

Exciting Opportunities for Nanotechnology R & D and Business in Singapore

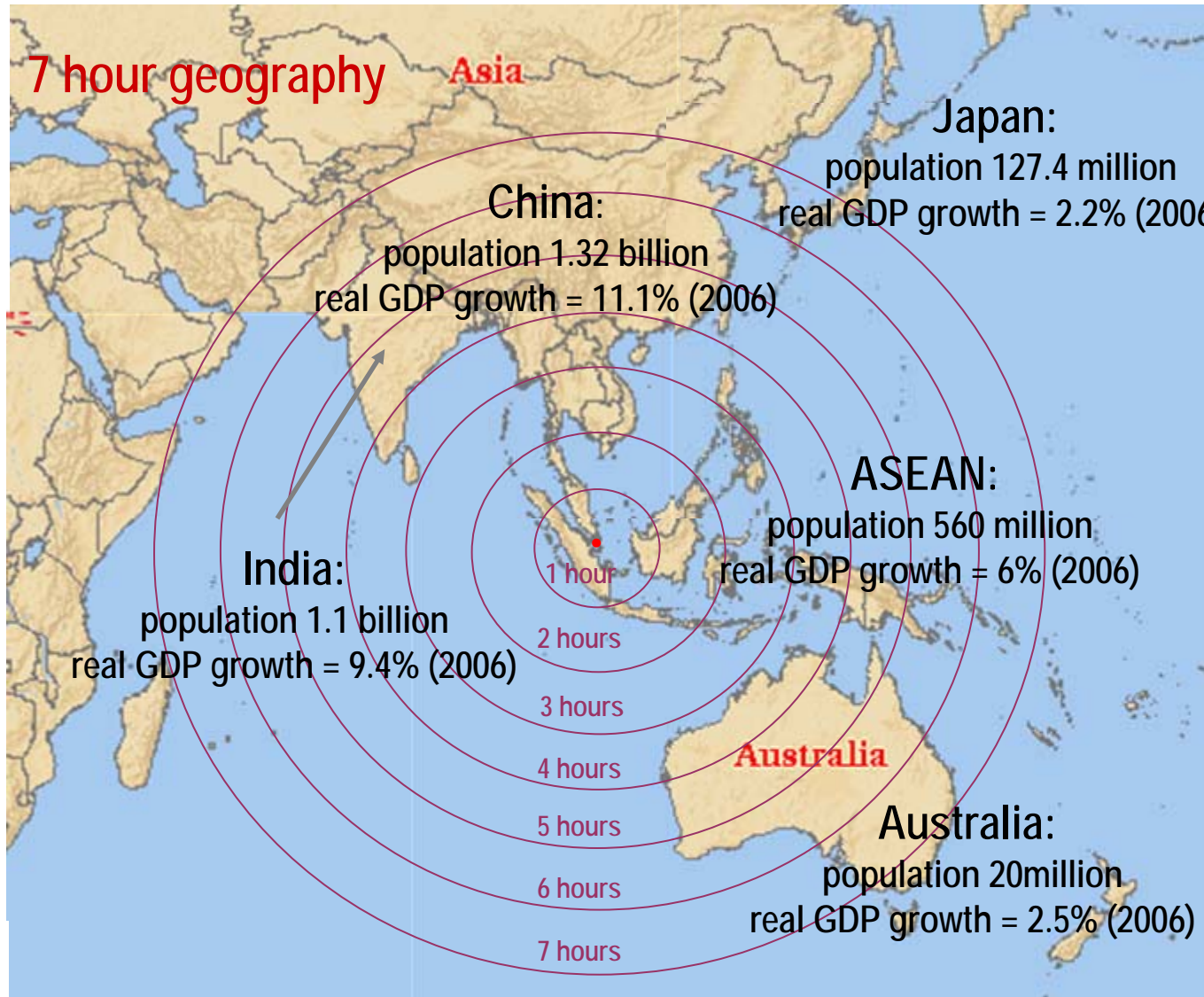
Lerwen Liu, NanoGlobe



AZNANO2008
Phoenix, USA

About Singapore

Nanotech in Macro Regional Opportunities



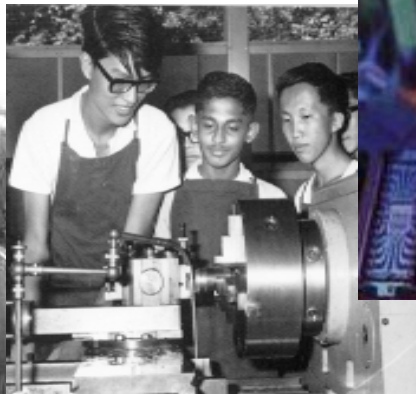
- Fastest Economic Growth Region
- Large Markets – 3.3 billion people
- HQ for Asia Nano Forum (ANF, www.asia-nano.org)
- Efficient Government
- Multi-cultural
- Tropical climate
- Resort living life style

