

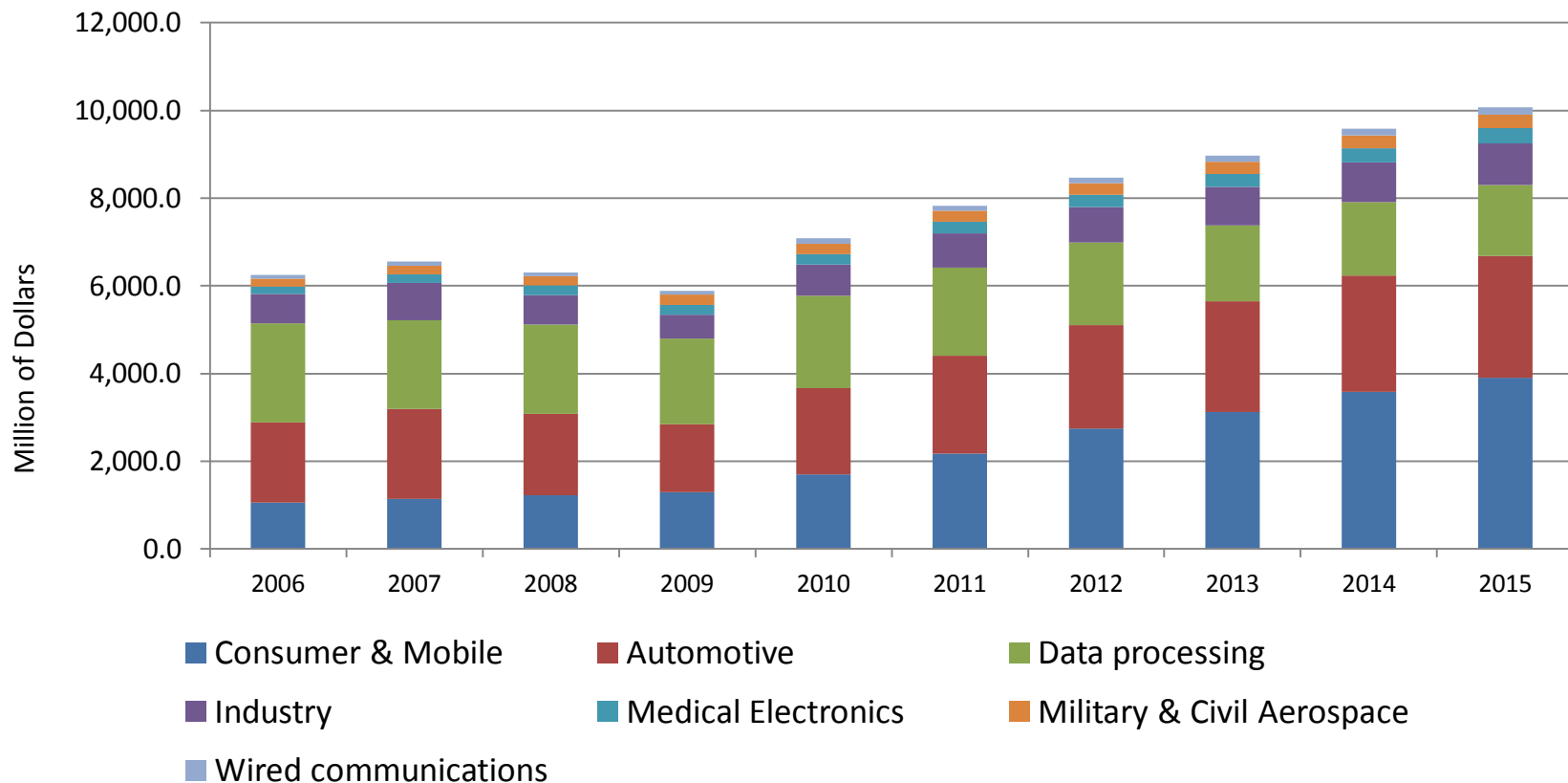


# An Overview of China MEMS & Sensor Industry

上海微技术工研院 SITRI

2014/3/24

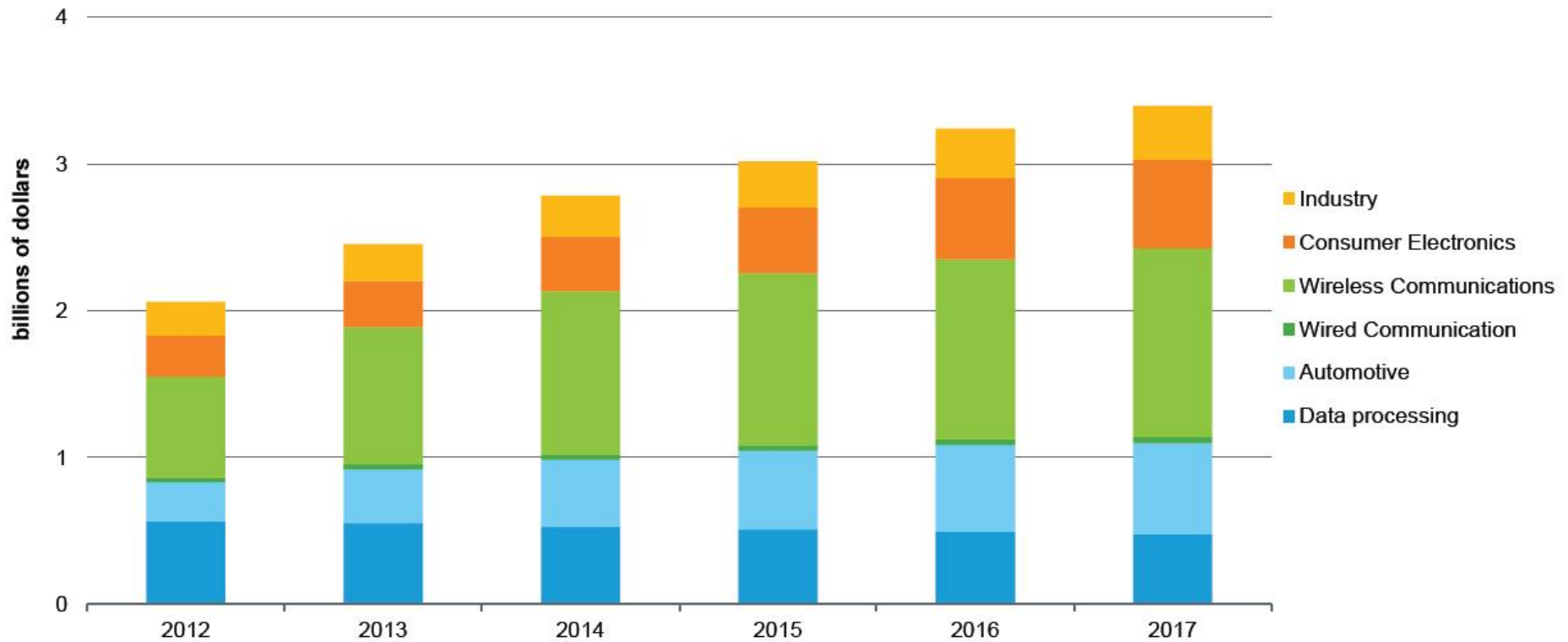
# Global MEMS Sensor Market



Source: IHS

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Semiconductor	265,025	275,216	261,144	231,686	307,638	310,760	303,171	318,742	337,899	353,507
MEMS	6,246	6,558	6,303	5,886	7,090	7,830	8,470	8,964	9,581	10,070
<b>MEMS/SEMI</b>	<b>2.36%</b>	<b>2.38%</b>	<b>2.41%</b>	<b>2.54%</b>	<b>2.30%</b>	<b>2.52%</b>	<b>2.80%</b>	<b>2.82%</b>	<b>2.85%</b>	<b>2.88%</b>
Y/Y growth of SEMI		3.8%	-5.1%	-11.3%	32.8%	1.0%	-2.4%	5.1%	6.0%	4.6%
<b>Y/Y growth of MEMS</b>		<b>5.0%</b>	<b>-3.9%</b>	<b>-6.6%</b>	<b>20.5%</b>	<b>10.4%</b>	<b>8.2%</b>	<b>5.8%</b>	<b>6.9%</b>	<b>5.1%</b>

