Approaches and Thoughts on the R&D of MEMS products in Silan

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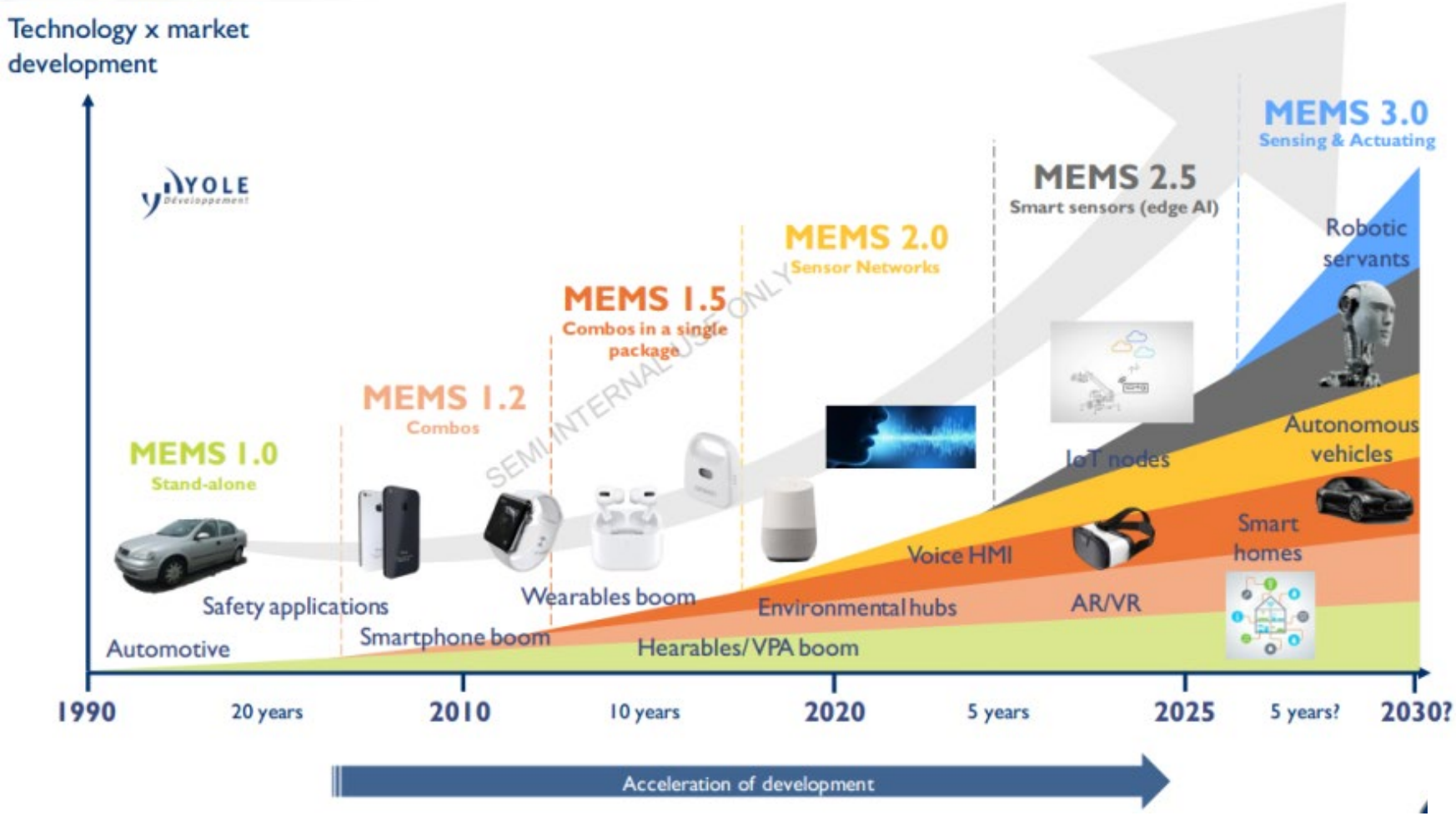
Contents

1、IDM mode of MEMS products

Trends of MEMS products: higher performance, more intelligent; more applications in different fields.



Foundry mode: provide services to fabless players; lead the product development of new category.

Foundry	Inkjet printheads	Pressure	Microphones	Inertial	Optical	Microfluidics	Infrared	RF	Oscillators	Environmental	Others
Silex			✓	✓	μmirrors	✓					μneedles, pMUT, cMUT
Teledyne Dalsa		✓		✓	switch	✓	Microbolometer				membranes
Sony			✓								
TSMC			✓	✓							cMUT
X Fab		✓	✓				Thermopile				magnetic
APM	✓	✓								✓	
IMT						✓		✓			actuators
Philips Innovation Service	✓			✓	μmirrors	✓					cMUT, μlenses, membranes
VIS (ex GloFo)				✓		✓					
Tower Jazz							✓	✓	✓		
UMC										✓	
Micralyne		✓		✓		✓					μneedles
STM						✓					μspeakers, autofocus
Rohm				piezo							
Silicon Sensing systems				✓							
Bosch	✓			✓	μmirrors			✓	✓		μspeakers, pMUT
Semefab		✓			μmirrors		Thermopile				Gas sensor, flowmeter
Tronics	✓			✓	μmirrors	✓		✓			μneedles

