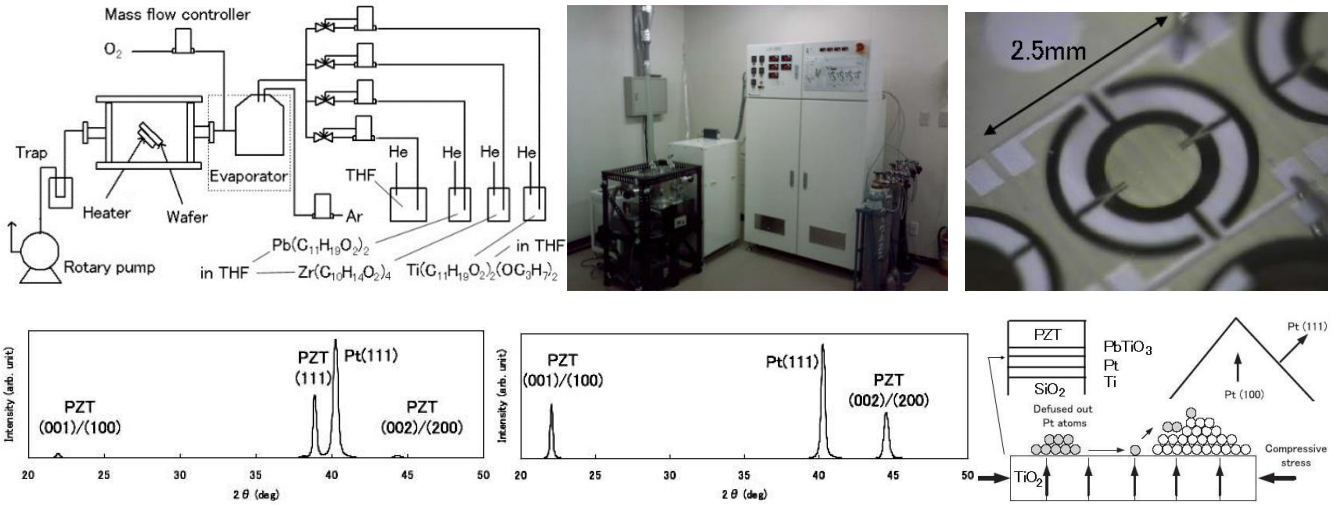
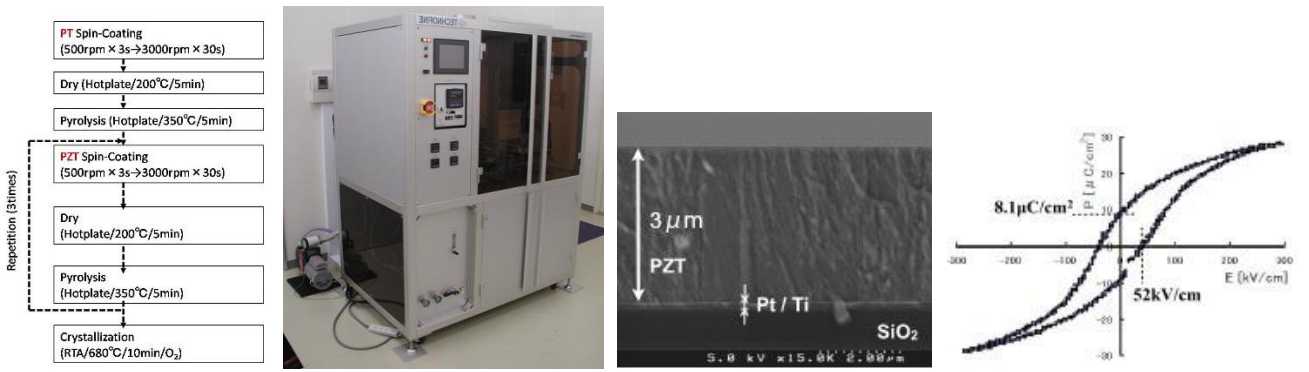


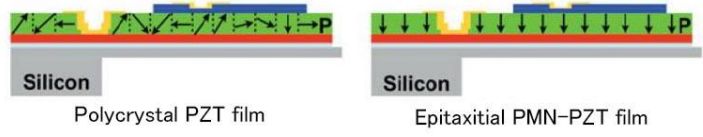
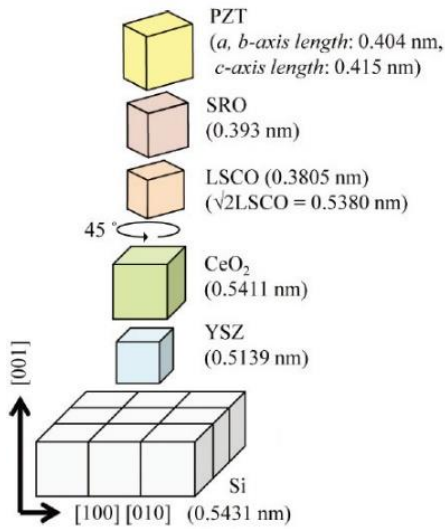
PZT thin films for MEMS



PZT thin film by MOCVD (H.Matsuo, Y.Kawai, S.Tanaka and M.Esashi, Jap. J. Appl. Phys, 49 (2010) 061503)



PZT thin film by sol-gel method (Y.Kawai, N.Moriwaki, M.Esashi and T.Ono, Proc. of the 27th Sensor Symp. (2010) 21)



| | Polycrystal PZT (MPB) | Epitaxial PMN-PZT | AlN | Epitaxial PMN-PZT | 40%Sc-AlN |
|--|-----------------------|-------------------|-----|-------------------|-----------|
| e_{31f} [C/m ²] | -12 | -25 | -1 | -14 | -2.5 |
| ϵ_{33r} | 1000 | 1500 | 10 | 270 | 30 |
| $(e_{31f})^2/(\epsilon_0\epsilon_{33r})$ [GPa] | 16 | 47 | 11 | 80 | 20 |

| Application | Figure of Merit (FOM) |
|---------------------------------------|---|
| Actuator | Piezoelectric constant d |
| Active sensor (e.g. Gyroscope) | (Piezoelectric constant) ² /(Dielectric constant) d^2/ϵ |
| Energy harvester | Electromechanical coupling factor $K^2 \propto d^2/\epsilon$ |
| Resonator (e.g. Acoustic wave filter) | (Electromechanical coupling factor) × (Q factor) K^2Q |
| Passive sensor (e.g. Microphone) | (Piezoelectric constant)/(Dielectric constant) $g = d/\epsilon$ |

Epitaxial PZT thin film with buffered layer by sputter deposition (S.Yoshida, et.al., IEEE Trans. on Ultrasonics, Ferroelectrics and Frequency Control, 61, 9 (2014) 1552)