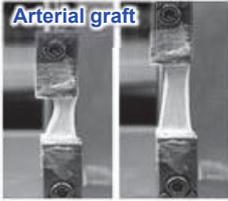
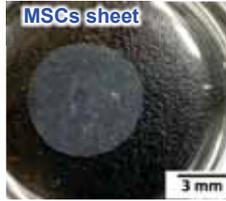


## 厚さ2 μmの薄膜の機械特性を計測するための鍵とは？

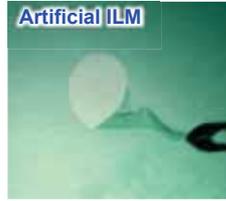
### Mechanical characterization of membrane tissues



U. Yokoyama, et al., Scientific Reports, 7, 140, 2017.



A. I. Pangesy, et al., J. Funct. Biomater, 7(2), 14, 2016.



S. Omata, et al., PLOS ONE, accepted, 2018.

#### Ex.) Internal Limiting Membrane (ILM) peeling

ILM is peeled for treatment of macular hole. (see movie)

Thickness: under a few μm

The model for training is highly demanded.

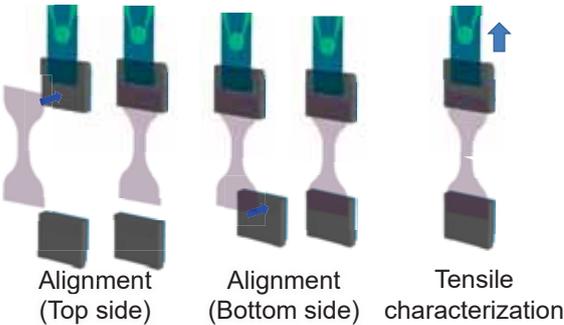


“Bionic” model:  
Color, Geometry (Shape, Dimension), Wettability, Mechanical properties, ...

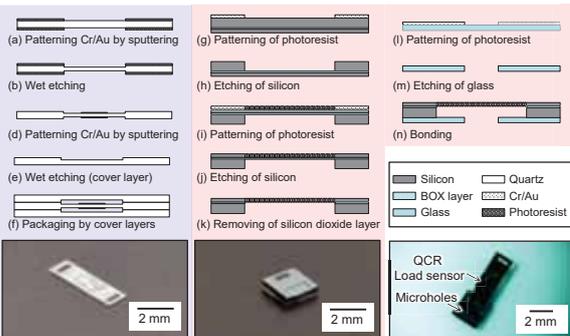
- >> Surgical training of medical doctors.
- >> Evaluation of new surgical tools and robots.

Geometrical difficulties		Target: Biological tissue
✓ Small	(milli-meter order)	✓ Wet environment
✓ Ultra-thin	(micro-meter order)	✓ Variety in mechanical characteristics
✓ Non-uniform	(non-desired shape)	