Singapore's economic progress



Labour-intensive

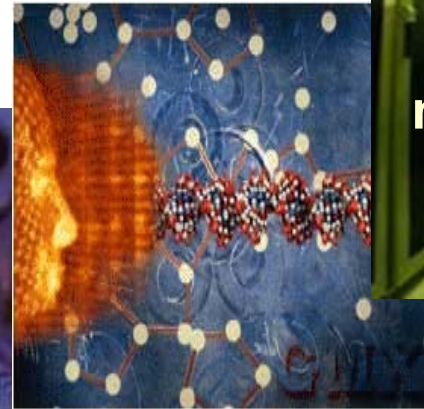
1960 GDP = S\$ 2 bn



Skills-intensive



Capital-intensive



Technology-intensive

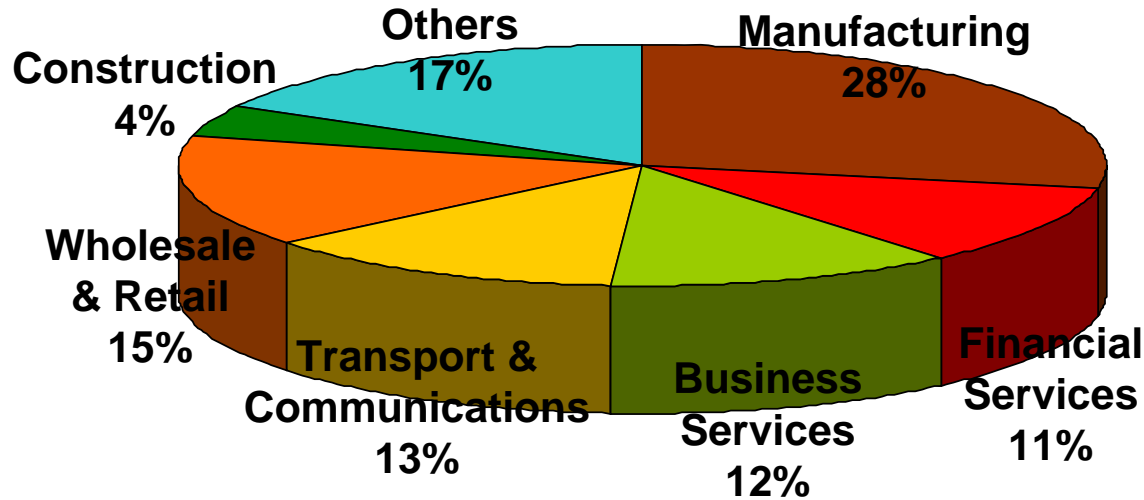


**Innovator of
new products
& services**

**Knowledge-
Intensive**

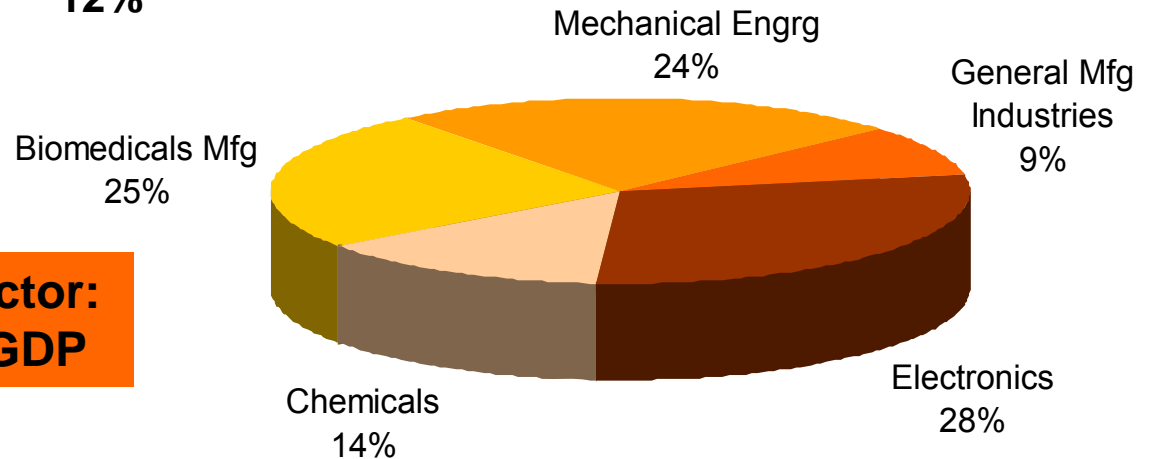
2006 GDP = S\$ 210 bn!

Singapore Economic Snapshot



2006 GDP: S\$210 billion
GDP Growth: 7.9%

Manufacturing VA by sector:
Still key contributor to GDP



Singapore's Value Proposition

Robust R&D Network

- Public R&D Centres (IMRE, IBN, IME)
- World-class Universities

Strong Govt Support

- Incentives
- Facilitation
- Fast to Implement

Excellent Stability

- Ranked lowest political risk in Asia

Strong IP Protection

- Ranked #1 in Asia



Logistically Connected

- Top air cargo hub in Asia
- World's largest transshipment port

Skilled Manpower

- Talent pool from local Universities, Polytechnics and from the region

Ease of Attracting Foreign Talent

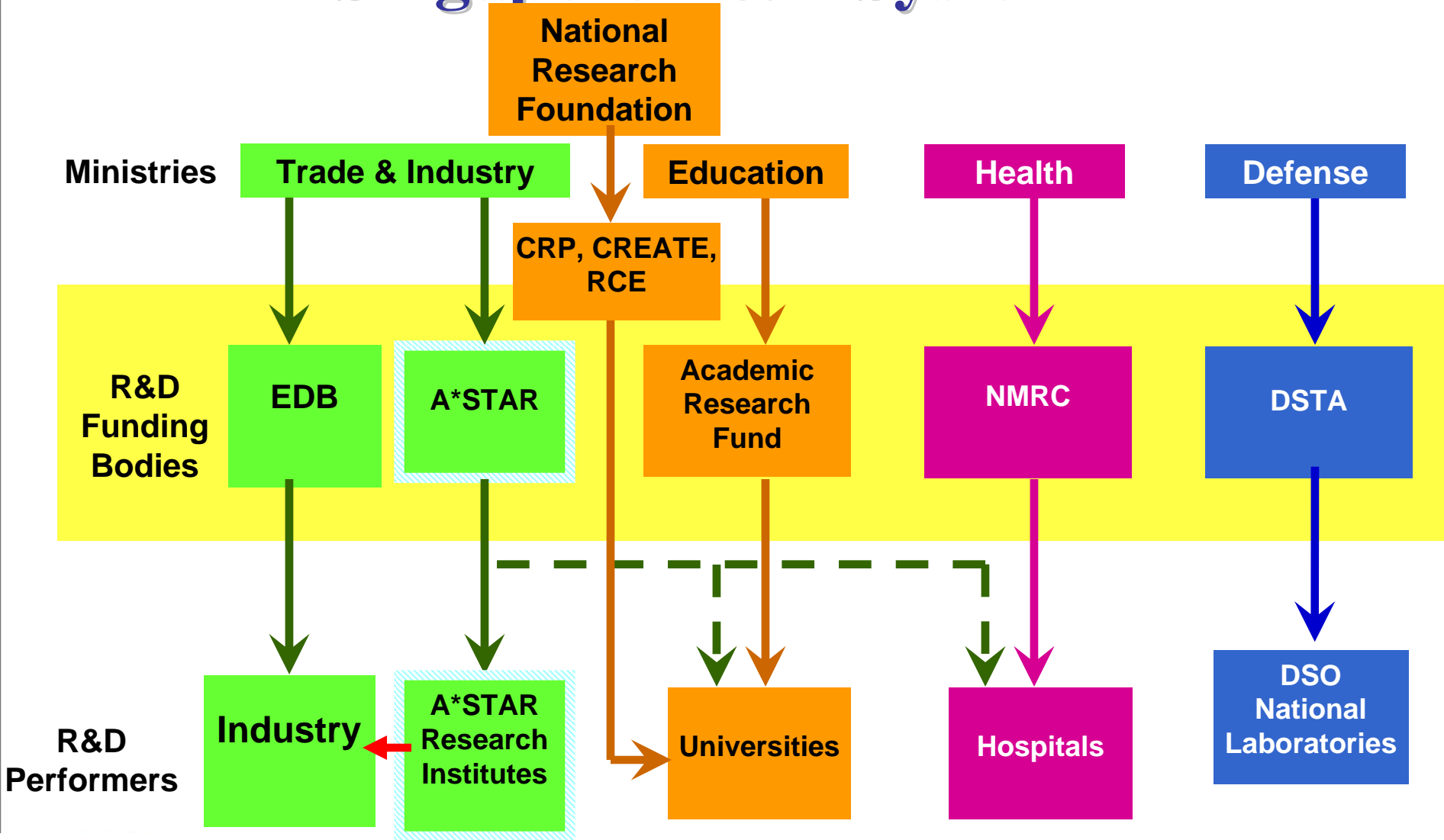
- High standard of living
- Low personal income tax and corporate tax

Vibrant Private Sector

- Companies from all parts of value chain
- Comprehensive ecosystem

Role of Government (Funding, Incentive Programs from ASTAR, EDB and SPRING)

Singapore R&D System



Government Industry Support

Ministry of Trade & Industry



Agency for industry development,
foreign investment attraction



Promotion of international trade &
internationalisation of Singapore-based
enterprises



Champion for enterprise development.
National body for productivity, standards
and conformance



Ensure supply of industrial facilities and
industrial space



Develop Singapore's research
capabilities.



Promote and develop tourism industry.



Regulate energy providers



Develop and promote Sentosa Island.

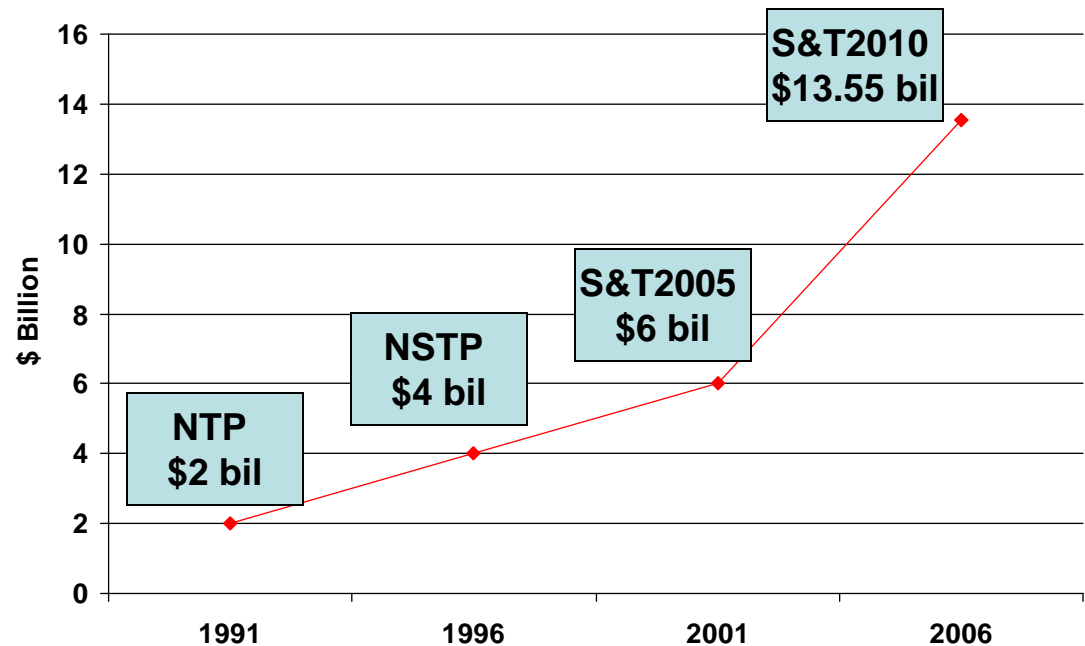


Regulate anti-competitive activities.