# China MEMS Sensor Market



Source: IHS

# Sensor Expansion in Mobile Phone



China Mobile Phones



iPhone 5



Accelerometer  
E-Compass  
Gyroscope  
Si Microphone  
Proximity  
Ambient Light

iPhone 5s



Accelerometer  
E-Compass  
Gyroscope  
Si Microphone  
Proximity  
Ambient Light  
Fingerprint identity sensor  
M7



Galaxy S3



Accelerometer  
E-Compass  
Si Microphone  
Proximity  
Gyroscope  
Ambient Light  
Barometer

Samsung Galaxy S4



Accelerometer  
E-Compass  
Si Microphone  
Proximity  
Gyroscope  
Ambient Light  
Barometer  
Temperature  
Humidity  
Hall Sensor  
RGB Sensor  
Gesture Sensor

Samsung Galaxy S5

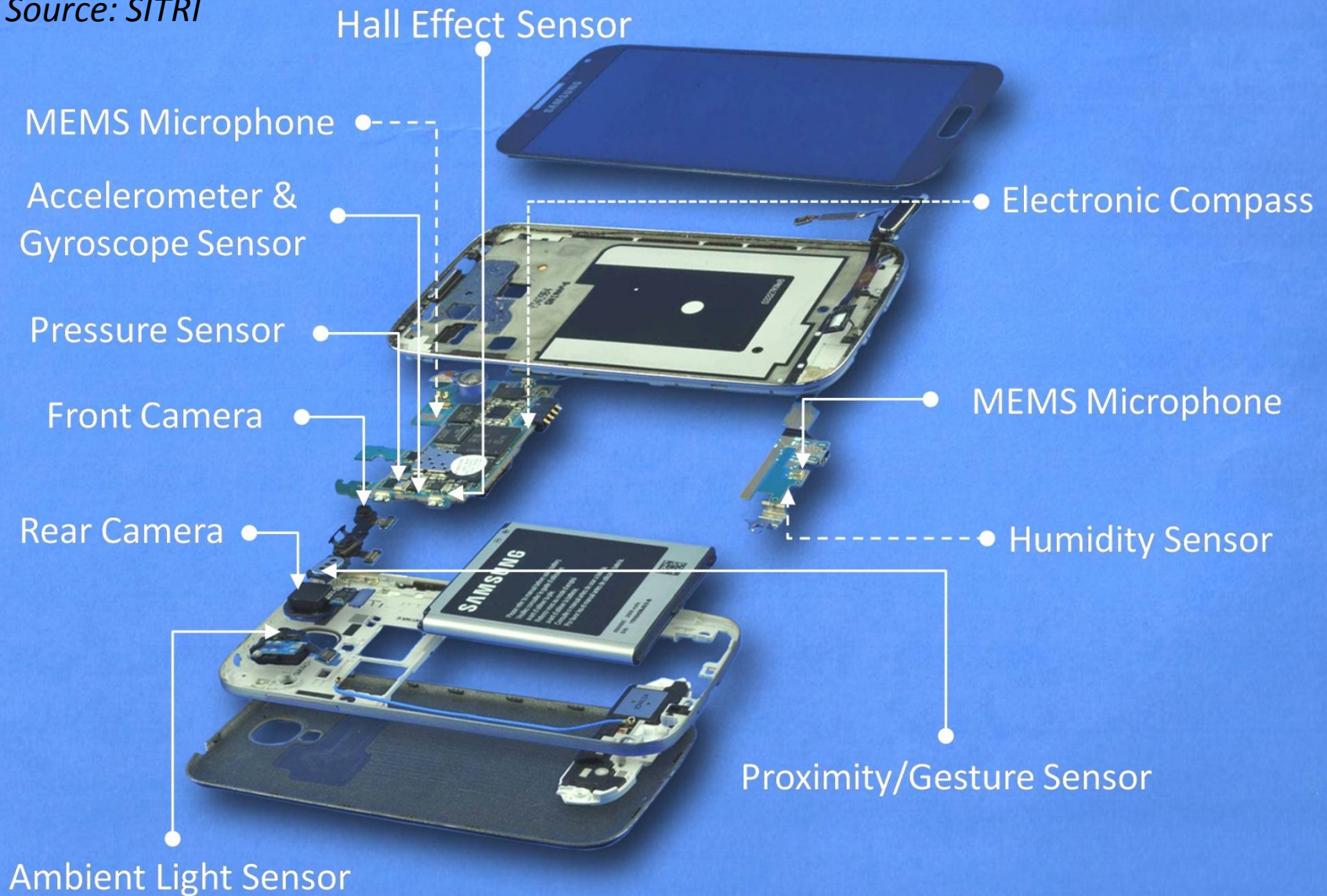


Accelerometer  
E-Compass  
Si Microphone  
Proximity  
Gyroscope  
Ambient Light  
Barometer  
Temperature  
Humidity  
Hall Sensor  
RGB Sensor  
Gesture Sensor  
Fingerprint identity sensor  
Heart Rate Sensor



# MEMS & Sensors in Galaxy S4

Source: SITRI



# Sensor Fusion Innovation

## Hidden Innovation in the GALAXY S4

GALAXY S4 gets you closer to what matters in life, bringing your world together

### RGB Light Sensor

Measures the red, green, blue, and white intensity of the light source  
- Samsung Adapt Display

### Hall Sensor

Recognizes whether the cover is open or closed  
- S View Cover

### Barometer

Identifies the atmospheric pressure at the user's current location  
- S Health: Walking Mate

### Gesture Sensor

Recognizes the user's hand movements using infrared rays  
- Air Gesture

### Proximity Sensor

Recognizes whether the mobile phone is located near the user by using infrared rays  
- Direct Call

### Gyro Sensor

Detects the mobile phone rotation state based on three axes  
- Smart Rotation

### Accelerometer

Detects the mobile phone movement state based on three axes  
- S Health: Walking Mate

