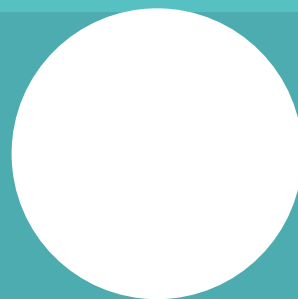
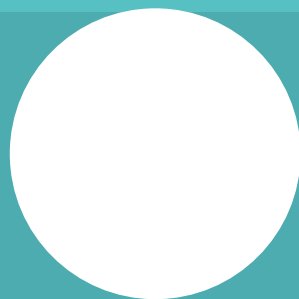
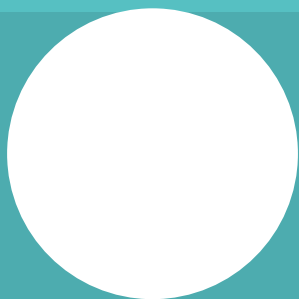


# R & D in Microelectronics



## To help increase value-add from electronics industries in Singapore by:

- Engaging in relevant R&D in selected, strategic fields of microelectronics
- Supporting and partnering electronics industries
- Developing skilled R&D personnel



## executing IME's mission ...

**IME employs a two-pronged approach to accomplish its mission.**

**We have equal emphasis on both core R&D to maintain our leading position for future technologies and R&D collaborations with industry partners to ensure our relevance to the industry.**

### **Our core R&D encompasses:**

- Upstream research with universities, research institutes, and corporate labs;
- Sharing of research resources, and
- Manpower development

### **Our industrial relevance hinges on:**

- Identifying technology roadmaps and industry needs;
- Networking for R&D collaboration, and
- Adding and creating value for the industry

# ... IME

**Founded in 1991, the Institute of Microelectronics (IME) is a research institute (RI) of the Agency for Science, Technology and Research of Singapore (A\*STAR). The Institute conducts research and development (R&D) through close collaborations with universities, research institutes, and industry partners.**

R&D at IME covers the semiconductor technology chain, viz integrated circuit design, wafer fabrication process technology, packaging and assembly, and reliability testing and analysis. It also conducts R&D in microsystem applications such as silicon-based micro-electro-mechanical-systems (MEMS). **These R&D programs are broadly classified under 3 laboratories, namely:**



**IME also has a dedicated Bioelectronics & BioMEMS (BEBM) Program to focus its R&D efforts to serve the bio medical industry and open up new opportunities for the semiconductor industry.**

# ICS ...



## Integrated Circuits and Systems

IME's R&D excellence in circuit design and device modeling area has led to its leadership in high frequency IC designs (Radio Frequency IC and Optical Communication IC) recognized in Singapore and abroad. The focus of ICS Lab is on CMOS RFIC designs. Our mixed-signal activities are focused on sensor interface circuits, which will be relevant to bioelectronics applications in future. We are now encompassing newer technological options such as SiGe and 90nm CMOS for low voltage and low power circuits, and designs with advanced architectures.

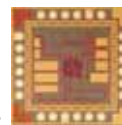
### Areas of research focus:

1. CMOS radio frequency and wideband IC design
2. CMOS low-power low-voltage RF and mixed signal IC design
3. Compact device modeling and characterization for RF CMOS

### Project highlights

#### Low power wireless link for sensor applications

- Development of a low power RF transceiver front-end for wireless sensor network applications.



RF link - VGA

#### 2.45GHz/900MHz RFID reader and tag ICs

- Designed an extremely low-cost passive 2.45GHz Radio frequency identification (RFID) tag for contact-less tagging and dual-band single chip reader IC.
- Developed the world's first integrated RFID tag with an on-chip antenna (OCA) that has read/write capabilities with passive RF power.



Single chip reader IC



RFID TAG IC



RFID-OCA



Assembled RFID TAG

#### 90nm CMOS Device Modeling

- Development of passive and active device RF CMOS compact models.
- Development of novel techniques for transistor modeling and characterization.
- Noise modeling in advanced CMOS technologies



Balun2



NMOS



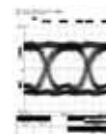
MIM



Inductor

#### Opto-electronics (OEIC) chipsets for 2.5Gbps/10Gbps Applications

- Developed a miniaturized and low cost trans-impedance amplifier, decision amplifier, clock and data recovery and demux chips.