InvenSense Innovation in MEMS™

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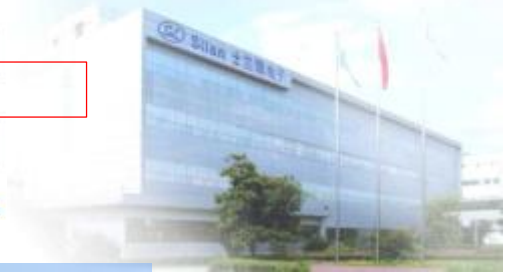
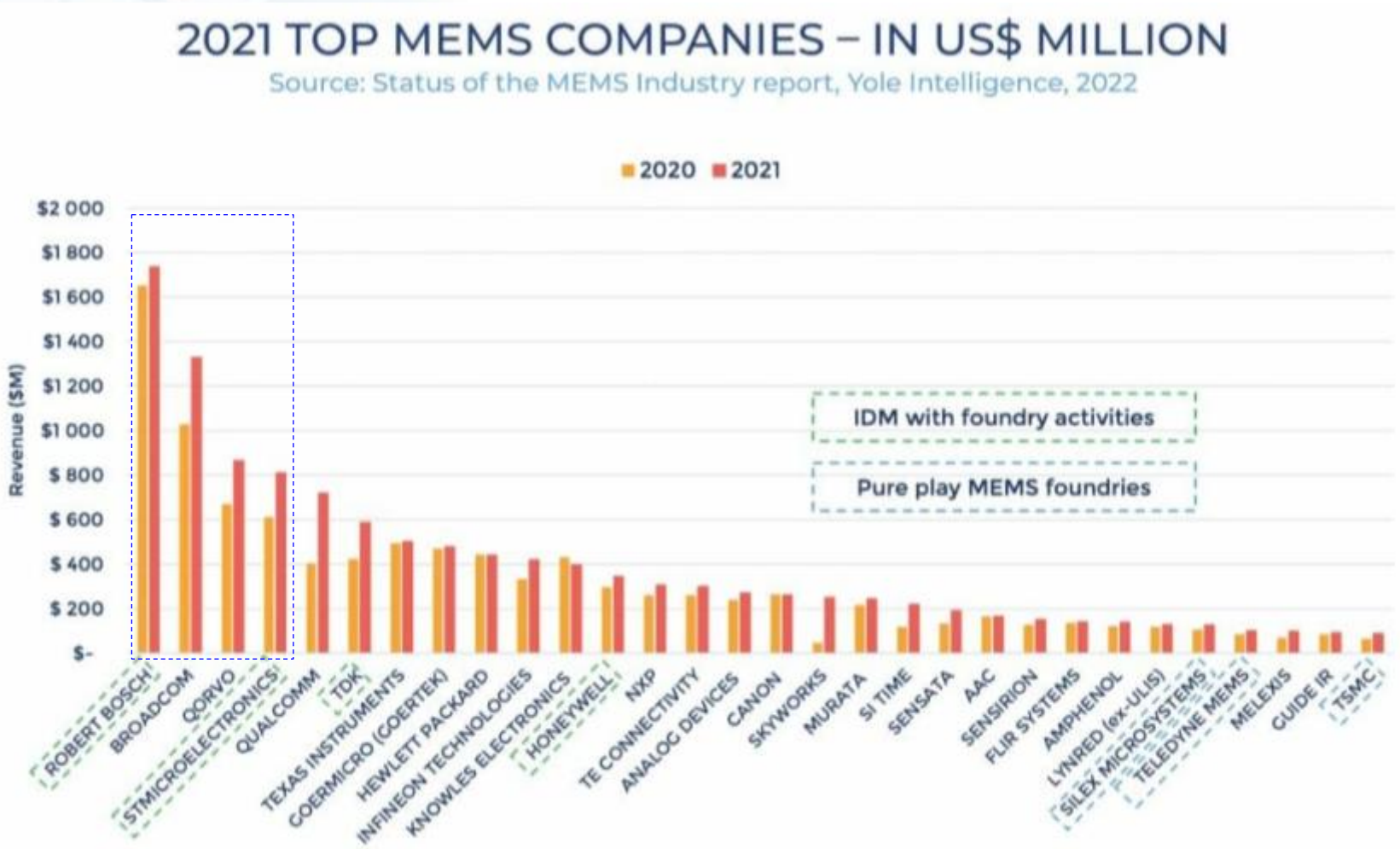
U SOUND