### Geomagnetic Sensor

Detects magnetic field intensity based on three axes  
- Digital Compass MAP

### Temperature Humidity Sensor

Checks temperature and humidity levels  
- S Health: Comfort Level

SAMSUNG TOMORROW

# Galaxy S4 Sensor Summary

Source: SITRI

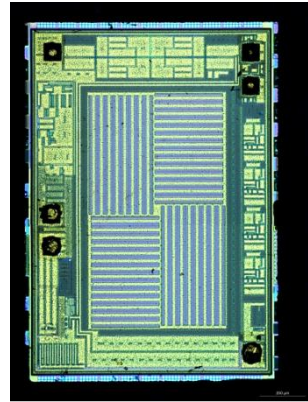
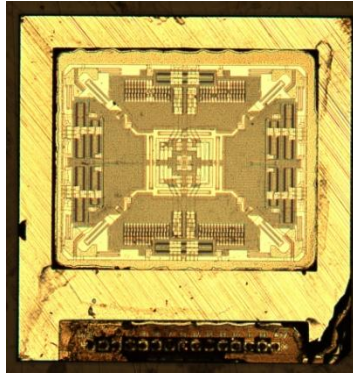
Sensor Type	Part Number	Vendor	Form	Pin Count	Die Size (mm*mm)
3D Accelerometer & 3D Gyroscope	LSM330	ST Micro	MCP-4 Chips	24	2.75x2.65
Pressure Sensor	BMP180	Bosch Sensortec	MCP-2 chips	6	1.40x1.10
Hall Effect IC	S5712ACDL1-L4T	Seiko Instruments	DFN	4	0.83x0.58
3-Axis Electronic Compass	YAS532B	Yamaha	Flip Chip Solder	6	1.47x1.47
Digital Humidity Sensor	SHTC1	Sensirion	DFN	4	1.32x0.76
2.0MP BSI CMOS Image sensor	S5K6B2YX03	Samsung	COB	54	4.50x3.30
Gesture Sensor	MAX88920	Maxim	DFN	14	1.59x1.12
Ambient Light Sensor	CM32xx	Capella Micro	DFN	4	1.00x0.89



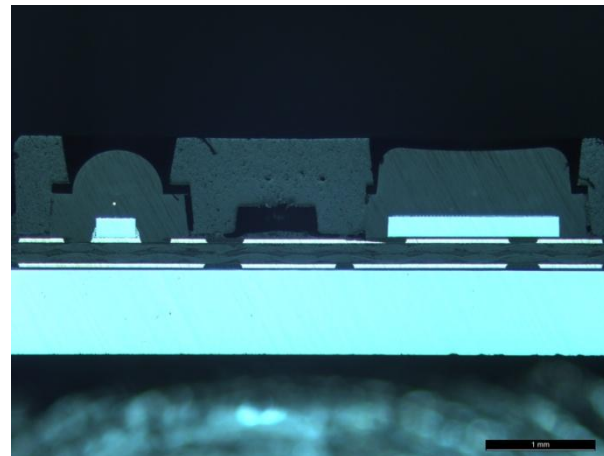
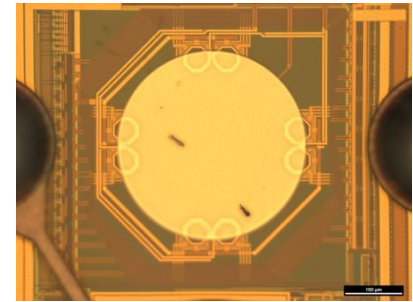
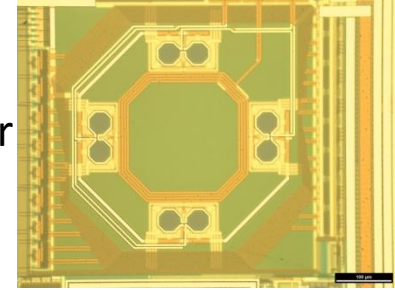
# Sensor Details in Galaxy S4

Source: SITRI

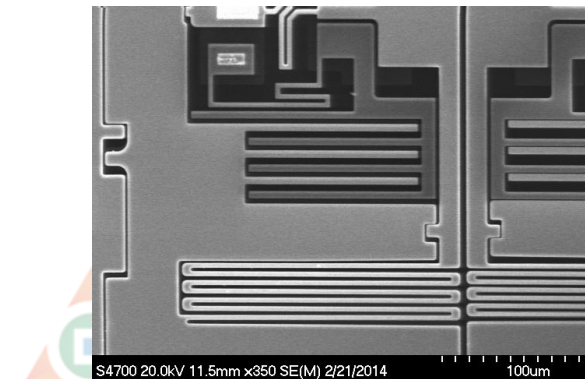
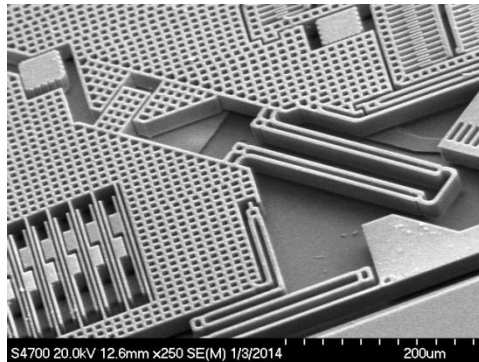
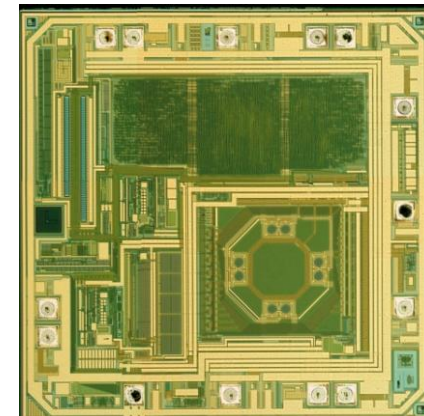
6-axis A+G Sensor