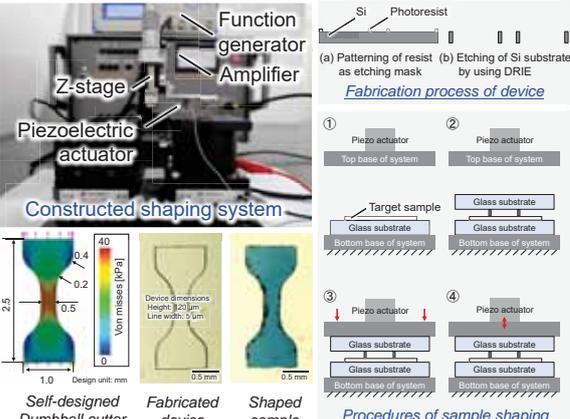
### Microfluidic clamp



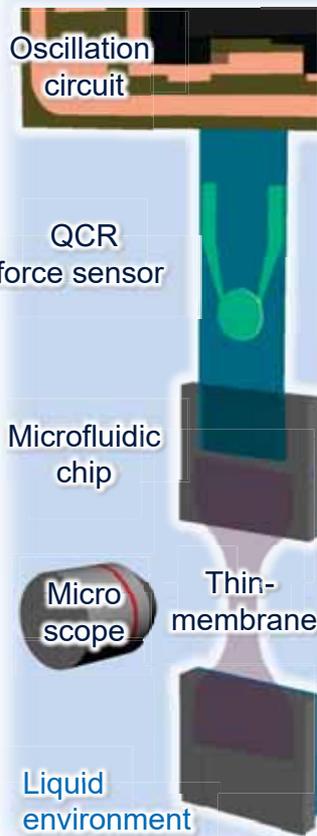
#### Measurement procedures



#### Fabrication; Microfluidic chip + Force sensor

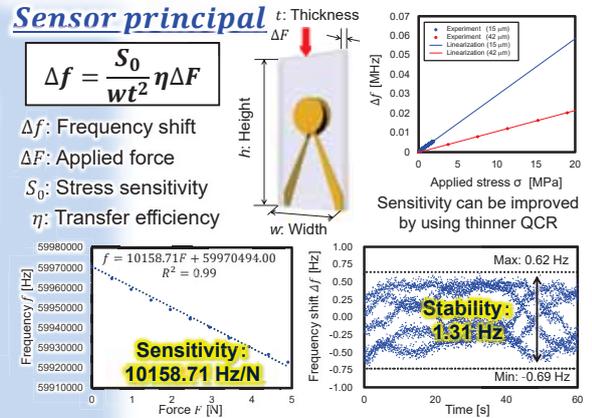


#### Sample shaping device



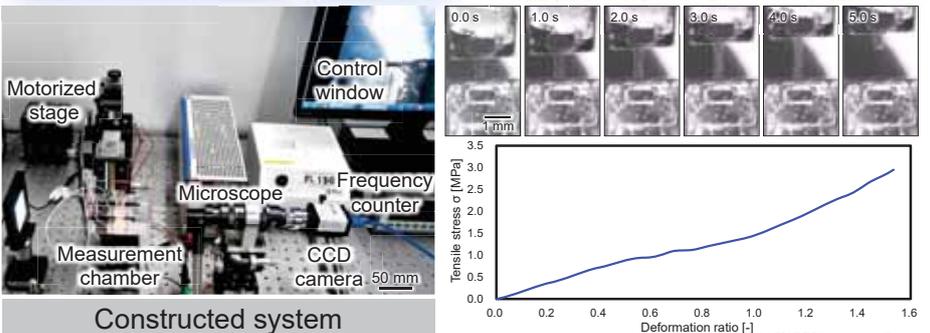
Condition	Force Range [N]	Measurement range [N]
Instron*	20 mN ~ 50 N	2.5 × 10 <sup>3</sup>
Shimadzu*	1 mN ~ 5 N	5.0 × 10 <sup>3</sup>
ADMET**	1 mN ~ 5 N	5.0 × 10 <sup>3</sup>
CellScale*	0.1 mN ~ 0.5 N	5.0 × 10 <sup>3</sup>
Our system**	130 μN to 4.9 N	3.8 × 10 <sup>4</sup>

#### Benchmark; Tensile characterization system



Measurement range: 3.8 × 10<sup>4</sup> (129 [μN] ~ 4.9 [N])

### Wide-range force sensor



**Conclusion:** We succeeded in the tensile characterization of ultra-thin membrane using microfluidic force sensing clamp. By utilizing the packaged quartz crystal resonator (QCR) as a force sensor, we achieved the wide measurement range of 3.8 × 10<sup>4</sup> (129 [μN] ~ 4.9 [N]). We showed the measurement results of tensile characterization in liquid environment using inner limiting membrane model (ILM model) whose thickness was 3 μm.

**Quick Access to References**

Sens Actuators A Phys. 265, 202-210, 2018. Force sensor probe using quartz crystal resonator with wide measurement range for mechanical characterization of HepG2 spheroid

Sensors. 17(5), 1067(1-13), 2015. Improvement of the Measurement Range and Temperature Characteristics of a Load Sensor Using a Quartz Crystal Resonator with All Crystal Layer Components