poLight

SiTime



IDM mode: shared by lots of international MEMS giants

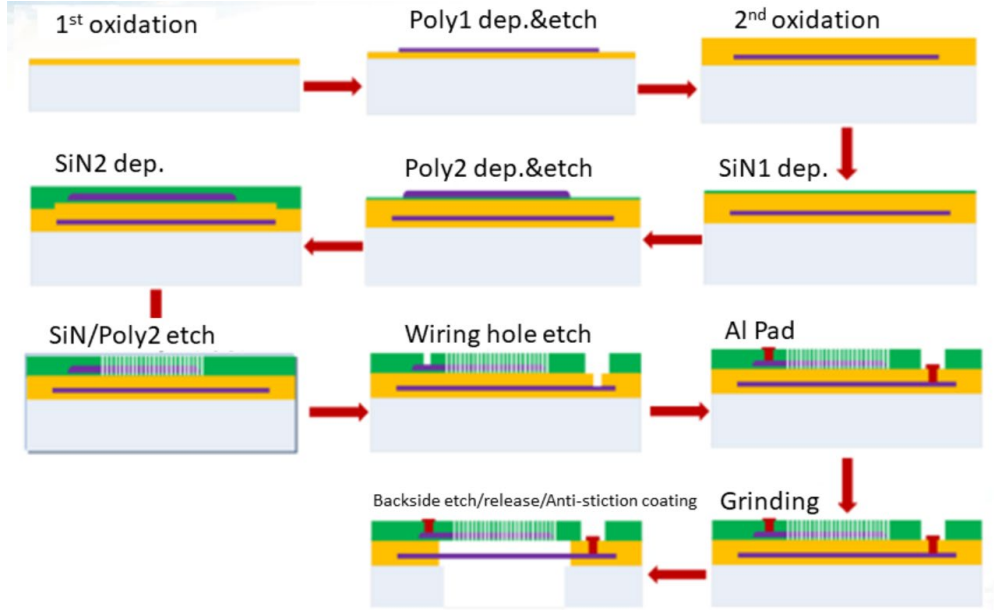


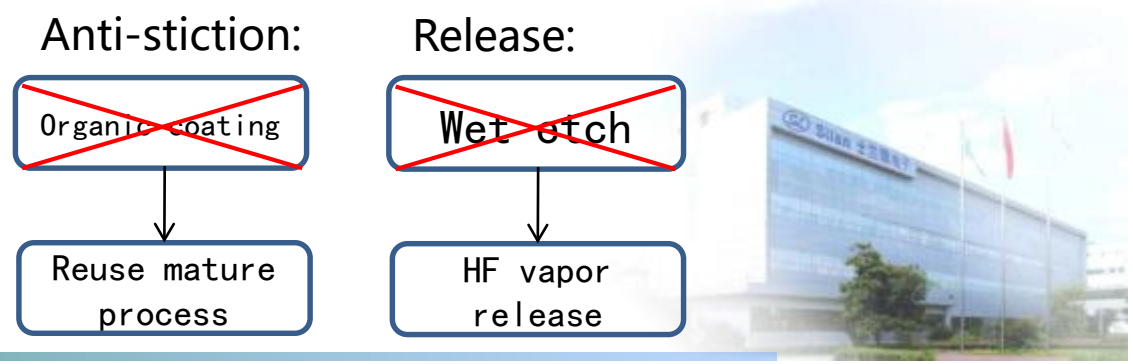
Necessity of IDM: to solidify capability in low-level processes to render product quality; to support more product categories to enlarge revenue

- MEMS product: One Product, One Process;
- MEMS market: enormous categories, but small market for each; high cost to develop specific process for a particular product
- Different products rely on the same low-level processes, therefore self-owned fab has the advantage to solidify low-level processes, and improve product quality;
- Packaging technology has substantial impact on performance and reliability for MEMS product, therefore self-owned package fab facilitates the control and optimization of package parameters;
- MEMS products need special test facilities different from IC products, therefore self-owned test facilities have the advantages to insure parameter coverage and control the cost.

Feasibility of IDM: to increase equipment reuse to average investment down; to add non-standard process equipment and reuse mature single-step process asap.

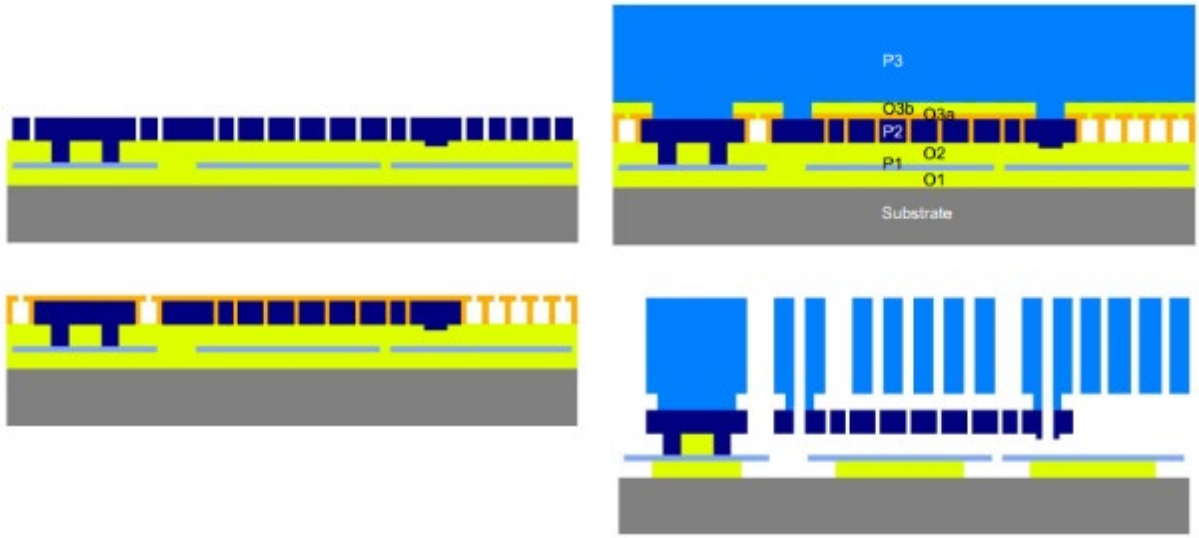
- Coexistence of CMOS and MEMS products in the same process line;
- Product selection: to choose MEMS product compatible to CMOS process
- Add equipment for non-standard processes (such as DRIE, HF vapor release, wafer-level bonding)
- To reuse mature single-step MEMS process step asap. in the design of process integration

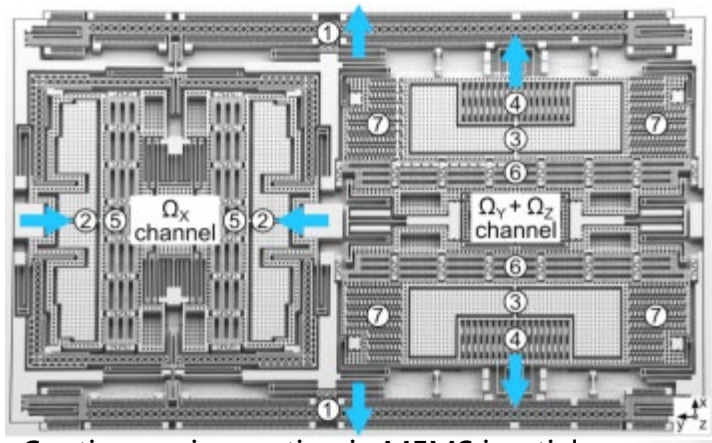




Advantages of IDM: to lower time-to-the-market and to facilitate technology innovation and quality improvement

- The time to market for new products can be reduced by 10% to 30%.
- To facilitate the collision of MEMS design and process R&D, and therefore help generate new product process IDEA and innovate to improve product performance and quality.
- To facilitate the designers to control the entire product process, control process fluctuations through the online monitoring module, and improve product quality.