Magnetic Sensor



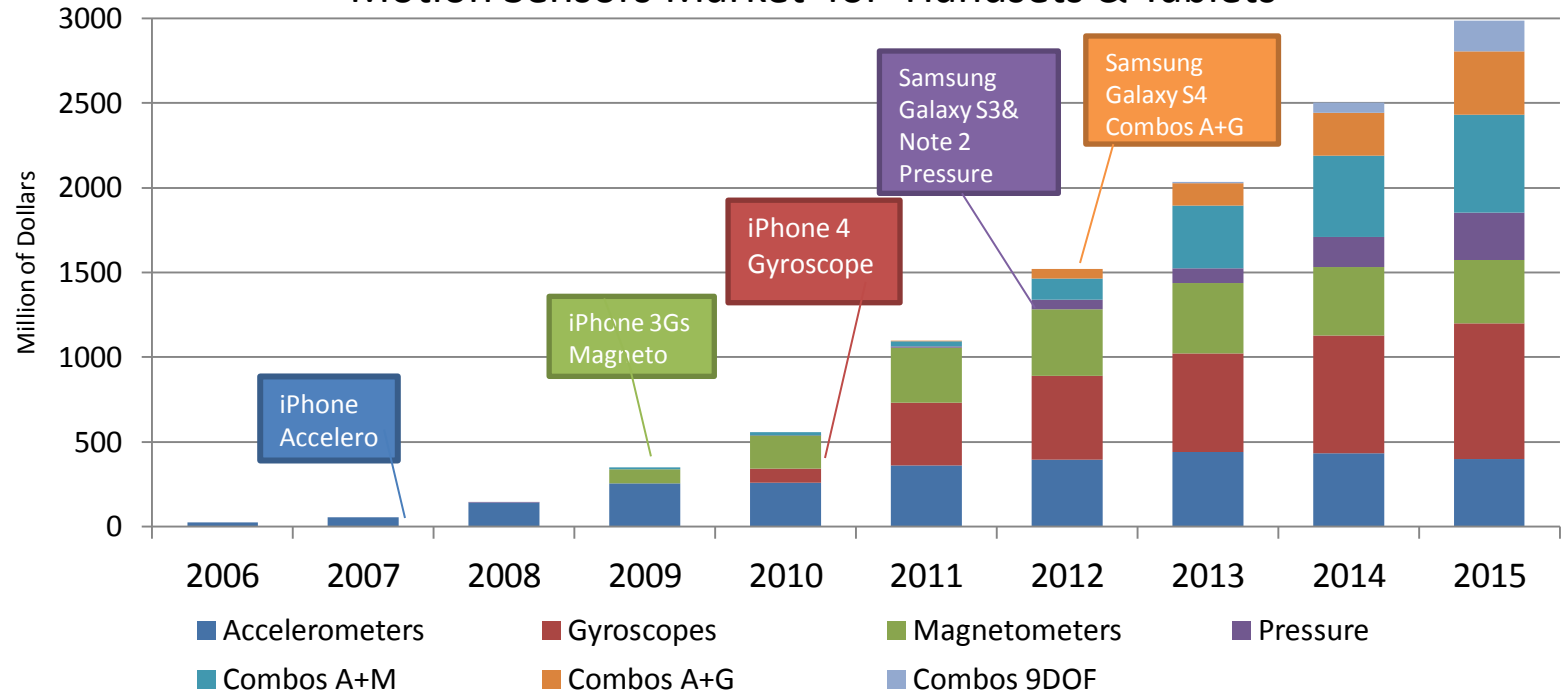
Gesture & Light Sensor





# Motion Sensor

## Motion Sensors Market for Handsets & Tablets



		Accelerometer	Magnetometer	Gyroscope	Combos A+M	Combos A+G	Combos 9DoF
		Overseas	ST	X		X	X
	Bosch	X	X	X	X	X	X
	InvenSense	X		X		X	
	Kionix	X			X		X
China	MEMSIC	X	X				
	Senodia		X	X			
	QST		X				
	MiraMEMS	X					

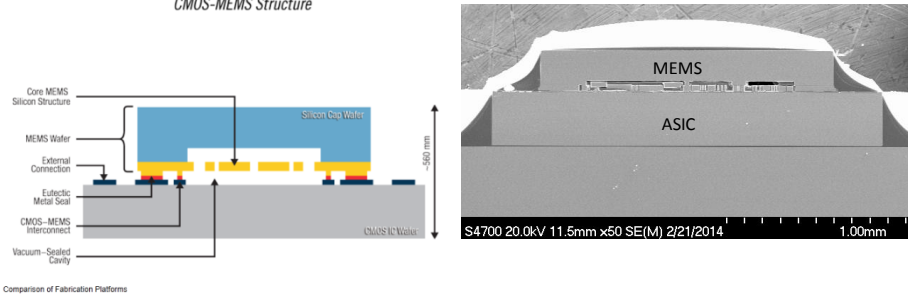


# Sensor Process Analysis- Accelerometer & Gyro

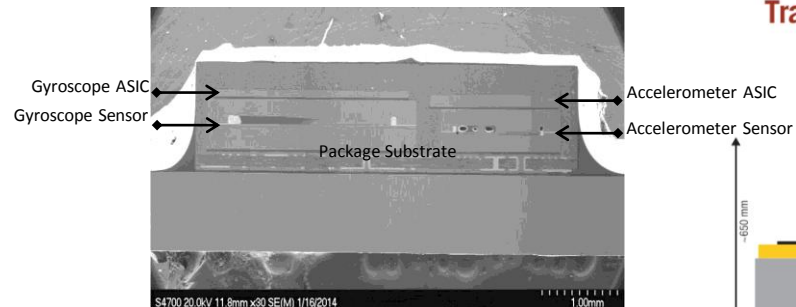
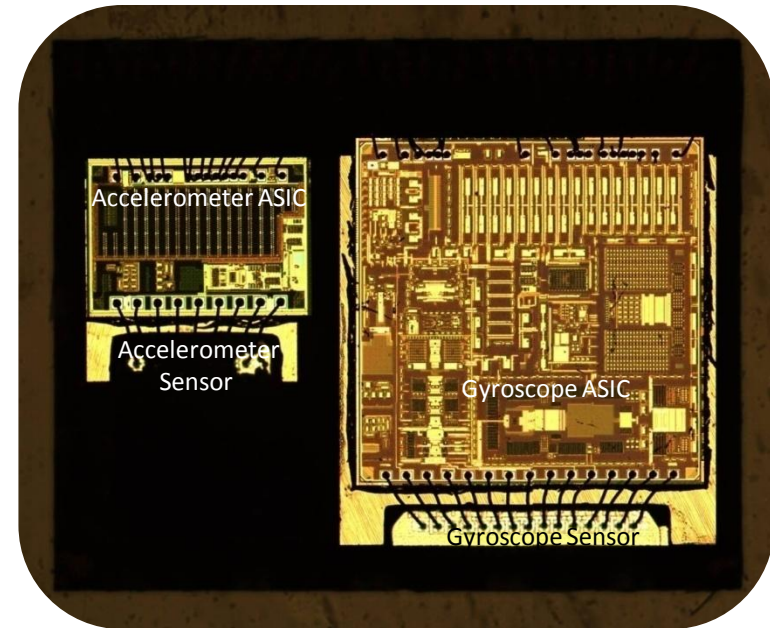
Source: SITRI

## InvenSense

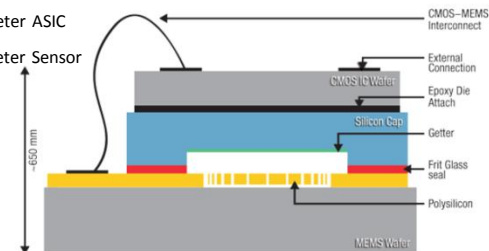
**InvenSense Fabrication Platform**  
CMOS-MEMS Structure



## ST Micro



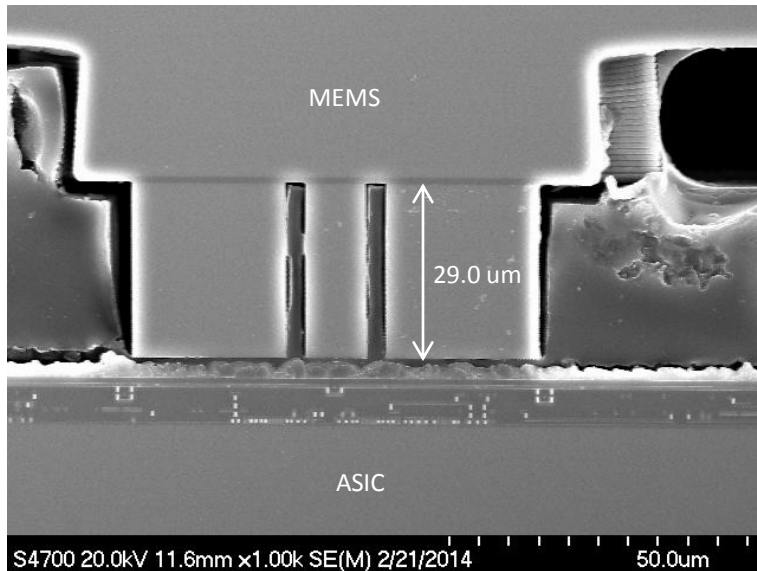
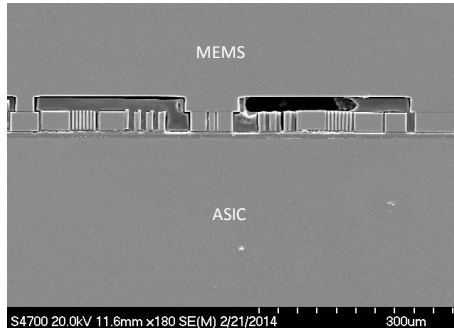
**Traditional MEMS Fabrication**  
MEMS SIP Packaging



