Construction of a process platform for 8-inch MEMS prototyping

Toshio Sakamizu, Katsuyori Suzuki, Makoto Saito, Toshibumi Uryu

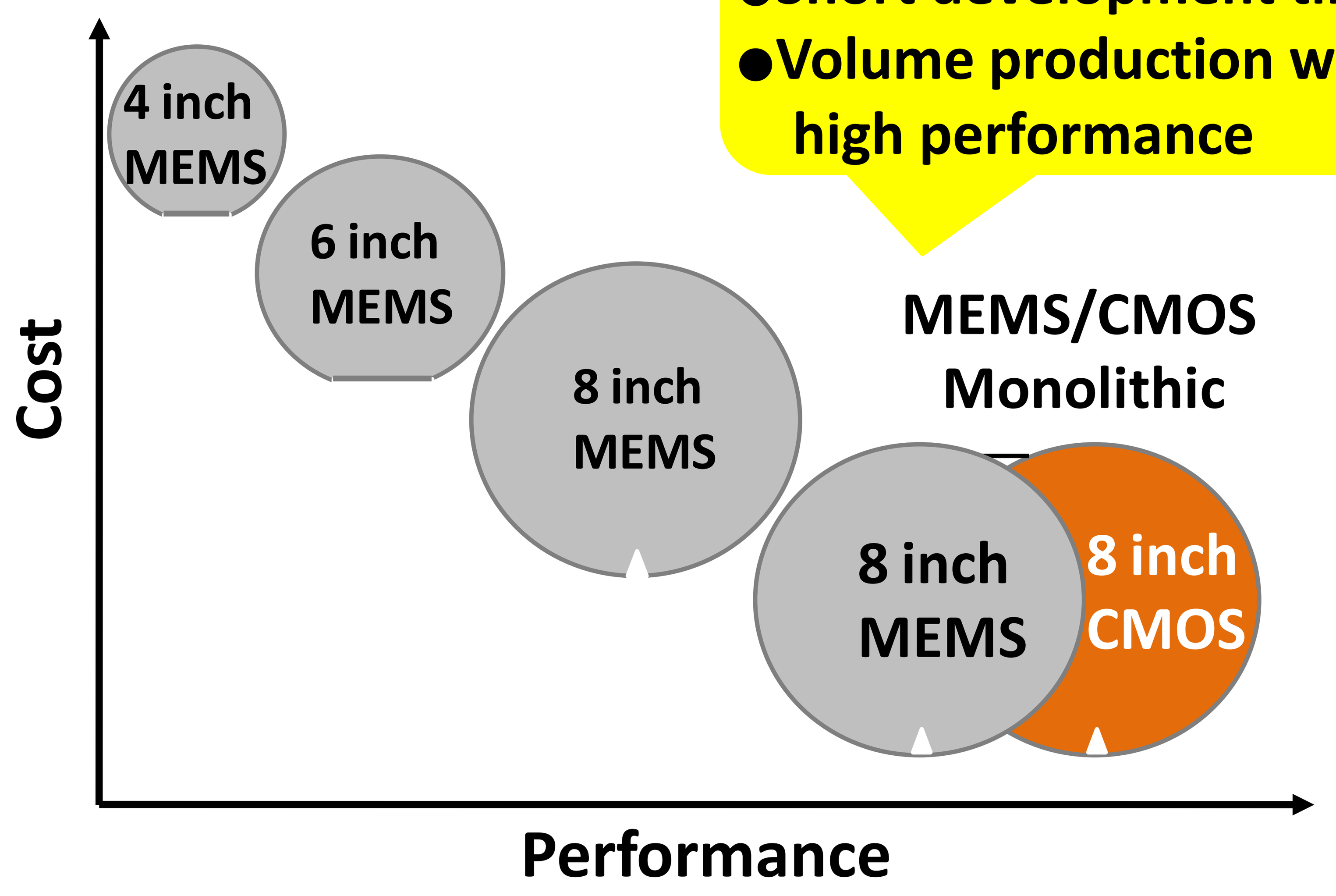
Keywords: 8-inch equipments, Si-based MEMS process, CD Uniformity, Sensor TEG prototyping