Significant Increase in R&D Funding



Investing in R&D



Target – Increase GERD to 3% GDP by 2010

Incentives SME and Start Ups in Nanotech

ASTAR (Agency for Science, Technology and Research)

Labs in RI Model (Share resources and man power)

T-UP Program (Technology Upgrade, 70% funded manpower)

P3 Research Program (Plastics Electronics)

SPRING (Standards, Productivity and Innovation Board)

Equity Financing Scheme (SEEDS- 300K matching 3rd party investment)

TIP Program (Technology Innovation Program, 50% support)

TIP Version 2 program (50M/5Y, Phase 1: 250K, Phase 2: 500K-To launch in April08)

Business Angel Scheme (1:1 matching up to 1M)

EDB (Economic Development Board)

Innovation Development Scheme (IDS)

Research Incentive Scheme for Companies (RISC)

Strategic Attachment and Training (STRAT)

Incentives In New Technology (INTECH)

Patent Support Grant (up to 20K)

SPRING Technology Enterprise Commercialisation Scheme (TECS)

- Based on US Small Business Innovation Research (SBIR) & Small Business Technology Transfer (STTR) programmes
- Aims to overcome high risks involved in commercialisation of new “quantum-leap” R&D ideas → encourage formation of technology start-ups
- S\$50 mil fund over 5 years
- 2 phases of funding:
 - (i) Phase I: up to S\$250,000 to demonstrate proof-of-concept of a commercialisable idea
 - (ii) Phase II: up to S\$500,000 on 85% co-sharing basis for further R&D. Only Phase I winners considered

R & D Infrastructures (Science Park I, II and III, biopolis, Fusionpolis, Network)

Biopolis

The Biomedical Hub of Asia



Phase 1 – 185,000 sqm (2003-)
Phase 2 – 28,000 sqm (2006-)
Phase 3 – Planning begins in 2007

fusionopolis

SCIENCE MEETS BUSINESS AND THE ARTS



Phase 1 – 120,000 sqm (2008-)
Phase 2A – 103,600 sqm (2010)
Phase 2B – 50,000 sqm (2010)

fusionopolis



SCIENCE MEETS BUSINESS AND THE ARTS

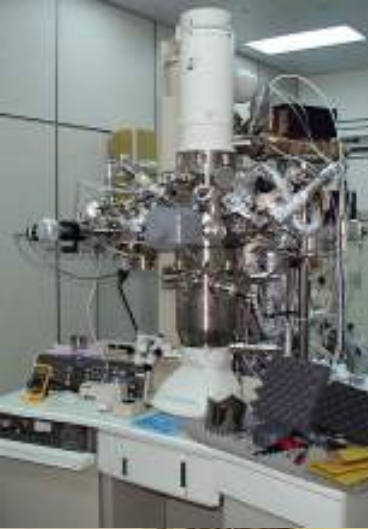
Will house the Science & Engineering Research Council (SERC) research institutes

Aim is to Foster innovation, experimentation and collaboration
Incubator for next generation applications and technologies.

Facilities available at Fusionopolis include

- Testbed from R&D stage to trial deployment
- 1-stop-shop for high end computing and IT needs
- High performance computing
- Network storage

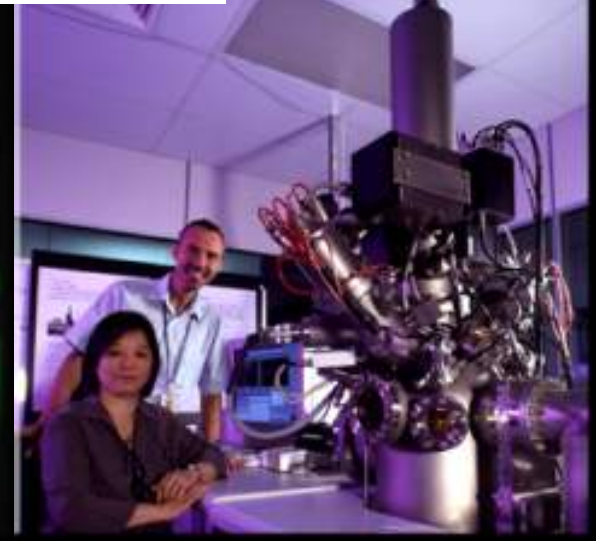
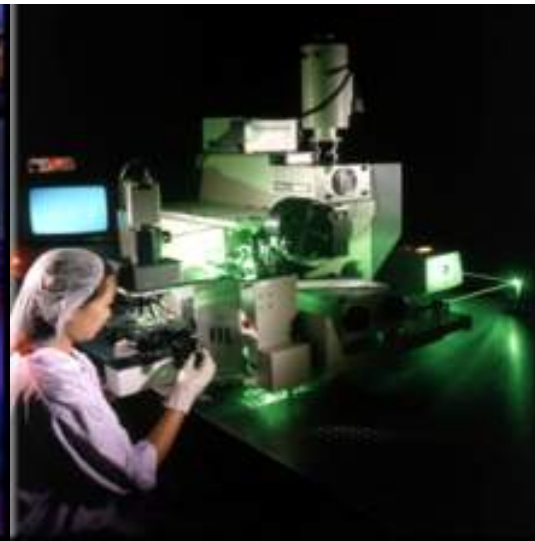
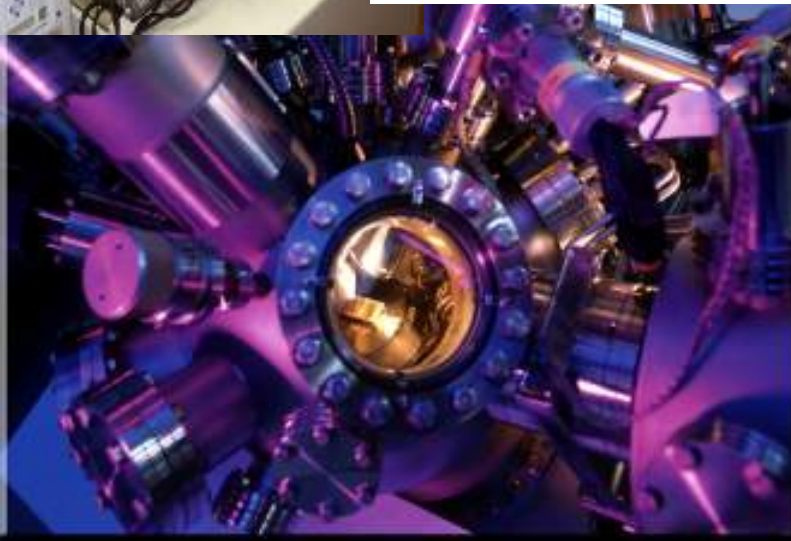