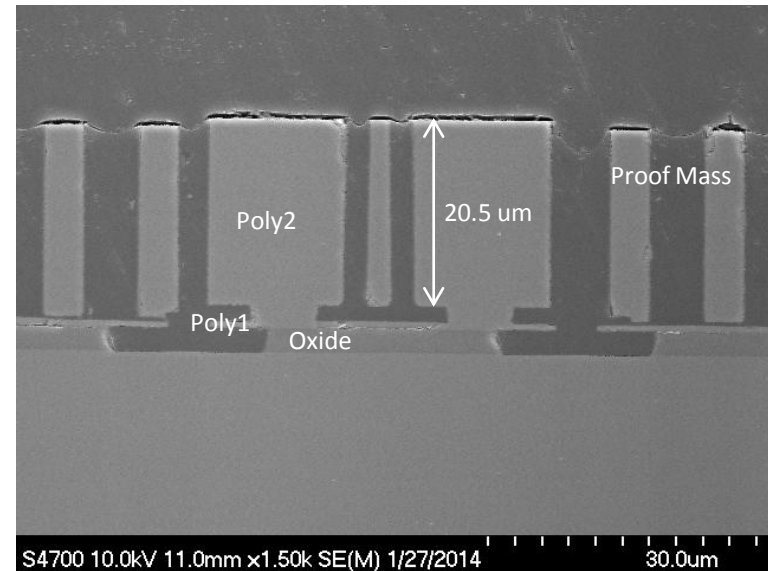
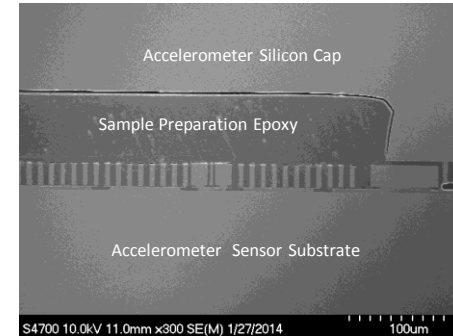
# Sensor Process Analysis- Accelerometer & Gyro

Source: SITRI

## Invensense



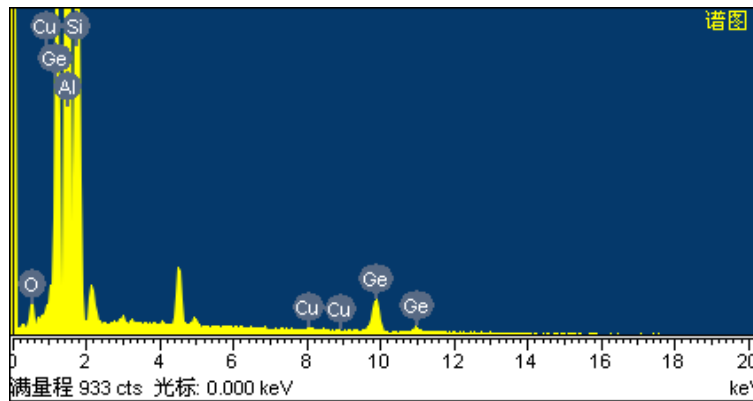
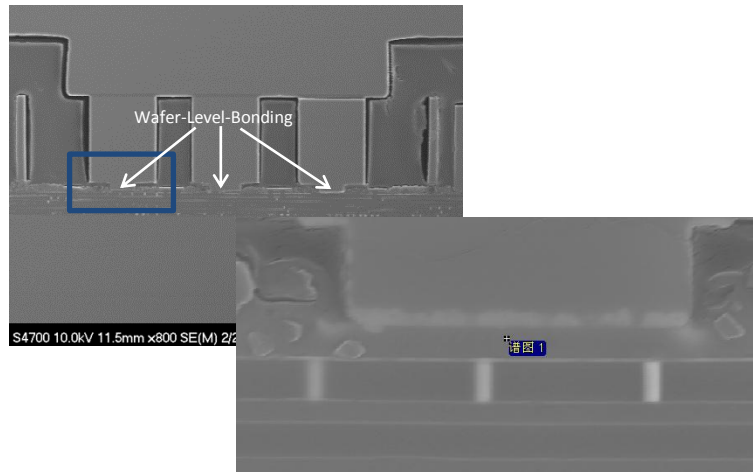
## ST Micro



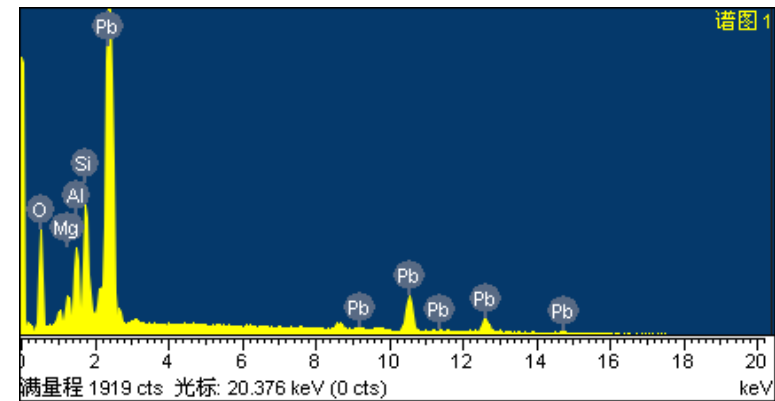
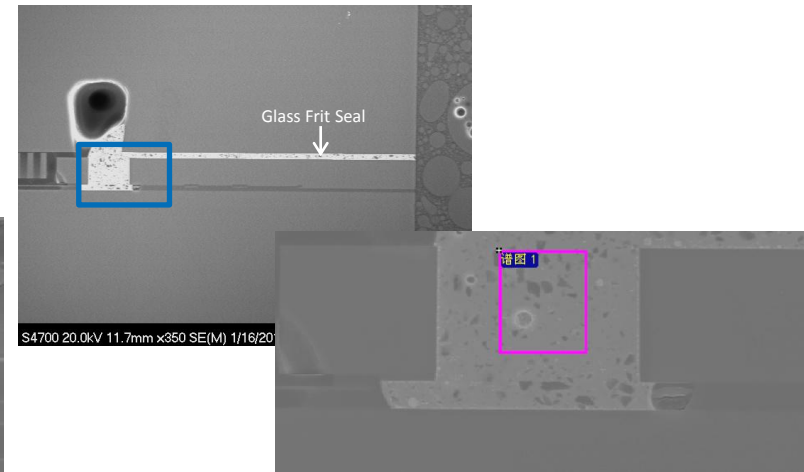
# Sensor Process Analysis- Accelerometer & Gyro