Eye Diagram



Clock Data recovery circuit in SiGe



Test PCB

#### Ultra-wideband IC

- Development of RF front-end transceivers, high data rate for positioning and low data rate for localization using DS-UWB as well as MBOA-OFDM standards.

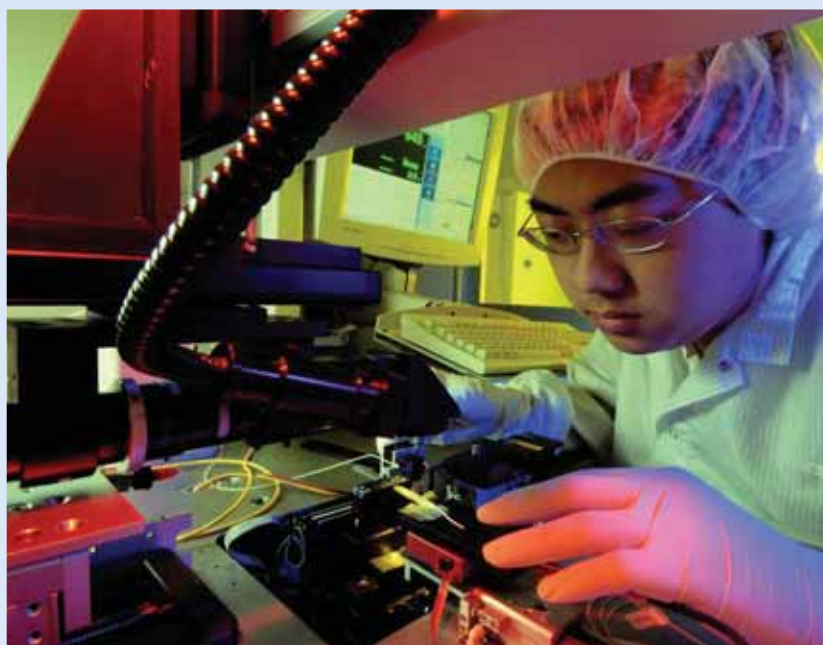


UWB



wpan

# MMCC...



## Microsystems, Modules & Components

In response to industry demands for miniaturized and highly integrated devices, IME is focusing its microsystems packaging technology development on ultra-thin package designs; flip-chip technology; 3D packaging; wafer level packaging; optical, electrical, thermal, mechanical design and assembly; Cu/low-k device assembly and packaging; as well as micro modules for RF, photonic, electronic, and hybrid integration. In addition, we are working in the fast growing realms of the life sciences, focusing on the packaging of Bio-Micro-Electro-Mechanical Systems (Bio-MEMS) and Micro Fluidics Devices. To cater to the needs of future IC package interconnects and assembly processes, we have also built up competencies and technologies in the area of nano-structured materials and self-assembly processes for device packaging.

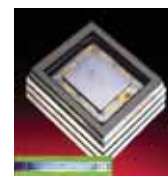
### Areas of research focus:

1. Advanced Packaging - fine pitch wafer level, 3-D, reliability
2. System-in-Package (SiP) technology - RF, Opto, Bio
3. Nano-structured materials and self-assembly processes in packaging

## Project highlights

### Si Stacked Module

- Developed a platform technology for 3D System-in-Package
- Combined different devices and circuit functions within a module
- Met complex performance, cost, and size demands of portable electronic devices, high-performance computing systems, as well as communication and entertainment systems



### Wafer Level Packaging

- Developed Bed of Nails - 100 $\mu$ m pitch Cu column with solder cap for mobile and handheld applications
- Wafer Level Super-Stretched Solder (WLSSS) of 2,000 I/Os @ 100 $\mu$ m pitch
- Compliant Wafer Level Test Interface for Fine Pitch High Density WLPs up to 8GHz



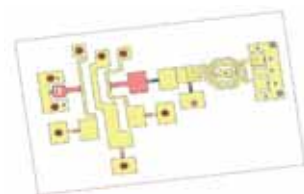
Fine pitch WLP @100 $\mu$ m

### Bio Packaging

- Developed Bio Micro-fluidic package for DNA Lab On a Chip (LOC) with integrated valves
- Integrated reservoir and passive valve in a microfluidic package to reduce the contamination