NanoFabrication & Characterisation Facility

A network of nanofabrication and characterisation facilities

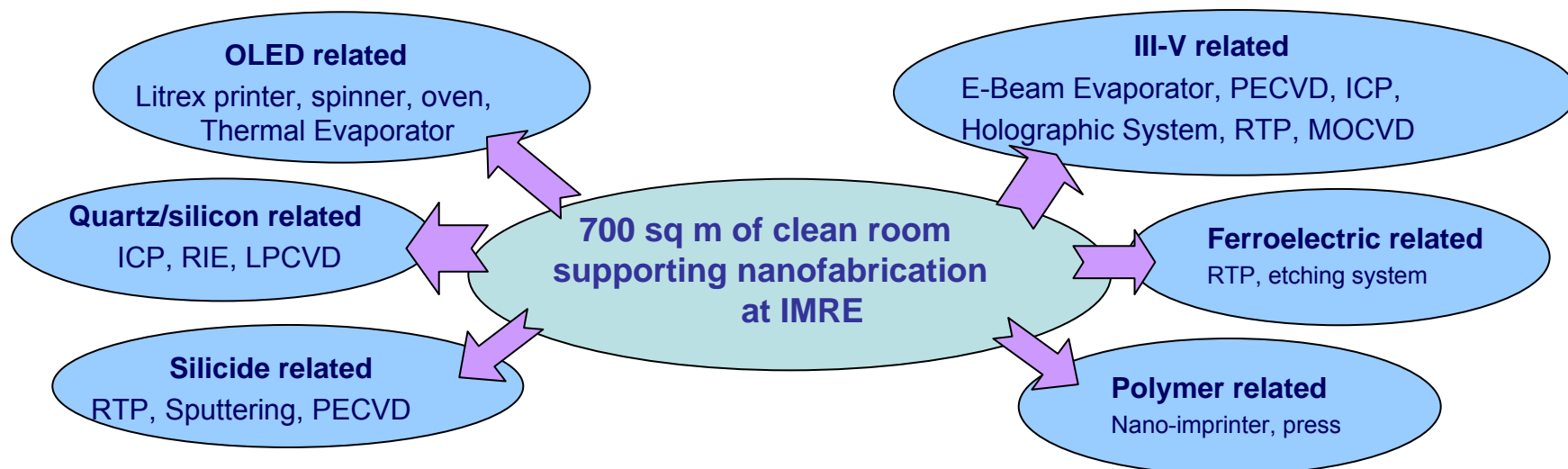
(<http://www.imre.a-star.edu.sg/rnd/SNFC.asp>)



Nanofabrication and Characterisation Facility

- Provide easy access to world class research facilities (equipment and clean room) for nanofabrication and characterisation
- Initially at IMRE, but will be expanded to other RIs and Universities only
- Available for use by all researchers
- Use of equipment individually or as process
- Use reserved through one web-site (<https://tetra.simtech.a-star.edu.sg/rbs/>)

Nano Fabrication Facilities



Materials Characterisation Facilities

Surface Characterisation

- XPS
- ToF-SIMS
- Scanning Probe Microscopy
- Dynamic SIMS

Mechanics Lab

- Nanoindentation
- High precision mechanical testing
- Other mechanical testing
- Mechanical Modelling

Microstructural Characterisation

- HR-TEM
- SEM / HR-SEM
- XRDs (powder, texture, 2D detection)

Chemical & Polymer Characterisation

- NMR (400 MHz, MAS)
- Spectroscopic Ellipsometry
- FTIR, DSC, TGA

ASTAR Centre for Nanometrology Excellence

*National facility to anchor Singapore's position
in international standardization activities*

- Nano-scale Measurement Facility set up in 2007
- SGD 10 million set aside for developing facility
- Housed in the Singapore Science Park, a hub for R&D and innovation
- Provides calibration/measurement services for MEMS, AFMs, LEDs, fiber optics, sensors and piezo-electric devices
- Users include Research Institutes, nano- and biotech firms, semiconductor companies and wafer fabs



“With the new Nano-scale Measurement Facility..... our industry which manufactures at nano-scale can make accurate and reliable measurements which are acceptable by international standards.”

- Mr. S Iswaran,

Minister of State for Trade & Industry

Nanotechnology Companies in Singapore

Nanomaterials & Manufacturing



Cal-Comp



Electronics & Nanometrology



DELPHI



Biotechnology



Pasture Group

Greener Pasture for Life



Services



NANO GLOBE

Creating Leadership in NanoTechnology R & D and Business



NanoSingapore (www.nano-globe.biz/nanosingapore), over organizations including over 50 nanotech companies

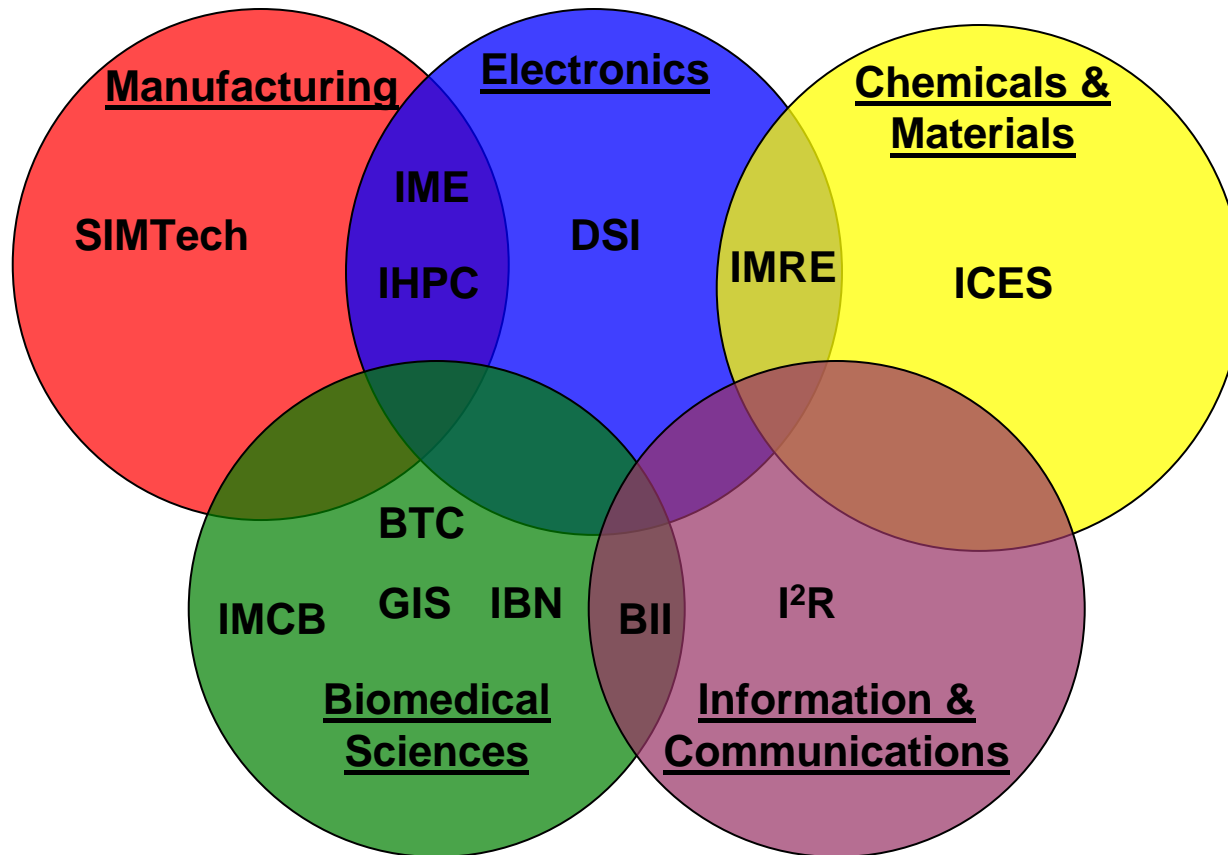
Nanotech R & D Strength

R&D: Why Singapore?