Source: SITRI

## Invensense



## ST Micro





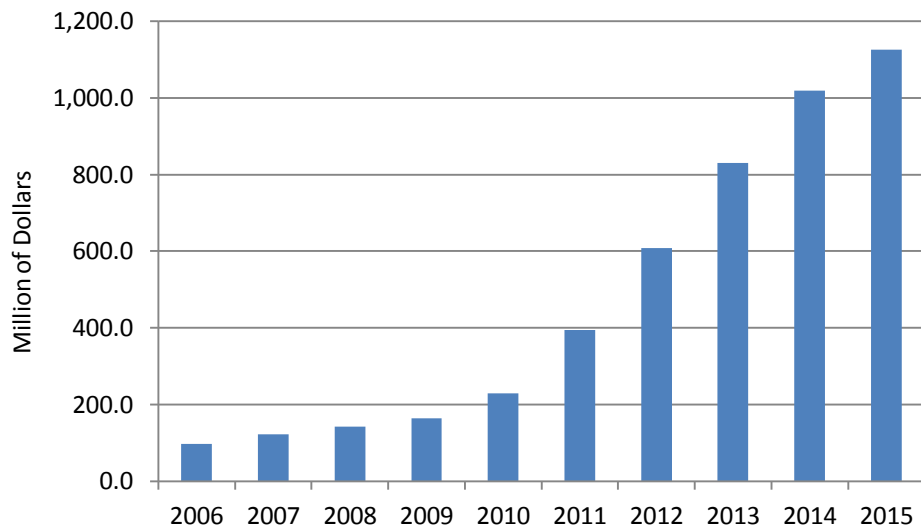
# MEMS Microphone



**Dual Microphone design starts from iPhone4**

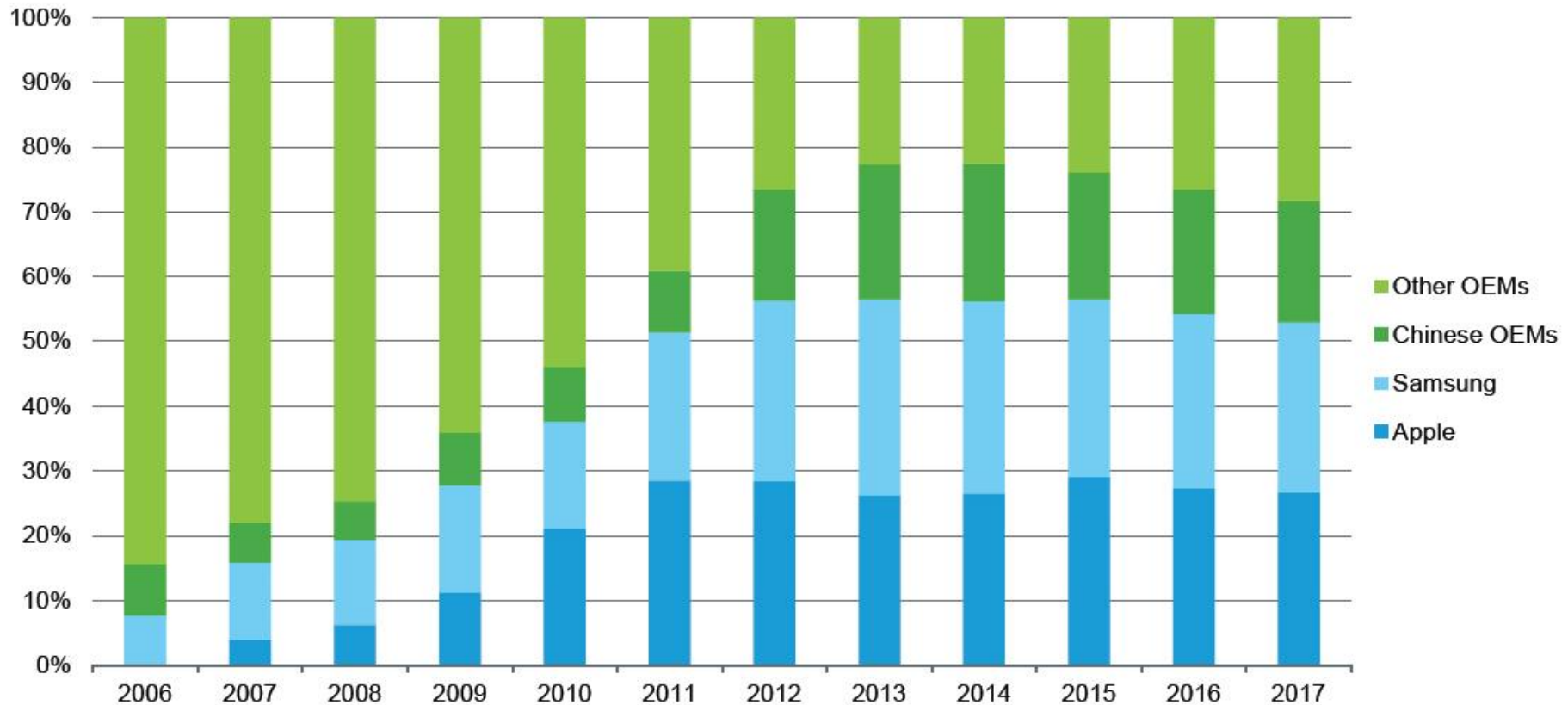
**Tripple Microphone design in iPhone5**

MEMS Microphone Market for Consumer & Mobile



		2012
China	Knowles	50.8%
	AAC	15.6%
	ADI	13.5%
	Goertek	8.0%
	ST	3.7%
China	Wolfson	1.75%
	Hosiden	2.0%
	Bosch	1.5%
	BSE	1.66%
	TDK-EPC	0.18%
China	NeoMEMS	0.69%
	MEMSensing	0.23%
	Others	0.26%

# Consumption of Motion Sensor and Microphones by OEM in Value in Mobile



Source: IHS

# Pressure Sensor

**Bosch Sensortec  
BMP085**



Motorola Xoom tablet



**STMicroelectron  
ics LPS331AP**



Samsung Galaxy Note



Samsung Galaxy III



**Bosch Sensortec  
BMP180**

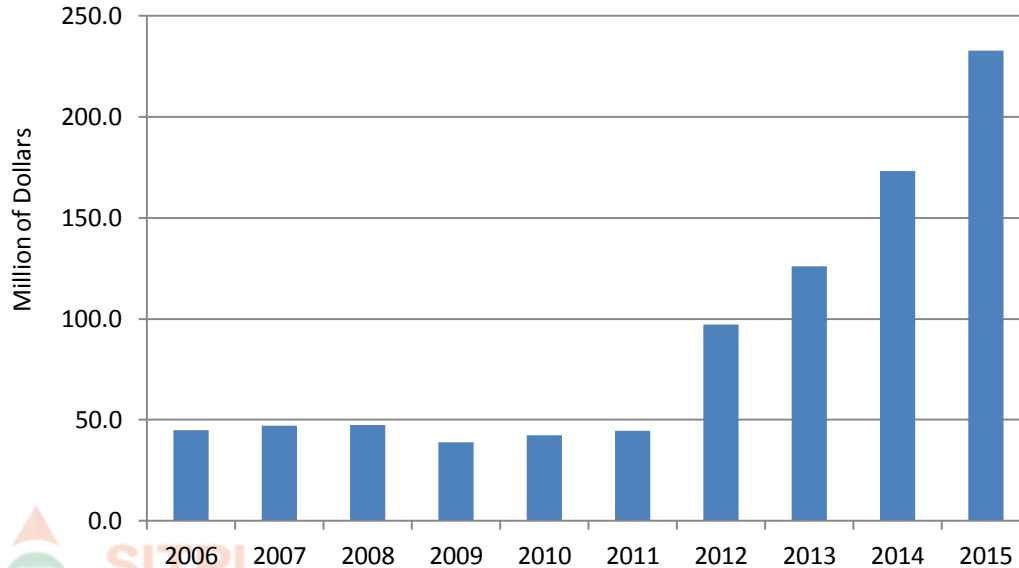


Samsung Galaxy Nexus



MI2S

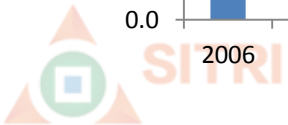
Pressure Sensors Market for Consumer & Mobile