Continuous innovation in MEMS inertial sensors

2、MEMS product development in Silan

HANGZHOU SILAN MICROELECTRONICS CO.,LTD

Hangzhou Silan Microelectronics Co., Ltd

MEMS/ASIC design

Headquarters

Silan Headquarters
--Marketing & Sales
--PL:Power Management and Driver
--PL:MEMS Sensor
--PL:PIM
--PL:R.F. and Mixed Signal
--PL:Digital Audio/Video
--PL:MCU
--PL:Discrete Device

Silan Test Factory in Binjiang
-- Wafer test
-- IC test

MEMS process

Hangzhou

Hangzhou Silan Integrated Circuit Co., Ltd
-- Wafer Fab 5" & 6"

Hangzhou Silan Multichip Co.,Ltd
-- Wafer Fab 8"

Silan Quanjia Semiconductor Company
-- (under construction)
-- Automotive qualified power module manufacture

Hangzhou

Hanzhou Silan Azure Technology Co., Ltd
-- High-luminance LED chip anufacture

Silan Multi-Color Optoelectronics Co.,Ltd
-- High-performance LED product package

Package&test

Chendu

Chengdu Silan Semiconductor Manufacturing Ltd
-- Silicon Wafer Fabrication Manufacture

Chengdu Silan Perfect Technology Co., Ltd
-- IPM package
-- Power devices package
-- MEMS sensor package

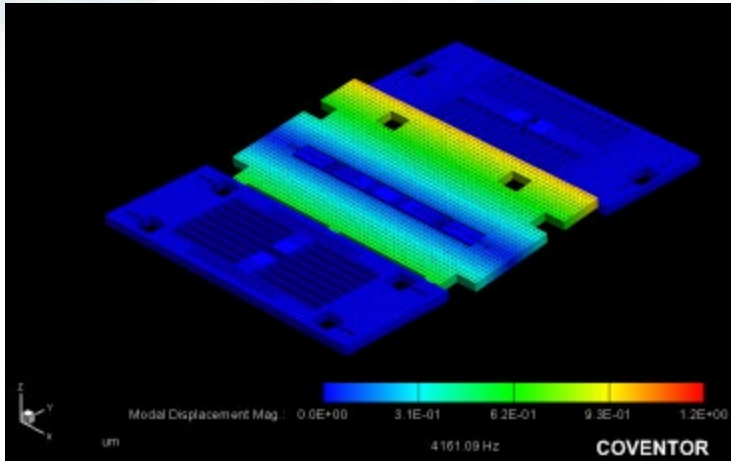
Xiamen

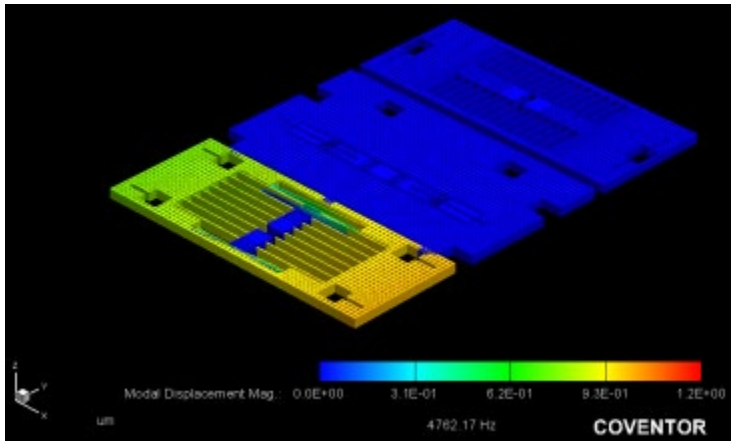
Xiamen Silan Microchip Manufacturing Co. Ltd
-- (under construction)
-- Wafer Fab 12"

Xiamen Silan Advanced Compound Semiconductor Co., Ltd
-- (under construction)
-- 6" Compound Semiconductor Fabrication

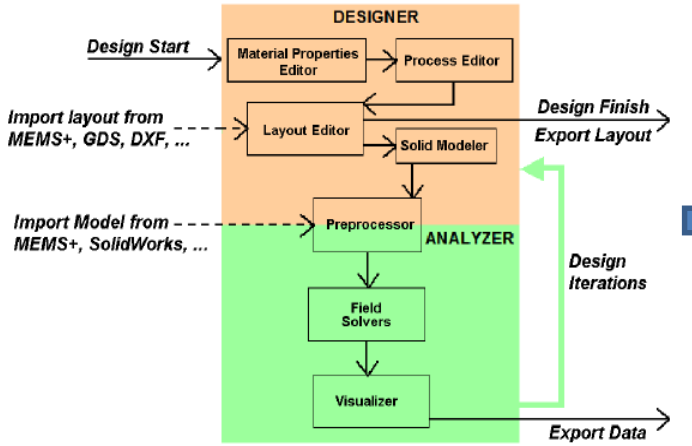
Overview of Sian MEMS in IDM mode

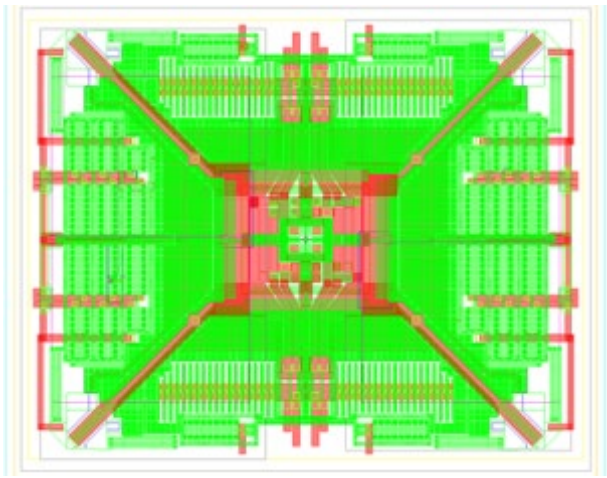
MEMS/ASIC design:



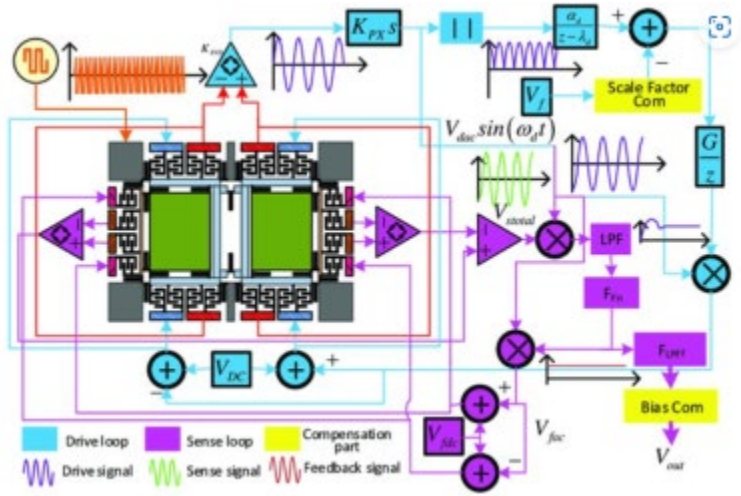


FEM simulation





Procedures of MEMS design



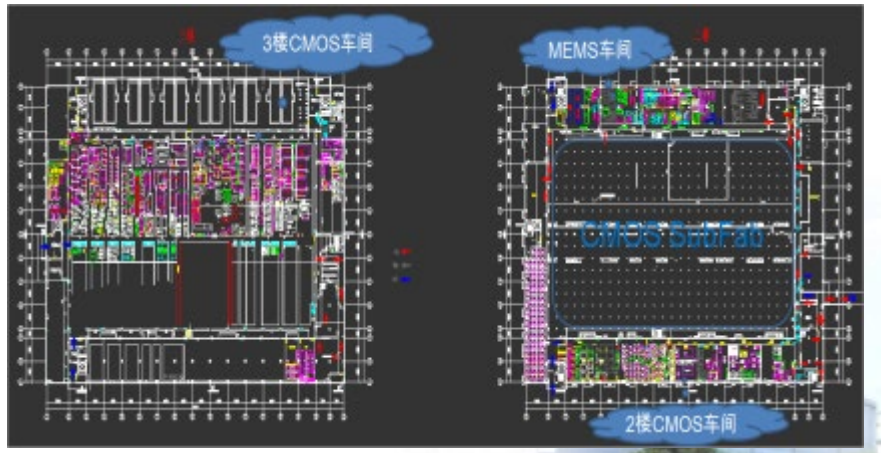
Collaborative design of MEMS&ASIC

Process capability: standard & non-standard process & self-owned package/test facility, Silan has the capability of 10k wafers/month for MEMS product

Process	Tool Type	Capability
PHOTO	NIKON Scanner S204 ASML AT1100	0.22um technology node 0.11um technology node
ETCH	LAM DSIE Hitachi M712 SPTS Rapier LAM 9600	60um depth Deep Trench Etch STI Etch MEMS Bosch Trench Etch Metal Etch
EPI	AMAT 5200	Super Junction RP/ATM Epi
PVD	AMAT Endura AMAT MoCVD	Metal Depo 0.18um Barrier Metal Depo
CVD	AMAT Ultima Novellus Altus	HDP WCVD
CMP	AMAT Mirra Ontrack	Poly, W, Oxide CMP
IMP	Varian	Backside High Energy H/He Imp
BG	Disco DTG8440	50um thin Backside Grinding

Non-standard process list to fully cover surface micromachining process:

- Deep reactive ion etch (Bosch);
- HF Vapor release;
- Double-sided lithography;
- Wafer-level bonding;
- Atomic layer deposition.



