



## Sumitomo can solve all MEMS business issues

### Voice of Customers,

- We have a particular needs for motion measurement but don't know how to realize it.
- We have a good concept/idea of MEMS. How can we make prototypes/products?
- We have MEMS design but don't know where it can be fabricated.
- We have problem in a particular process to fabricate MEMS devices.
- We have an idea of inertial sensor application, but we need some customization.

### Voice of Customers

Having good idea/concept

Looking for a Fab.

Having issue in a process

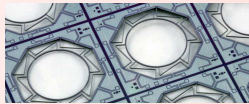
Wishing to use inertial sensors

[memssolutions@spp.co.jp](mailto:memssolutions@spp.co.jp)

Consulting/Concept creation

### SUMITOMO PRECISION PRODUCTS CO., LTD.

SILICON SENSING

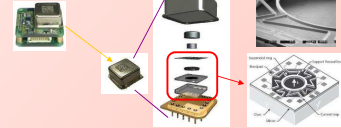


MEMS Foundry Service

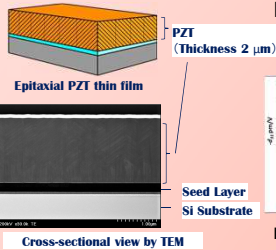


Inertial Sensors

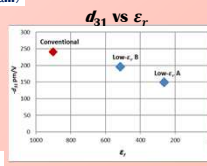
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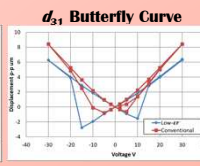
MEMS Gyroscopes and related systems



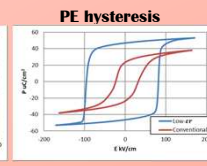
Cross-sectional view by TEM



Different materials available

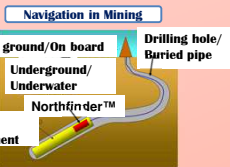


Wider  $d_{31}$  linear region



Higher residual polarization & coercive electric field

Low-  $\epsilon_r$ , Epitaxial PZT for MEMS Devices



Navigation in Mining

On ground/On board  
Underground/  
Underwater  
Mining equipment

Drilling hole/  
Buried pipe  
Northfinder™

SPT

SPP Technologies Co., Ltd.



Manufacturing Equipment

### Various "MEMS Solutions" available

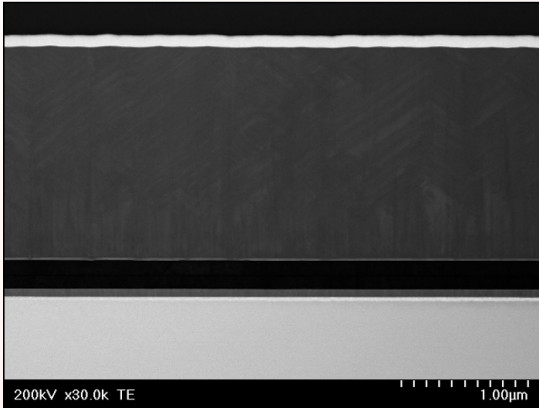
- Consultation on MEMS business development concept
- Design and development of MEMS devices and system products
- Providing MEMS semiconductor manufacturing equipment
- Development of thin film materials (e.g., PZT) and their production processes
- MEMS foundry service for prototyping and mass production
- 30 years of experience in the MEMS industry

Contact to [memssolutions@spp.co.jp](mailto:memssolutions@spp.co.jp)