**Bosch Sensortec**

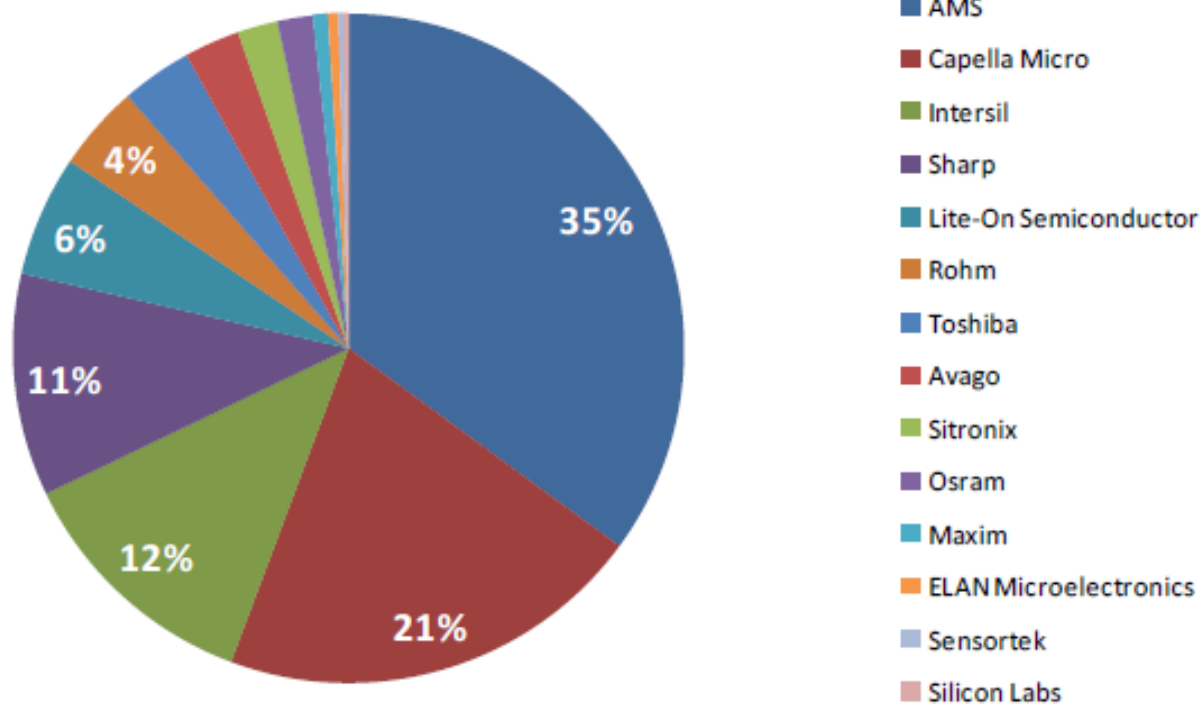


上海丽恒光



# Light Sensor

## Ambient Light / Proximity Sensor Vendor Analysis



Source: SITRI

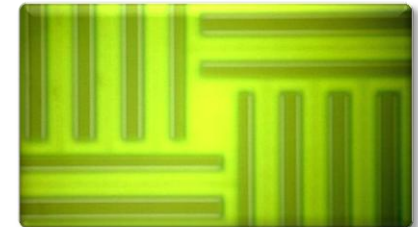
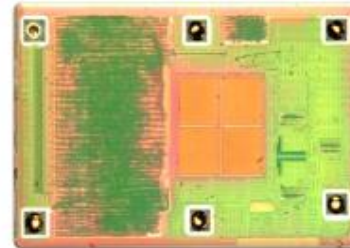
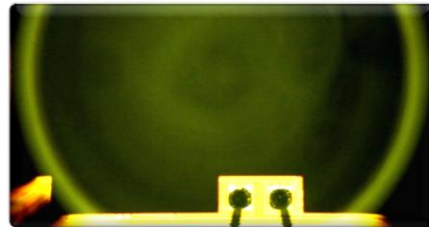


# Light Sensor

Source: SITRI

## Combo Solutions

Manufacturer	Part Number	Solution
ams-TAOS	TMD2771	ALS+PS+IR LED
Maxim	MAX44000	ALS+PS+IR LED Driver
Rohm	BH1772GLC	ALS+PS+IR LED Driver
Capella Microsystems	CM36682	ALS+PS+IR LED
Panasonic	CNB4001F	ALS+PS+IR LED
Sharp	GP2AP002A00F	ALS+PS+IR LED
Sharp	GP2AP050A00F	Gesture & Proximity & RGB Sensor
Melexis	MLX75031	Gesture & Proximity Sensor
Silicon Labs	Si114x	Gesture & Proximity & Ambient Light Sensor
Epticon 艾谱科微电子	EM30713	ALS+PS+IR LED

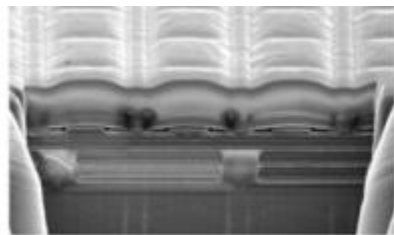


# RF Frontend/MEMS in Mobile Phone

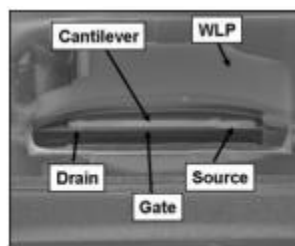
Technology	Stopped	R&D	Prototyping	Production
GaAs / Fixed passive		Skyworks, * Triquint...?	* Epcos	* Sony * NEC / Murata
SOS				* Peregrine
SOI		* Skyworks...?		RFMD
BST - Ferroelectric				* Paratek ST Micro. / OnSemi
MEMS ohmic switches	Baolab Maxim ...	Fujitsu * GE research * HT Micro * Senda Micro Technologies * 苏州希美 * 天津诺思 *	* RFMD + partner * Mitsubishi * IBM * * Epcos (switched IPDs)	* Delfmems * Omron
MEMS variable capacitors		Toshiba * * Epcos	* Cavendish Kinetics	* Wispry



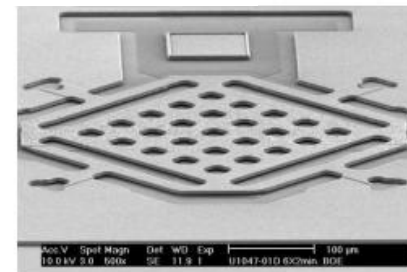
Source Wispry



Array of cavities (source Cavendish Kinetics)

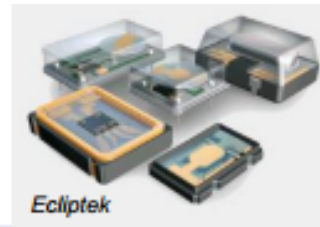


Source RFMD, DelfMEMS

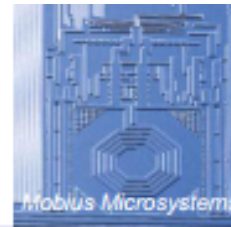


Source Epcos

# MEMS Timing



Quartz oscillator



CMOS oscillator



MEMS oscillator

## Technical factors

Stability (temperature compensated)	+++ (lower than 0.1ppm)	- (150-15000 ppm)	++ 0.5-240ppm (std is 20-50 today)
Low phase noise / Low jitter	+++	+	++
Frequency range	+++ (Up to 35GHz)	+	++ (Up to 800MHz)
Current consumption	+++	+++	-
Flexibility for custom frequency...	-	+++	+++
Small size	-	+++	+++
Immunity against mechanical shock and vibration	+	+++	+++
Potential for integration	-	+++	+++

## Business factors

Low cost	+	+++	++
Short lead times	-	+++	+++
Low risk (market access, maturity...)	+++	++	-