Management optimization in fab

Process backbone: surface micromachining compatible to CMOS

1、oxidation

2、backside mark&poly1

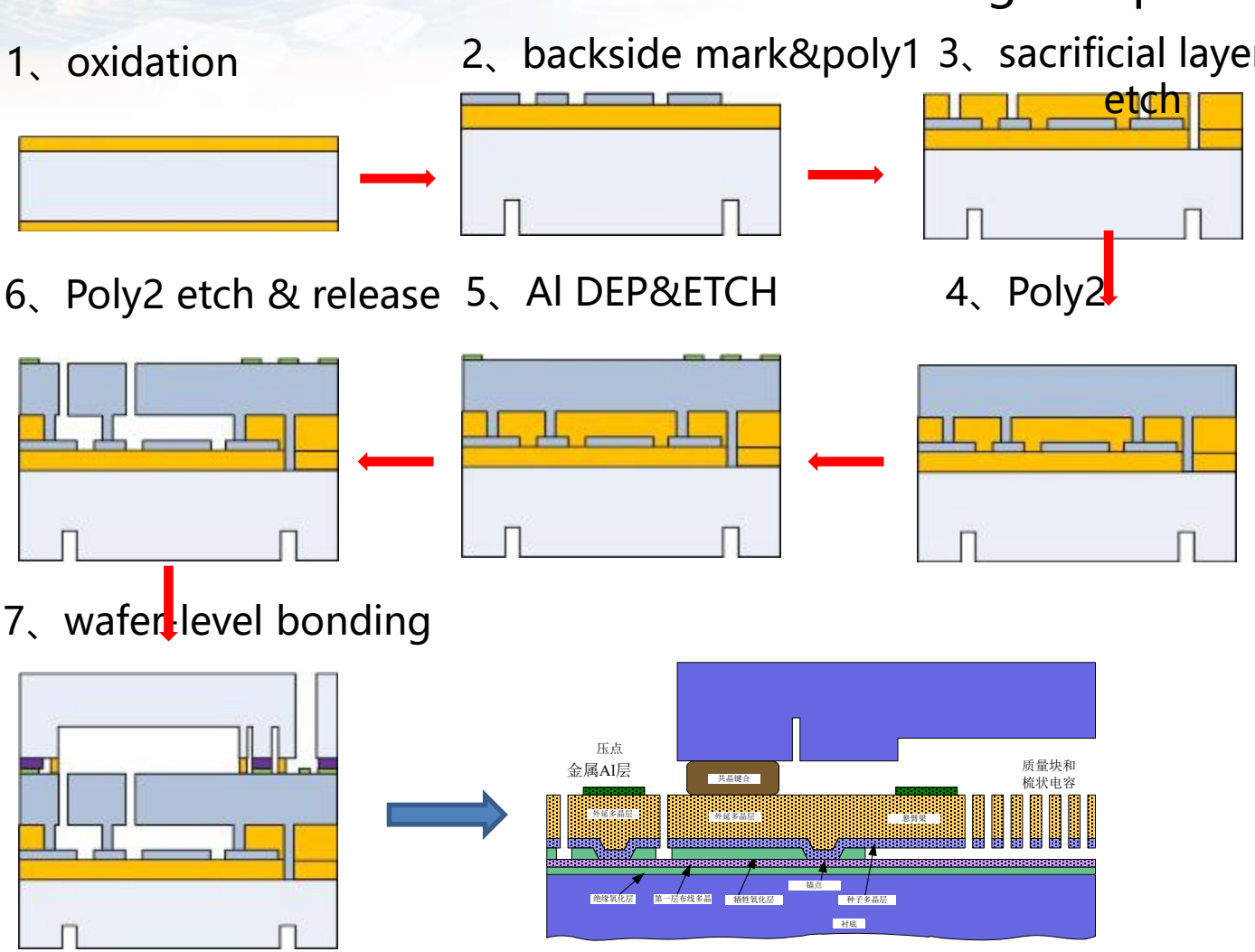
3、sacrificial layer and etch

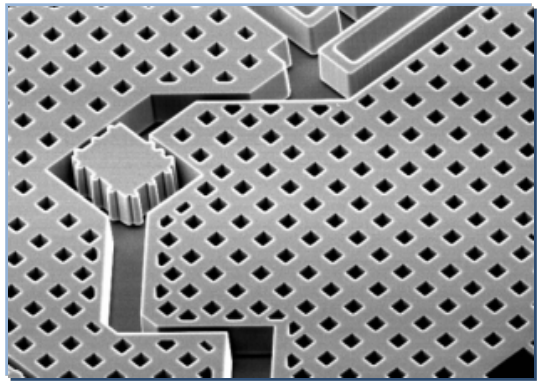
4、Poly2

5、Al DEP&ETCH

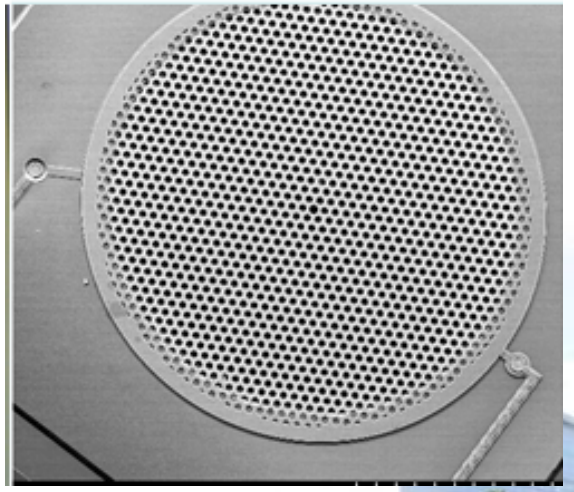
6、Poly2 etch & release

7、wafer-level bonding





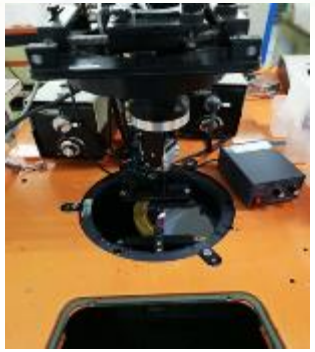
Inertial sensors

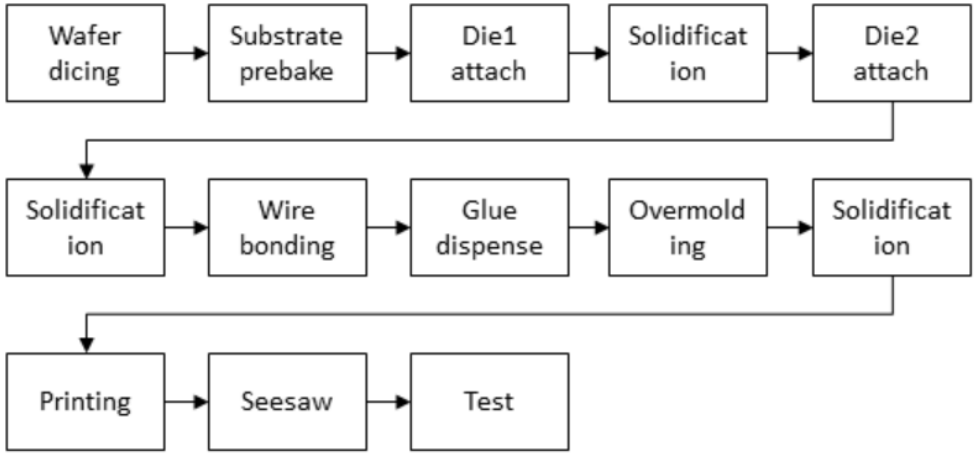


MEMS microphone

Package & test: self-owned fab and facilities in full coverage

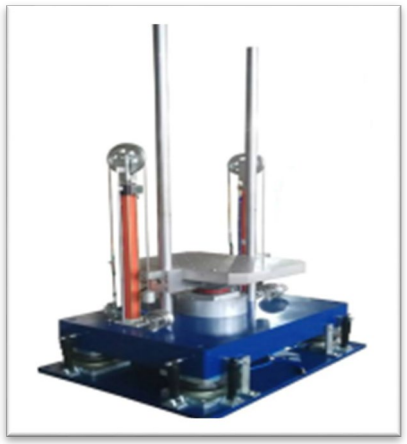
CP test:





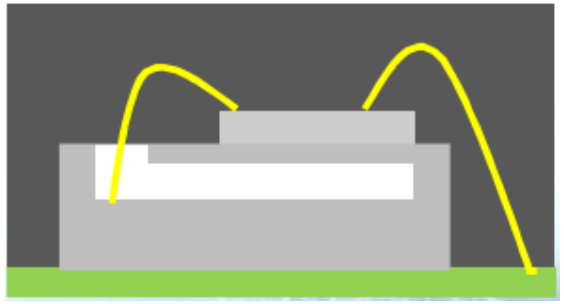
Reliability test:

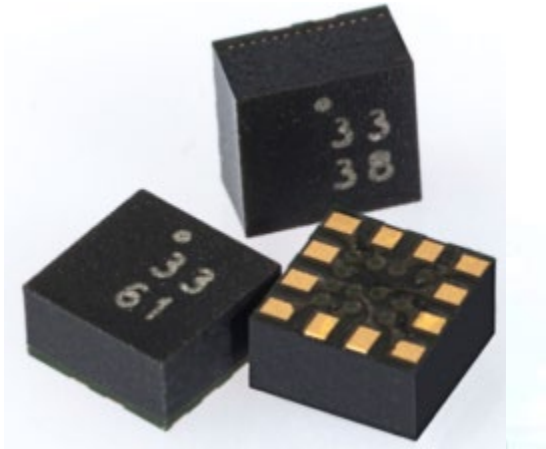
20cm free fall



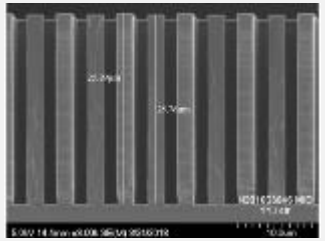
0.2ms@10000g shock

1.2m tumbling barrel

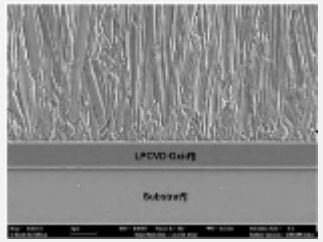




Achievements: performance improvement, reliability improvement and new product

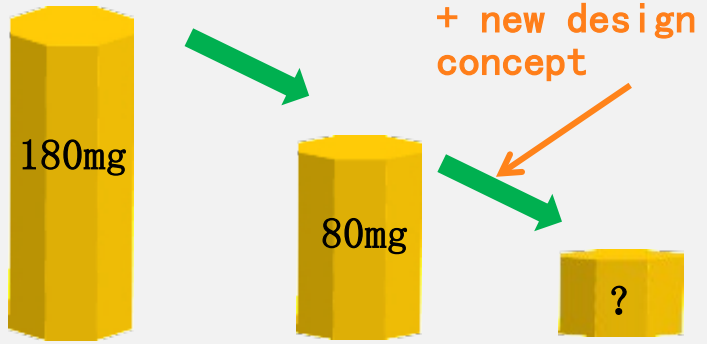


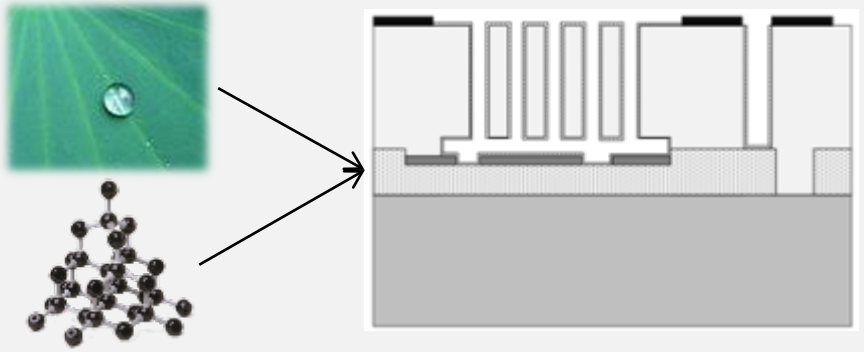
Optimization of single-step process



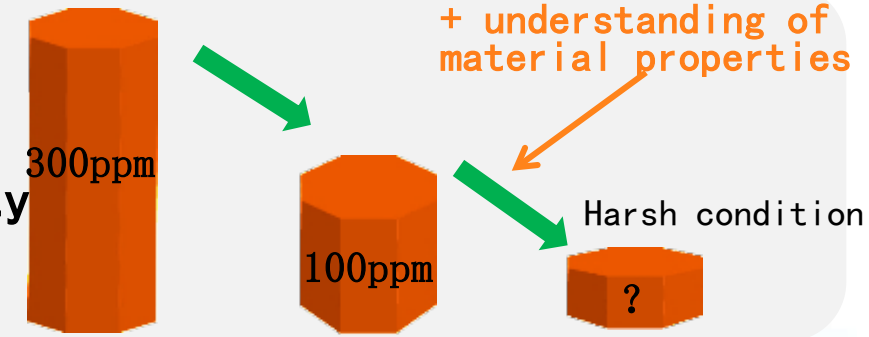
Optimization of material properties

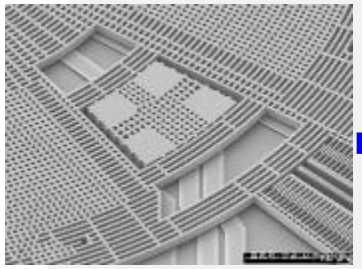
g-sensor offset



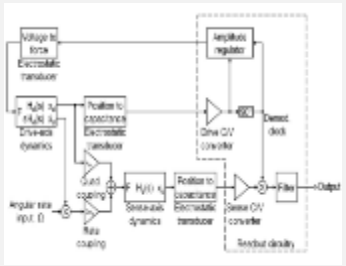


g-sensor reliability