Abstract

◆A 8-inch wafer processing facility was launched on Nov.,2010 in Tsukuba Innovation Arena NMEMS (AIST Tsukuba East) aimed at developing advanced process technologies and prototyping with low environmental impact. Process capability and CD variations of 8-inch tools have been evaluated, providing enough potential for MEMS devices development and prototyping with Si DRIE process. Sensor TEG chips with a 2-µm minimum feature size and 4-9mm^2 chip area have been fabricated and wafer-level evaluation of their electrical and mechanical properties will also be conducted shortly.

Motivation

●Short life-cycles products
●Short development time
●Volume production with high performance



8-inch core process technology and first-stage prototyping of sensor TEG

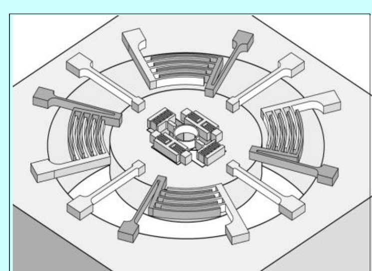
◆**Lithograph**
Tool: i-line stepper (Nikon NSR-2205i11), Double Side Mask Aligner Mask (EVG6200TB)
Thickness :1-10 µm, Resolution: 0.35µm

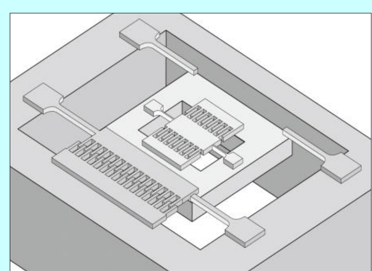
◆**Dry Etching (Si, SiO_2, poly-Si, SiN, metal, PZT)**
Tool: Si DRIE (Sumitomo MACS Pegasus-N)
Etching rate: >10µm/min. , CD uniformity: <±5%
Sacrificial layer (SiO_2) etcher (memsstar SVR vHF),
Metal wiring etcher (Panasonic E-658),
SiO2/SiN dry etcher (Panasonic E-628)

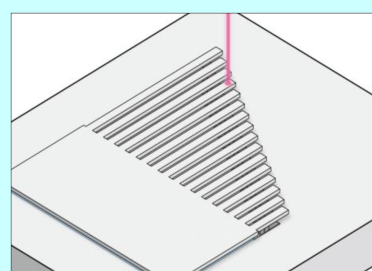
◆ **Metallization**
Tool: Sputter (ULVAC SME-200) Film: Ti, Pt, Cr, Au, Al, Ni, Mo, AlN, W CD uniformity: <±5%

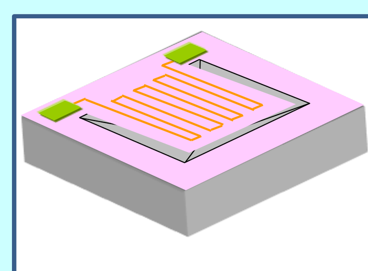
◆**Dielectric film formation**
Film: Dry/wet oxide, SiNx, poly-Si, B diffusion

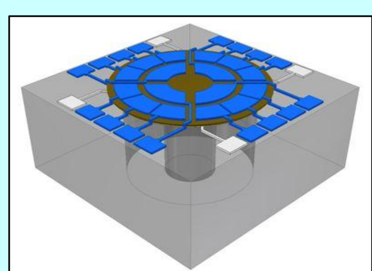
◆**TEGs Prototyping to verify practical performance and efficiency of the 8-inch MEMS process infrastructure**