### Broadband & RF Module

- Developed laminate based mixed signal (digital/RF) module with integrated antenna



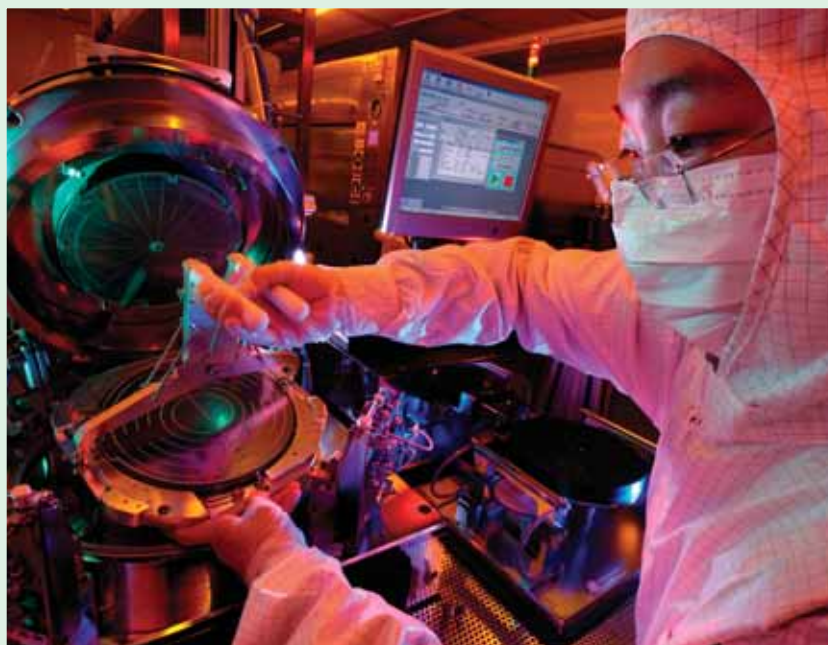
Integrated band-pass filter and balun

- Applications: UWB, W-LAN, Bluetooth, etc.

### Optoelectronic Modules

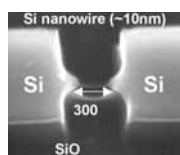
- Developed capabilities for four channel CWDM and burst mode transceiver technologies
- Established optical waveguides and Polymer optical modulator capabilities
- Competencies in waveguide based biosensors and organic optoelectronics technologies

# SPT...

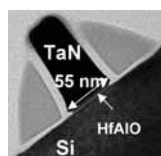


## Semiconductor Process Technology

With the help of advanced Si micro and nano-fabrication infrastructure, our R&D activities focus on nanoscale CMOS devices using new materials and device architectures. Using our CMOS platform technology and Si nanotechnology as enabling capabilities, we are addressing the functional integration of materials, structures and devices for RF, opto- and bio-electronics applications.



Si nanowire formed in a CMOS compatible process for bio-sensor applications



MOS Transistor with High-k/Metal Gate Stack

### Areas of research focus:

1. Materials and devices for Si-based nano-electronics applications
2. High performance integrated RF passive components
3. FET-based biosensors
4. MEMS/Sensor Technologies

### Project highlights

#### Nanoscale CMOS platform technology

- Established nanoscale transistor baseline with gate-length down to 50nm through device demonstration
- Developed integration scheme for incorporating high k gate dielectrics, metal gate and Ni silicide

**Developed process techniques for achieving high Ge content SiGe on insulator (target applications: high mobility CMOS channels and templates for SiGe based optoelectronics)**

**Developed Si nanowire processes for research in Gate All Around MOSFETs and bio-sensors**

**Developed analytical techniques to estimate lattice strain using high resolution transmission electron microscopy and demonstrated with MOSFET drive current enhancement performance**