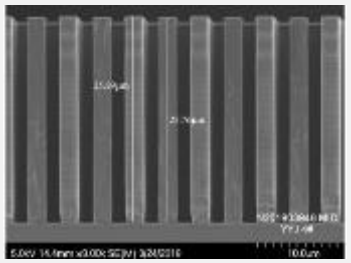




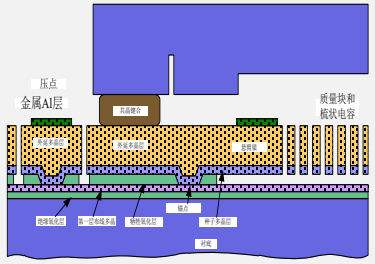
Patented micromechanics



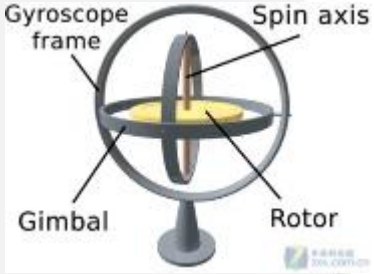
Self-designed ASIC



Process optimization

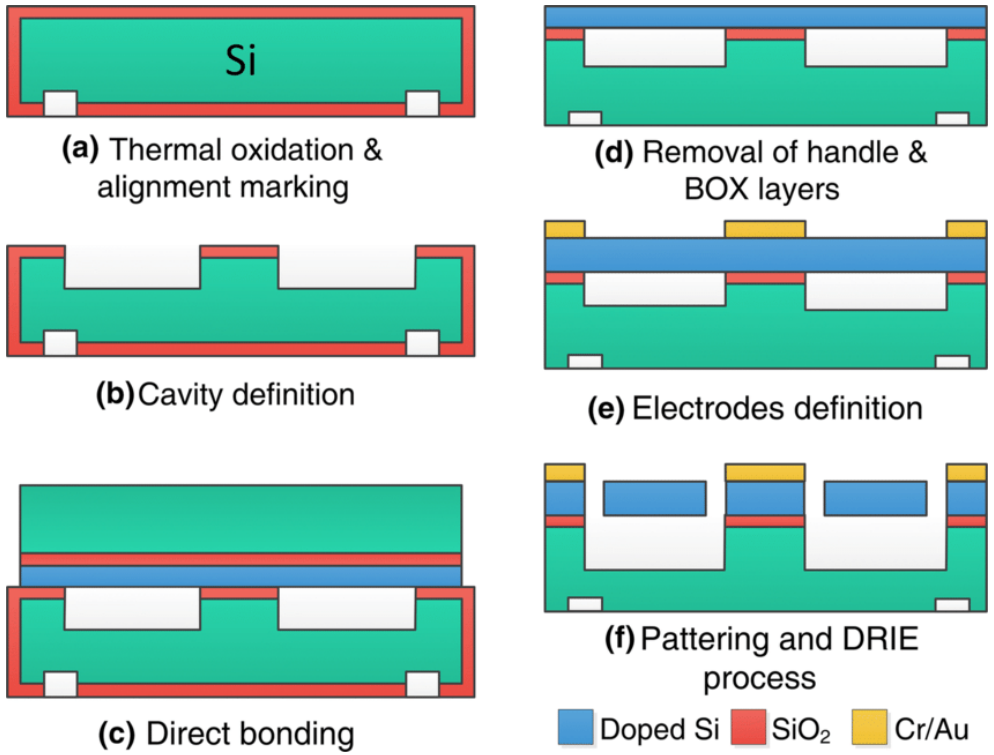


WLP in vacuum

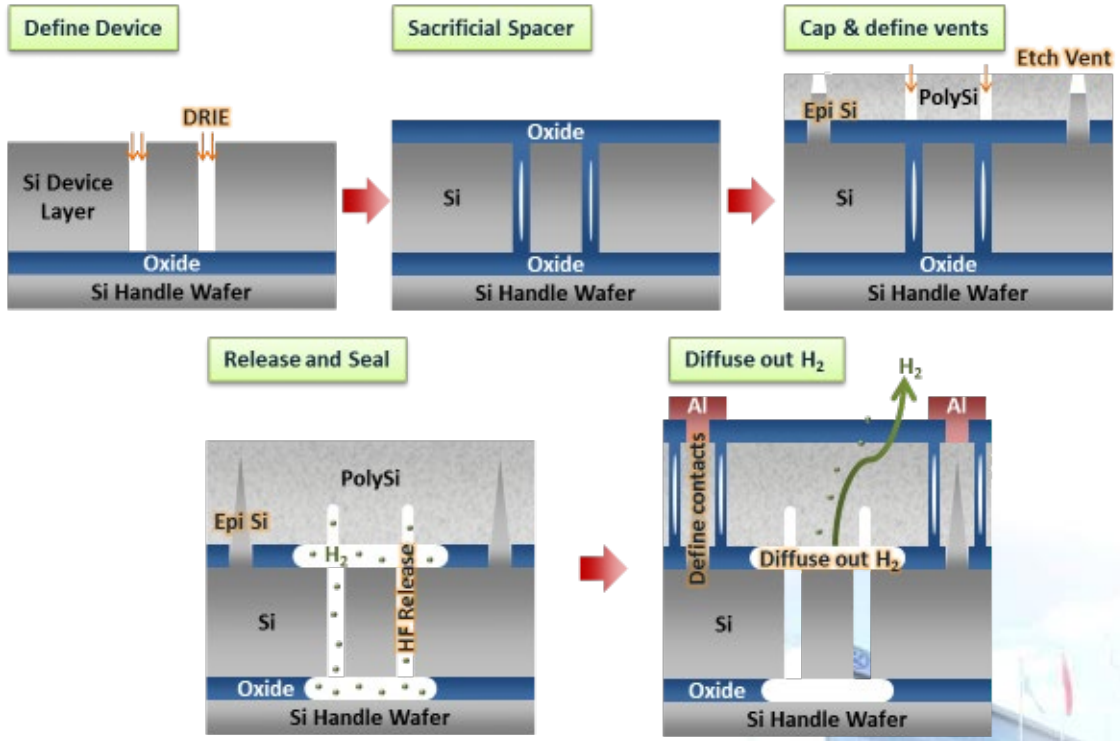


CE gyroscopes

SOI-based MEMS products: consider to develop more high-end products (to exploit thicker device layer and extraordinary mechanical properties of SCS) other than consumer electronics



Cavity-SOI-based MEMS process



SOI-based surface-like micromachining

THANK YOU