- Gross Expenditure on R&D – **2.39%** of GDP
- More than **22,600** Research Scientists & Engineers
- 102 researchers per 10,000 workforce***



Agency for
Science, Technology
& Research



- SIMTech** - Singapore Institute of Manufacturing Technology
- IME** - Institute of Microelectronics
- IHPC** - Institute of High Performance Computing
- DSI** - Data Storage Institute
- I²R** - Institute for Infocomm Research
- ICES** - Institute for Chemical & Engineering Sciences
- IMRE** - Institute of Material Research & Engineering
- IMCB** - Institute of Molecular and Cell Biology
- BTC** - Bioprocessing Technology Centre
- GIS** - Genome Institute of Singapore
- BII** - Bioinformatics Institute
- IBN** - Institute of BioEngineering & Nanotechnology

*Source: *National Survey of R&D in Singapore 2006*, Agency for Science, Technology and Research (A*Star), 2006

ASTAR SERC Research Institutes & Centres



1,311 Researchers, of whom 782 hold PhDs

SERC RIs filed 95 patents and published 1,300 papers in FY2007*

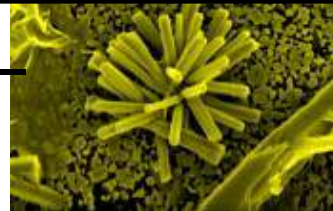
**National
Technology
(NMC)**



**Singapore
Institute of
Manufacturing
Technology
(SIMTech)**



**Data Storage
Institute (DSI)
(from Magnetic
Technology Centre)**



**Institute of
Materials
Research &
Engineering
(IMRE)**



**Institute for Chemical
& Engineering
Sciences (ICES)**

1989

1991

1996

1997

2002

2008

Nanotech R&D in SERC

Institute of Material
Research & Engineering

Institute of
Microelectronics

Institute of High
Performance Computing

Institute of Chemical
Engineering & Sciences

Data Storage
Institute

Singapore Institute of
Manufacturing Technology



Atomistic modeling
molecular manipulation



Catalysis



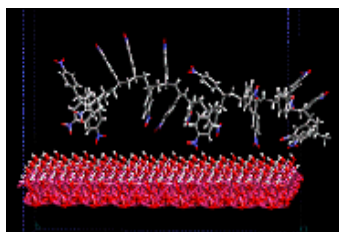
Nanobiomimetics



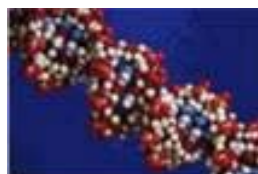
Spintronics



NanoElectronics



Molecular self
assembly



Chemical process
technology



Multifunctional
coatings,
membranes



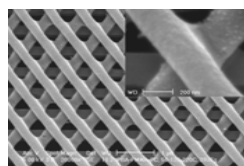
Organic & polymer
electronics



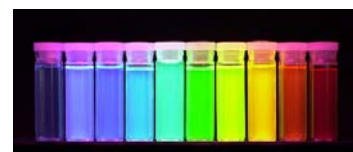
MEMS NEMS



Advanced Nano-
materials



Nanoimprinting



Quantum Dots



Nanomachining

IME 200mm Si-Based Wafer Processing and MEMS Prototyping Facility

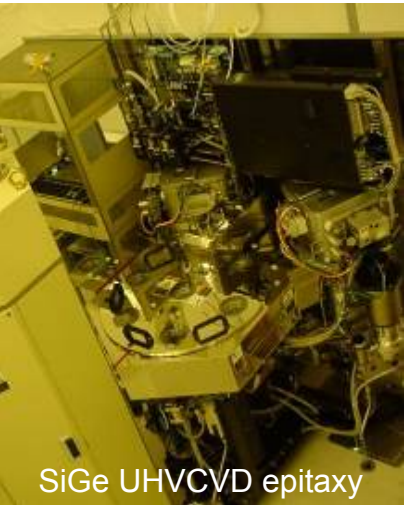
Deep UV Lithography



SEM defect review



SiGe UHVCVD epitaxy



Micro & Nano-Electronics

- Diffusion / LPCVD furnaces
- SiGe epitaxy (UHVCVD)
- ALCVD for high k / metal gate & interconnects barrier
- Ion implanter
- Wafer Cleaning
- RTA for S/D spike and metal/silicide
- Metallization
 - Metal PVD for Gate / Barrier / Silicide
 - W (Tungsten) plug CVD
 - PVD for barrier and Cu - interconnects
- Lithography
 - Electroplating for interconnects
 - 248 nm DUV
 - E-beam Lithography
- Dielectric (low-K) Deposition
- Plasma etch for poly-Si, dielectric, metal
- CMP for oxide, W, and Cu
- In-line metrology/Analysis

MEMS & Post-CMOS

- Double sided contact / proximity aligner
- Wafer bonder
 - High pressure bonding (Thermo-compression, Anodic and Frit glass bonding)
- Plasma deep Si etch
- Wet TMAH/KOH etching
- Electroplating for Cu, Ni, Au, photoresist
- Wafer thinning & polishing



R&D Foundry for micro-, nano-, bio- and opto-electronics

Wafer Process and Package Assembly Characterization

- **Advanced analytical & test tools for:** structure / surface analysis, device / package assembly diagnostics and reliability characterization
- More than 800 jobs and investigative projects performed for local MNC, SME and universities per year



FIB



D - SIMS



AFM



M-STEM/EELS/Holography



X-ray imaging



ESD



SAM



Probe Stations



TEM/EDX



SEM/EDX



FEAUGER

IME's collaborator facilities



TOF-SIMS



**Wet-chemical
Analysis**



**Scanning
Analytical PEM**



FTIR



GC-MS



DSC/DTA/TMA/TGA



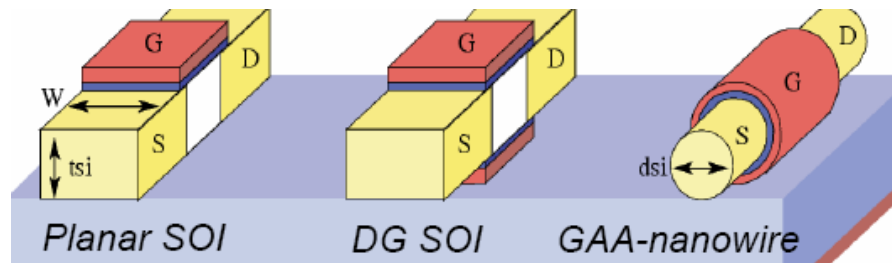
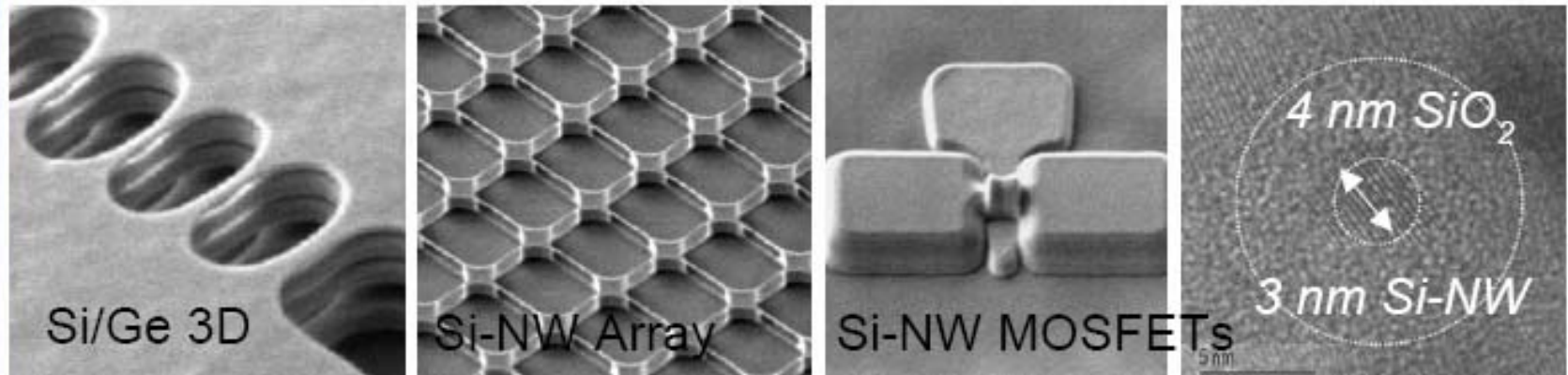
**Reliability
Chamber
s**