Capacitance type gyro sensor
TRF: 7-24kHz


Accelerometer
TRF: 7-10kHz


Silicon resonator
TRF: 100k-1MHz

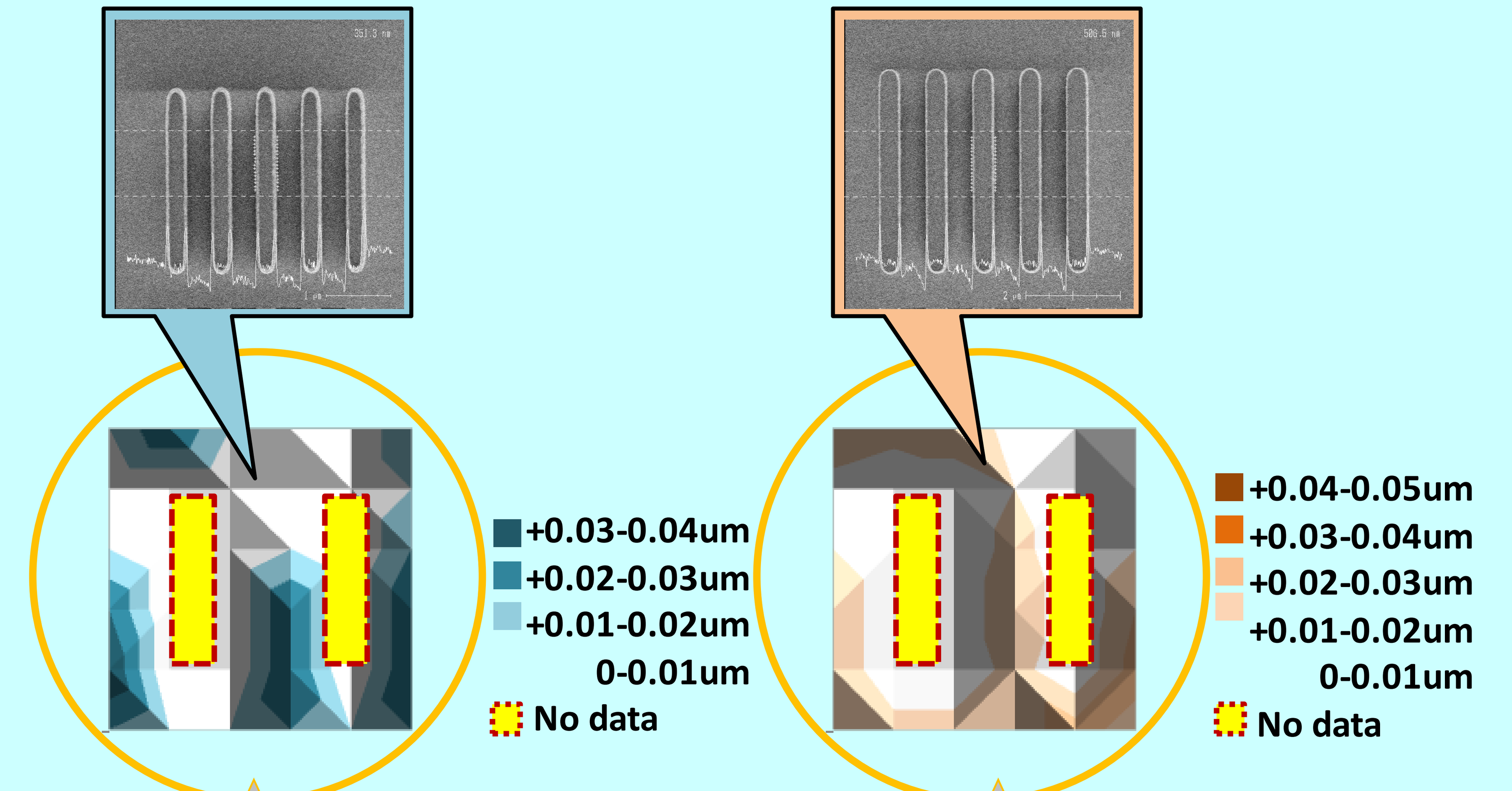

Sensor with silicon membrane structure


Gyro sensor using the PZT thin film
TRF: 20-32kHz

*TRF: Target resonance frequency

Process results

◆**CD uniformity to target resist patterns**

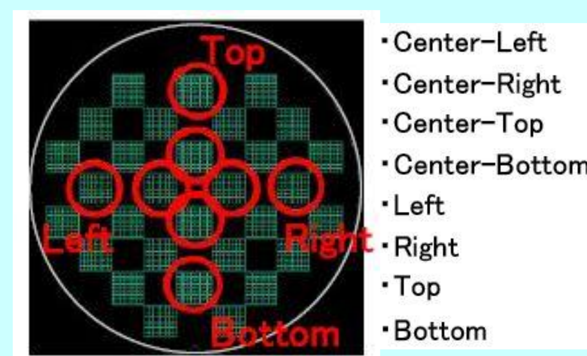


0.35µmL&S
σ: 0.013µm

0.50µmL&S
σ: 0.012µm

Resist CD was measured by using a Hitachi S-9200 CD-SEM
*CD: Critical Dimension

◆**Evaluation of etch depth/width uniformity, profile control, and etch rate for DRIE process**

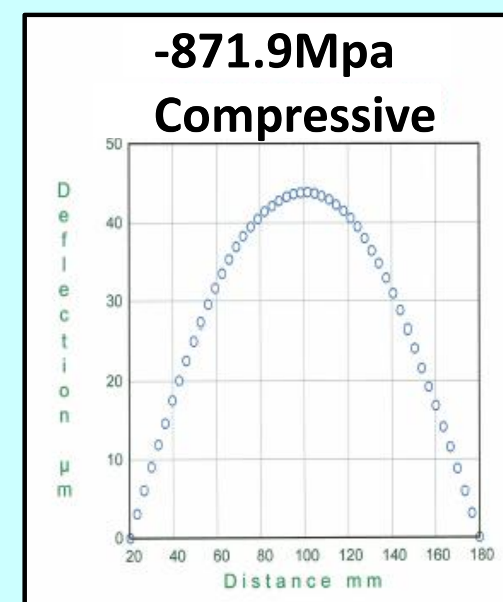


Target L/S=4/2µm
Etching rate 2.4µm/min
Uniformity ±1.4%

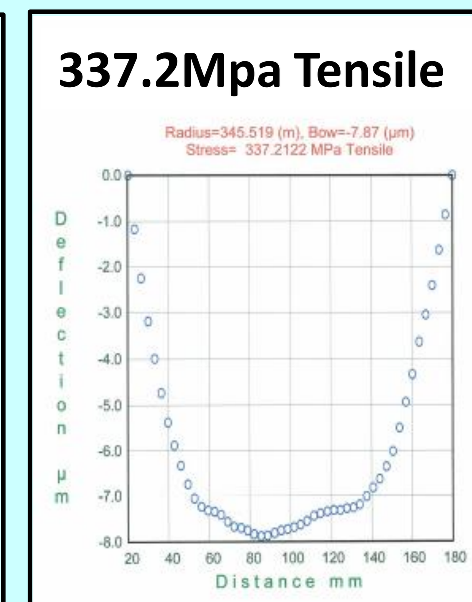
	Center-Left	Center-Right	Center-Top	Center-Bottom
Cross-section SEM images Magnification: 3k				
Cross-section SEM images (top) Magnification: 25k				
Cross-section SEM images (bottom) Magnification: 25k				
Etching depth	24.1 µm	24.3 µm	24.0 µm	24.5 µm

	Left	Right	Top	Bottom
Cross-section SEM images Magnification: 3k				
Cross-section SEM images (top) Magnification: 25k				
Cross-section SEM images (bottom) Magnification: 25k				
Etching depth	24.3 µm	24.3 µm	24.3 µm	24.7 µm

◆**Film stress measurements of SiO_2 and SiN films formed by vertical furnace LP-CVD**



SiN film
(600-nm thickness)



SiO_2 film
(600-nm thickness)

Film stress measurement System: Toho Technology FLX-2320-S

Stress measurements of the films on 8-inch Si wafer

Summary

(i) The characteristics of front-end wafer equipments have been evaluated, allowing MEMS process Integration and 8-inch prototyping.