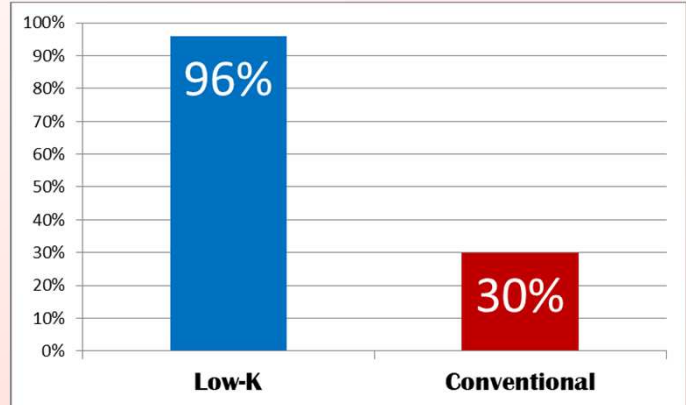


# Low-K PZT film suitable for PMUT

**Cross Section of Low-K PZT film**



**$d_{31}$  at 2V ratio of without/with poling**

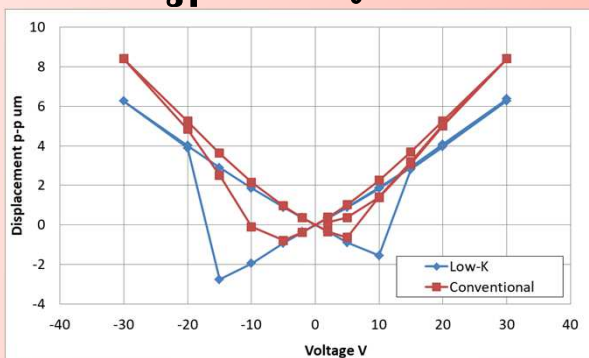


By improving the crystallinity, the relative permittivity of the PZT film becomes low and the self-polarization becomes high.

|   | Low-K A      | Low-K B | Conventional |
|---|--------------|---------|--------------|
| $\epsilon_r$                                  | 264          | 516     | 900          |
| $-d_{31}$                                     | 149          | 196     | 240          |
| FOM ( $\propto \frac{d_{31}^2}{\epsilon_r}$ ) | 53           | 48      | 40           |
| Wafer Type                                    | Silicon, SOI |         | Silicon, SOI |
| Wafer Size                                    | 6", 8"       |         | 6", 8"       |

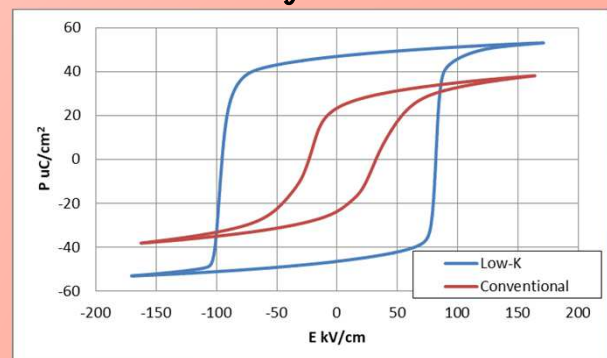
Figure of Merit (FOM) showing the performance of the piezoelectric thin film that combines both actuator and sensor functions required for PMUT has achieved the highest performance in the world.

**$d_{31}$  Butterfly curve**



Can be used in a wider applied voltage range than conventional products

**P-E Hysteresis**



Higher residual polarization and coercive electric field than conventional products

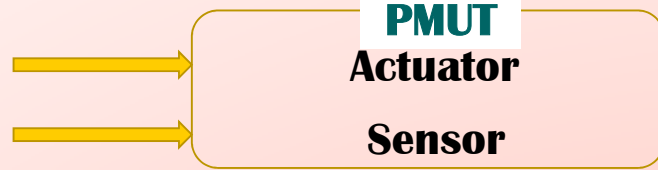


# 3 Reasons to choose Silicon Sensing Foundry Service

## 1. PZT suitable for PMUT

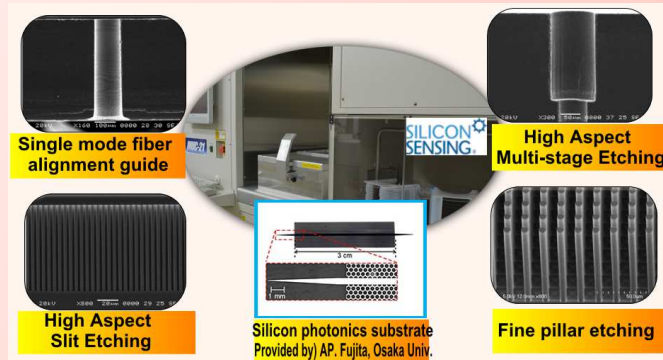
—A high piezoelectric constant ( $-d_{31}$ ) and low dielectric constant ( $\epsilon_r$ ) PZT film meets the requirements for PMUT

|              |                     |
|--------------|---------------------|
| $-d_{31}$    | <b>210-240 pm/V</b> |
| $\epsilon_r$ | <b>900</b>          |



## 2. Integrated production : deposition & fabrication

- More than 10 years of experience in device production
- Mass production experience of PZT gyroscope as in-house product
- Si DRIE technologies (Products of SPT, Sumitomo Precision Group)



Piezoelectric MEMS gyro CRM series oscillator

## 3. Commercialization achievement support

Sumitomo Precision Group can support you from MEMS design to MEMS process and production.