XPS

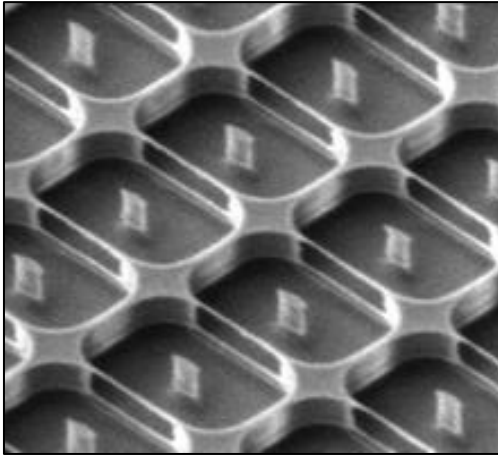
Focus Area: Si-Nanowire Technology

- Establish CMOS-compatible Si-nanowire device and technology platform
- **Facilitate applications in:** Low-Power Logic Circuits, High Performance Memories, Wire-based Sensors

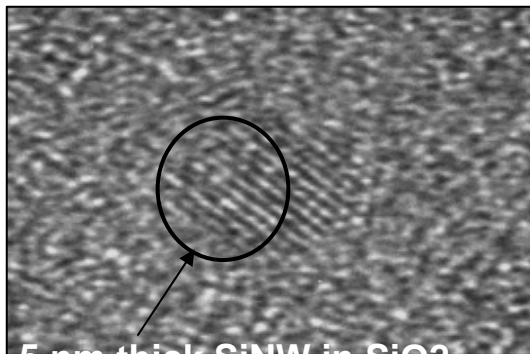


E. Gnani et al. / Univ Bologna, ESSDERC'06

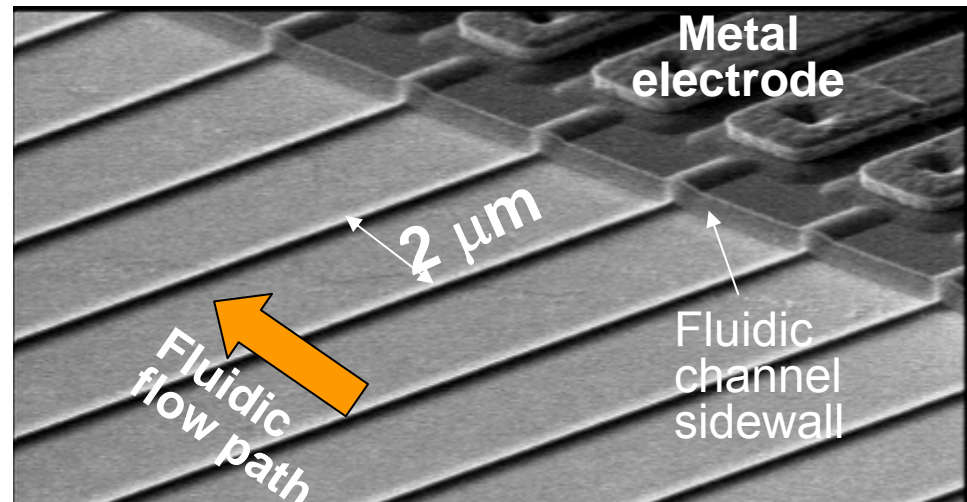
CMOS-compatible Si Nanowire Array for Biomedical Application



- Silicon nanowires offer high surface-to-volume ratio and hence increased sensitivity of detection through conductance change
- Silicon nanowires can be functionalized to detect cancer biomarkers and other biomolecules such as virus and sequence-specific DNA



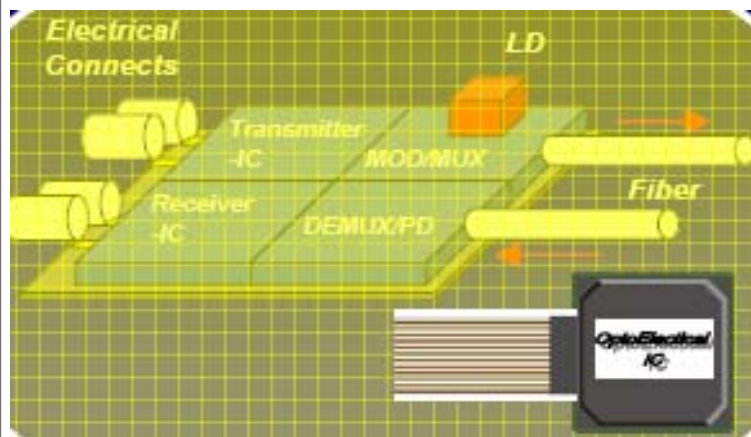
HRTEM image of Si Nanowire
embedded in SiO₂



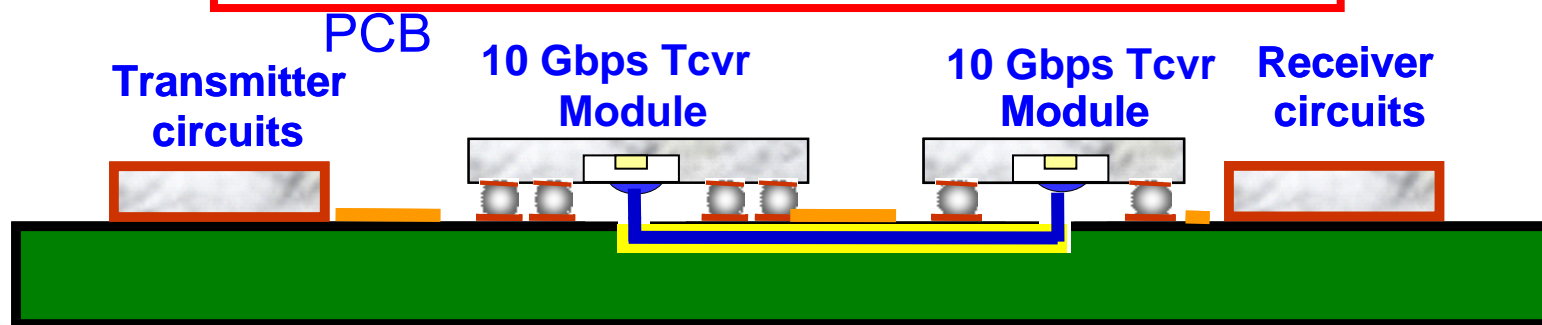
Si Nanowire Array for Bio-sensors

Focus Area: Photonics

- Establish CMOS-compatible monolithic technology platform for OEIC



- Bi-Directional optical-interconnects on



Bi-Directional Optical link on FR4 PCB

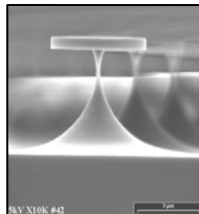
MEMS at IME

The MEMS (Micro-Electro-Mechanical Systems) R&D programme in IME started as far back as 1993.

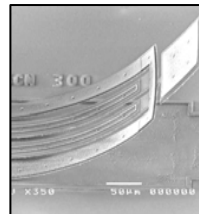
We have developed integrated research capabilities for MEMS, including MEMS design, Application Specific Integrated Circuit (ASIC) design, process development and custom package development.

We have developed many cost-effective MEMS products and devices such as integrated pressure sensor, accelerometer, micro-relay, ISFET immunosensor, micro-PCR and micro-CE, and IR bolometer.

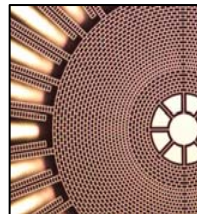
Several of these devices have been successfully commercialized.