# MEMS/Sensor Industry Ecosystem In China

**Research**

**Development**

**Fabless**

**Foundry**

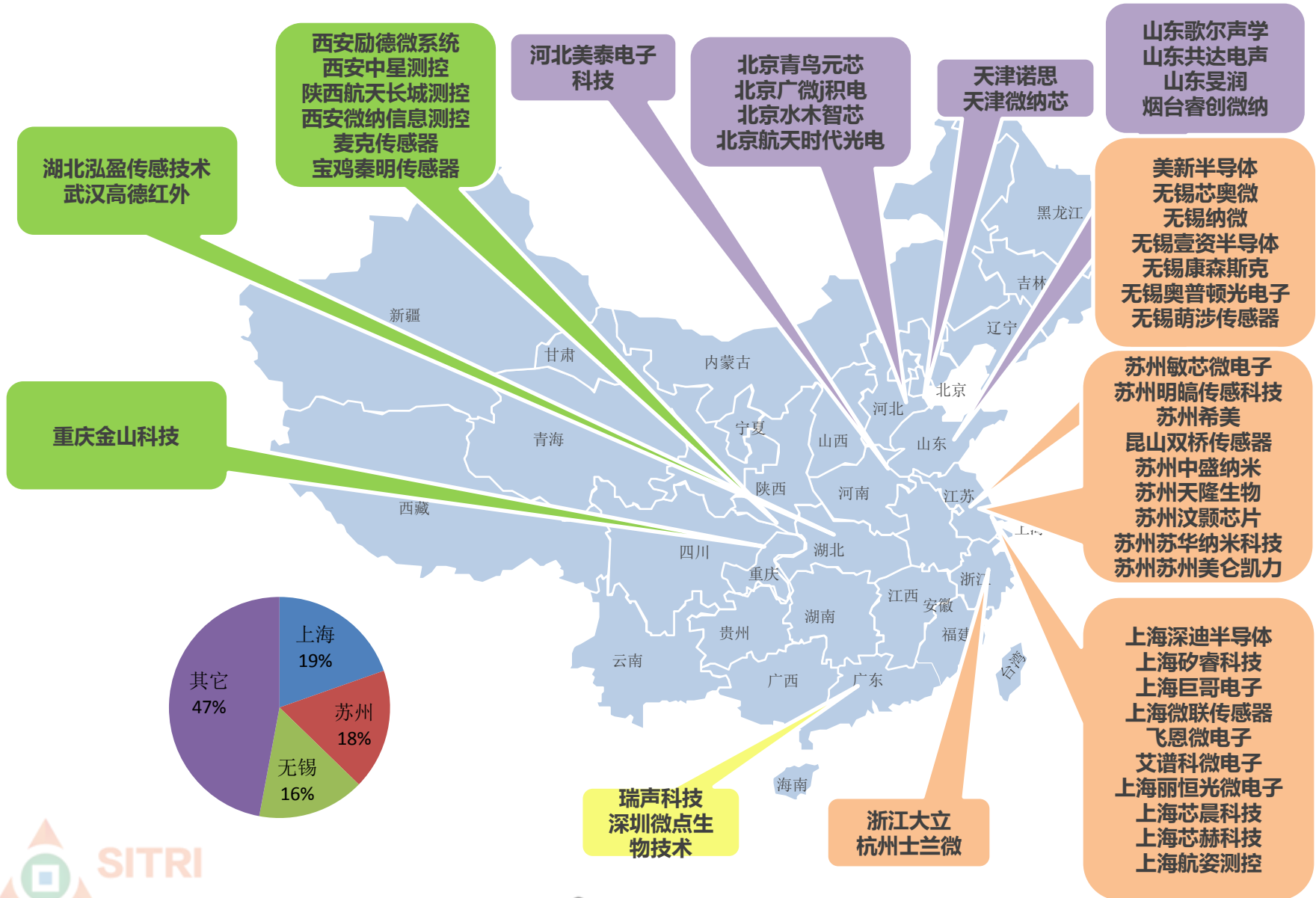
**Packaging & Testing**

**Application**





# MEMS/Sensor Player in China



# MEMS/Sensor Players in China

Consumer & Mobile	Inertial sensor	MEMSIC 美新、Senodia深迪、QST矽睿、MiraMEMS 明皜、TUMEMS 水木智芯、Silan 士兰微
	Microphone	Goertek 歌尔、AAC 瑞声、GETTOP共达电声、MEMSensing敏芯、NeoMEMS芯奥微、MicroLink上海微联
	Pressure sensor	Consensic无锡感芯、Lexvu上海丽恒光
	Light sensor	Epticore上海艾谱科微、Simaera上海芯晨
	RF MEMS	SiMEMS 苏州希美、ROFSmicro 天津诺思
Automotive & Industry	Inertial sensor	MT Microsystems河北美泰、MEMSensing 苏州敏芯
	Pressure sensor	First MEMS青鸟元芯、NanoMEMS无锡纳微、EASYMEMS 无锡壹资、FineMEMS上海飞恩、MEMSensing敏芯、SQsensor昆山双桥、Haorun山东昊润、Qinming宝鸡秦明、Chinastar M&C西安中星测控、NOKISENS北京鑫诺金
	Infrared thermal imager	Dali-Tech浙江大立、Magnity上海巨哥、Luxvu上海丽恒光、Guide Infrared武汉高德、GWIC北京广微积电、Raytron烟台睿创
Biological & medical	Jinshan重庆金山、Micropoint深圳微点生物技术、Wenhaochip苏州文颢、WQMicrosystems苏州文曲	

# MEMS/Sensor Foundry in China



	ASMC	CSMC	SMIC	HHGrace
Process	6'	6'	8'	8'
Capacity	3000pcs/month		3000pcs/month	
Products	flow sensor, microphone, accelerometer, gyroscope, pressure sensor and etc.	microphone, pressure sensor, gyroscope, accelerometer and etc.	pressure sensor, MEMS oscillator	accelerometer and etc.
Description	Engaged in MEMS production very early in China, collaborates with many of the MEMS fabless, covers diversified product lines	Involved in national projects and collaborate with several local companies.	Involved in national projects and work with the local companies to develop CMOS-MEMS technology.	Involved in national projects. The production line is still under development.

# MEMS/Sensor Packaging in China



- Nantong Fujitsu Microelectronics  
The earliest packaging company engaged in MEMS in China.



- Suzhou WLCSP  
Capability of Wafer Level CSP



- JCET  
Start mass production



- Hua Tian  
MEMS packaging technology under development



# MEMS/Sensor R&D Fabrication Line



Su Zhou	Wu Xi	Shanghai
<ul style="list-style-type: none"><li>●6 inch R&amp;D fabrication line</li><li>●6 &amp;8 inch packaging and testing service</li></ul>	<ul style="list-style-type: none"><li>●MEMS packaging and testing platform</li></ul>	<ul style="list-style-type: none"><li>●8 inch R&amp;D fabrication line</li><li>●Comprehensive engineering service</li><li>●MEMS wafer testing system</li></ul>



# Outlook for China MEMS/Sensor Industry

## Opportunity

- ✓ Largest markets
- ✓ Fast-growing apps
- ✓ Complete supply chain
- ✓ Oversea returnees+ local talent pool
- ✓ R&D platforms and partners
- ✓ Government support

## Challenge

- ✓ Fierce competition with international companies
- ✓ The limitation of volume manufacturing
- ✓ Ecosystem improvement
- ✓ Lack of VC investment
- ✓ Technical challenges
- ✓ Limited product offering



# Thanks for your time !

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[kzhu@sitrigroup.com](mailto:kzhu@sitrigroup.com)