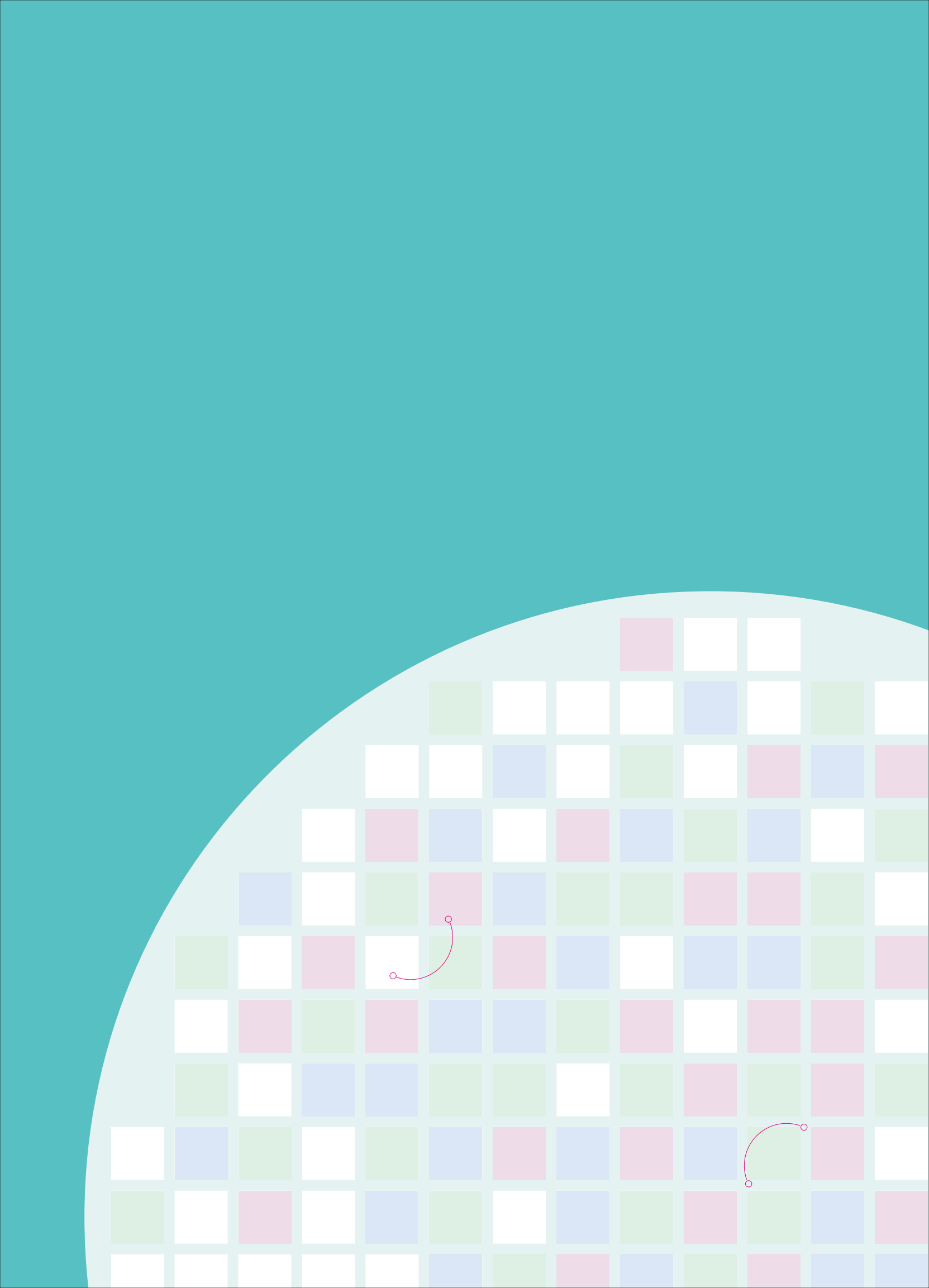
**Developed Wafer Transfer Technology to effect wafer level transfer of circuit patterns from Si onto plastic, glass or rubber. Demonstrated enhanced RF performance of inductors**

**Developed post-CMOS processes for integrating on-chip antenna**

**Developed integration scheme for "high k MIM" capacitors with multi-level Cu/low k interconnects technology. Demonstrated superior high frequency performance**

**Established Si microfluidics process capabilities for bio-medical applications**

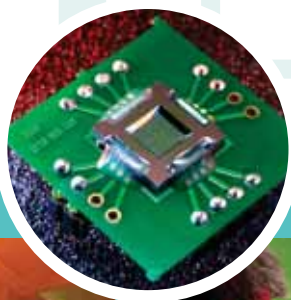
**Extending CMOS technology for bio-sensor applications**



DNA Extraction Chip



Electrochemical Bio-sensor



Si-Micromirrors



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