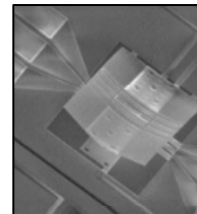
Silicon tips



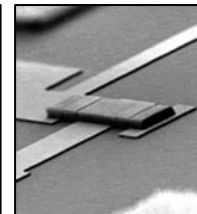
Micromirror



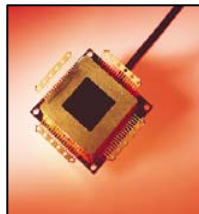
HDD actuator



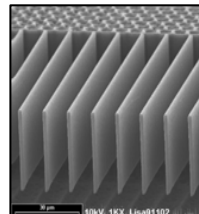
Micro-relay



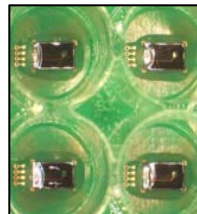
RF resonator



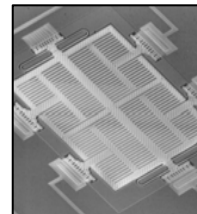
Vacuum sealed
bolometer



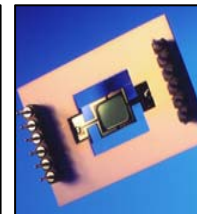
30:1 high
aspect ratio Si



Cantilevers
inside bio-wells



Silicon
accelerometer



μPCR for DNA
amplification

MEMS-Specific Processes Available

- **Double sided contact / proximity aligner**
- **Wafer track for coating thick resist and Polymers**
 - Spin coating of thin/thick resists
 - Photo/non-photo sensitive BCB coating
- **Wafer to wafer bonding**
 - fusion pre- bonding/alignment
 - anodic bonding
 - frit glass bonding
 - polymer bonding
 - Eutectic and Solder bonding
 - Metal to metal thermal-compression bonding
 - Low-temperature hermetic bonding
- **Bulk Si-micromachining**
 - Deep Reactive Ion Etching
 - Wet TMAH/KOH etching
 - 3 and 4 terminal electrochemical etch
- **Surface micromachining**
 - RIE/wet etching of polysilicon, Silicon Nitride, Silicon dioxide, Aluminum and other thin films (CMOS compatible tools, however separate tools needed to avoid contamination issues)
- **Release etching process**
 - XeF₂ and SF₆ Silicon release etch
 - HF vapor release etch of silicon dioxide
- **Electroplating for Cu, Ni, Au, photo resist**
- **Wafer thinning & polishing**
 - Wafer grinder/polisher
- **Thin/thick film deposition**
 - Low stress/controlled stress films such as polysilicon, silicon nitride, and silicon dioxide
 - Thick dielectric films 5-10μm
- **Metallization**
 - e-beam evaporation and PVD
 - Al, AlSi, Cu, Au, Chromium, refractive and rare-earth metals
 - Ti/TiN and TaN barrier metallization
- **Supercritical CO₂ drying**
- **Self assembling monolayer coating for anti-stiction**
- **Bio-compatible polymer microstructure fabrication-** PDMS, parylene

Nanotech R&D in NUS and NTU



NUS NNI
*Nanoscience and
Nanotechnology
Initiative*

Research

- Nanobioengineering
- Nanoelectronics
- Nanophotonics
- Nanomagnetics & Spintronics
- Nanofiber science & engineering
- Nano- micro-fabrication



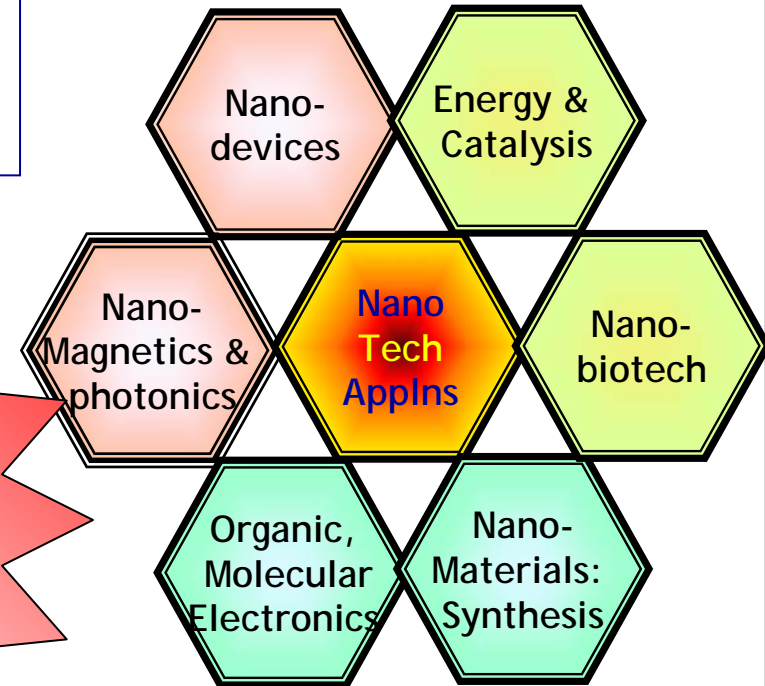
NTU Nanocluster
*Nanoscience and
Nanotechnology
Cluster*

<http://www.ntu.edu.sg/nanocluster/>

Mech Engrg
Elect Comput Engrg
Chem Env Engrg
Civil Engrg
Bioengrg
Biology
Medicine
Biochemistry

Physics
Materials Science
Mathematics
Chemistry

**Cross-faculty
joint research
collaborations**



Nanotechnology R&D in Universities



National University of Singapore (NUS):

Nanoscience and Nanotechnology Initiative (NUSNNI)

- Involves some 189 faculty and research staff from 20 research labs around NUS; working on some S\$17 million worth of research grants per year.
- Nanoscience - molecular self-assembly and devices, nano-structure formation, and in-situ nano-characterisation instrumentation
- Nanotechnology- photonics, silicon nanodevices, information storage materials, quantum computing, spintronics, Graphene, nanoscale materials and systems, bio-nanotechnology
- **Solar Energy Research Institute (130MSGD/5Y funded by EDB) and Quantum Information Science and Technology (150MSGD/5Y funded by NRF)**



Nanyang Technological University (NTU):

Nanoscience and Nanotechnology Cluster (NanoCluster)

- Close to 90 faculty members from all disciplines of science & engineering
- Wide network of research centres with shared facilities for nanofabrication, nanocharacterization, and exploitation of nanotechnologies. **MEMS R & D Foundry Services**
- **Key areas: Microelectronics & Photonics, MEMS, Precision Engineering, Advanced Materials, Analysis & Characterization, Testing & Simulation**

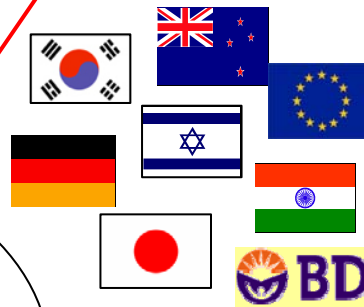
Driving Commercialization

Ready Partners within 250 sq miles

Multi-national Corporations



Private & Public Incubators



Startup Enterprises



Access to regional & global markets



Attracting and Growing R&D

In FY2007*, SERC RIs undertook
173 R&D projects with 335 different companies

 SUMITOMO ELECTRIC

Lucent Technologies
Bell Labs Innovations



NSG
NIPPON SHEET GLASS
OFFICIAL SITE

STATS™

 SHOWA DENKO

 muvee
Technologies

 Infineon
technologies

 Chartered
semiconductor manufacturing

 U-TAC

 ASAHI
SOLDER

 EPCOS

 IMD

 Mitsui Chemicals

CISCO SYSTEMS

degussa.
RohMax
OIL ADDITIVES

CET Technologies Pte Ltd

agere systems



Honeywell

Tezzaron
SEMICONDUCTOR

TOPPAN

 Hitachi Global Storage Technologies

 PHILIPS

 ST

 hp
invent

 mol

Seagate
We turn on ideas



SATS 

THALES

 YOKOGAWA

 MOLECULAR IMAGING
CORPORATION

Rhodia
Asia Pacific

MBE
TECHNOLOGY

Role of Private Sector (VCs, Corporate R & D Partnership, SPRING Matching Funds)

Investing Nanotech Start Ups

SPRING/EDB

Bio* One Capital

Nanofrontier (NTU)

NUS Entrepriase

ASTAR Exploit Technologies

Nanostart Asia

Innosight Asia

Capvista Capital

Business Angel Groups

Upstream Venture

Imprimatur Capital

Others global investors

~ 600,000 wafers per month output (200mm equivalent)

~ 8% of global wafer starts

~ 1000 R&D engineers

Three 300mm fabs

- Chartered Fabs 2, 3 & 7 (300mm)
- Chartered Fab 5 - Silicon Manufacturing Partners (Chartered-LSI)
- Chartered Fab 6 - Chartered Silicon Partners (Chartered-Avago)
- Chartered Fab acquired from Hitachi in Mar 2008
- SSMC - Systems on Silicon Manufacturing Company (NXP-TSMC)
- STMicroelectronics (3 fabs)
- Numonyx (1 fab)
- TECH Fabs 1 & 2 (12" conversion) (Micron-Canon-HP)
- UMC Fab 12i (300mm)

Upcoming Fabs

- IM Flash Singapore - under construction (300mm)
- Qimonda - announced in Apr 07 (300mm)



UMC Fab 12i



Chartered Silicon Partners

First Global Research Facility in Asia

Only Competence Centre for
Nanostructured Surfaces and R&D
Centre for Organic Electronics in Asia
Research collaboration with IMRE on
organic photovoltaics

Business Times, 15 November 2005

BASF plans to set up global nanotech R&D centre in S'pore

The company will
spend 3m euros on
its first such Asian
facility in first year

By RONNIE LIM

were many factors which
swung the decision in Sin-
gapore's favour.

"In addition to its cre-
ative and innovative R&D
environment and abun-
dant of well-educated
people with chemistry and

innovative products for its
"growth" markets like au-
tomotive, construction,
household, cosmetics and
electronics.

The centre will also
"support unique scientific
solutions for emerging

ber of BASF's board of ex-
ecutive directors and exec-
utive research director,
said in Germany yesterday:
"I am convinced that a
strong research environ-
ment like Singapore, as
well as the vicinity to

Economic Development
Board chairman Teo Ming
Kian said the centre "is
very much in line with our
objective of fostering basic
to applied research in Sin-
gapore in areas which are
closely tied to our key in-

oxide. In April,
acquired Merck
electronics bus-
including Merck's
plants producing
for semiconduct-
screens. And reflect

"I'm convinced that a strong research environment like Singapore, as well as the vicinity to emerging markets, will enable us to speed up innovations for nano-based applications."

— Dr Marcinowski, member of BASF's board of Executive Directors and Executive Research Director.

News Release

BASF opens Organic Electronics R&D center in Singapore

- **Expansion of research activities to reinforce commitment to innovation**
- **Embarks on Organic Photovoltaics project with IMRE**

Singapore, May 14, 2007 – BASF said today it is investing about S\$4 million to set up a new research and development center for Organic Electronics in Singapore as part of the expansion plan of its research activities in Asia Pacific. BASF has embarked on a new project on Organic Photovoltaics with the Institute of Materials Research and Engineering (IMRE) in the center.



STMicroelectronics set up corporate R&D Centre

- Focus on theoretical research and application development of carbon nanotubes
- Close collaborations with Singapore research institutes and universities

"Singapore has been chosen because we have had a very successful partnership and experience here over the years"

Dr Gianguido Rizzotto,
Group VP, Corporate R&D

Singapore chosen as nano research centre

STMicroelectronics is bringing its high-end research to Singapore because of its successful experience here, the semicon giant's top scientists tell **Tang Weng Fai**

CUTTING-EDGE research that will help Singapore play a more effective role in the global nanotechnology arena is coming into the Singapore labs of French-Italian semiconductor giant, STMicroelectronics.

STMicro's group vice-president of corporate R&D Gianguido Rizzotto told BizT that the company will move its research in carbon nanotubes into Singapore "sometime next year".

"We have some help from the Economic Development Board (EDB) in this and will be jointly identifying the people and the location," he said.

About eight to 10 candidates will be sent for training of up to a year in STMicro's main research labs in either Italy or France before starting up the new research centre here.

Carbon nanotubes are structures 1.2-1.4 nanometre (nm) wide, made of carbon that under an electron microscope looks very much like wire-mesh. These tubes have the unique property

BT exclusive

of being able to behave like a metallic, semiconducting material or a combination of the two, depending on whether it is made from one or many layers of carbon. A nanometer is a billionth of a metre.

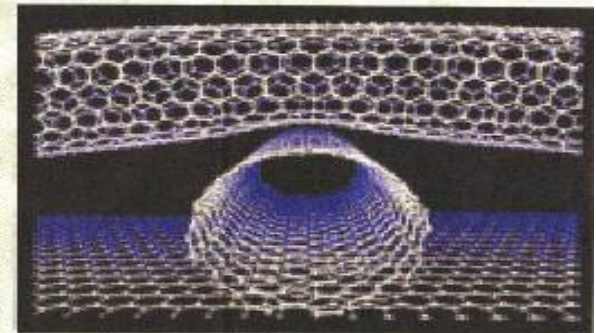
"Standard CMOS (complementary metal on silicon-oxide semiconductor) will be running out of steam as a technology not many years from now," says Salvatore Coffa, director of research at corporate R&D in STMicro. "We need to start work on the next generation."

Today, the cutting-edge feature size on a standard integrated circuit is 130 nm (0.13 micron) which is used for applications like flash memory and

miniaturisation. For example, the latest International Technology Roadmap for Semiconductors published by the Semiconductor Industry Association sees, by 2016, more than 8.6 billion transistors on a 280 mm sq surface. This is 25 times more dense than the typical 130 nm chip available today.

This makes nanotubes attractive as a new way to build ever-smaller devices, such as single-electron transistors, that will drive miniaturisation beyond the current limits of silicon-based technology.

Mr Coffa says that STMicro believes there is more life in silicon than most people currently realise. That is why it prefers an approach to maximise the useful life of cheap silicon than invest into more expensive materials like compound semiconductors



Carbon nanotubes: research into this exciting area is a long-haul process

Honorary citizenship for STMicro chief

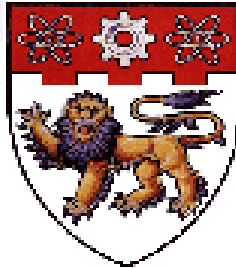
By Tang Weng Fai
STMICROELECTRONICS chief executive Gianguido Rizzotto, a native Ital-

ian in Singapore, has invested about US\$1.5 billion in more than 20 years of operation here led by Mr Rizzotto.

NanoFrontier

Transforming conceptually-proven tech into investable companies

NANO
FRONTIER

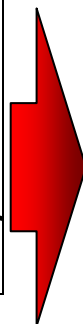


“*(The) launch of NanoFrontier reflects Singapore's concerted efforts to develop nanotechnology-enabled products and applications. We will continue to build up a larger and stronger nanotech community...*”

-Dr. Vivian Balakrishnan,
2nd Minister for Trade and Industry

- Private company spun out of Nanyang Technological University in 2004
- Nanotechnology Incubation Hub which:
 - attracts and develops top talent
 - works with leading nanotech companies in the world
 - spins out companies that focus on commercialising nanotech IP
- Strategic partnerships with top institutes like California NanoSystems Institute (CNSI), Northwestern University and ETH

Locally-
Based
+ Overseas
Companies



NEW
Products,
Processes,
Services, IP
and
Enterprises

Singular ID

Nanomaterial applied in security, anti-counterfeit & brand-verification



- Multiple award-winning Micro and Nanotech company founded Dec 2004 in Singapore
- Magnetic tagging technology for tracing and authentication
- Acquired by global pharmaceutical packaging firm Bilcare in Jan 2008 for S\$19.6 million:

“ This product is innovative in its use of a magnetic property to solve a business problem of identifying whether a product is genuine or not, solving the serious problem of counterfeiting. ”

- ZDNet Asia

Bilcare buys Singapore's Singular ID for S\$20m

2008-01-04 12:40:21

Source : CNBC-TV18

Bilcare has acquired Singapore-based **Singular ID** for 20 million Singapore dollars, reports CNBC-TV18. The latter provides pharma counterfeit solutions.

Bilcare has been looking at advancing its technology, in terms of solutions for counterfeit drugs. Now, it has gone ahead and acquired a Singapore-based company called Singular ID. They had been looking at this particular company for sometime.

Singular ID is a very high technology company, which uses nanotechnology, in terms of developing solutions to minimize the use of counterfeit drugs, which is seen as a big menace for most of the pharmaceutical companies.

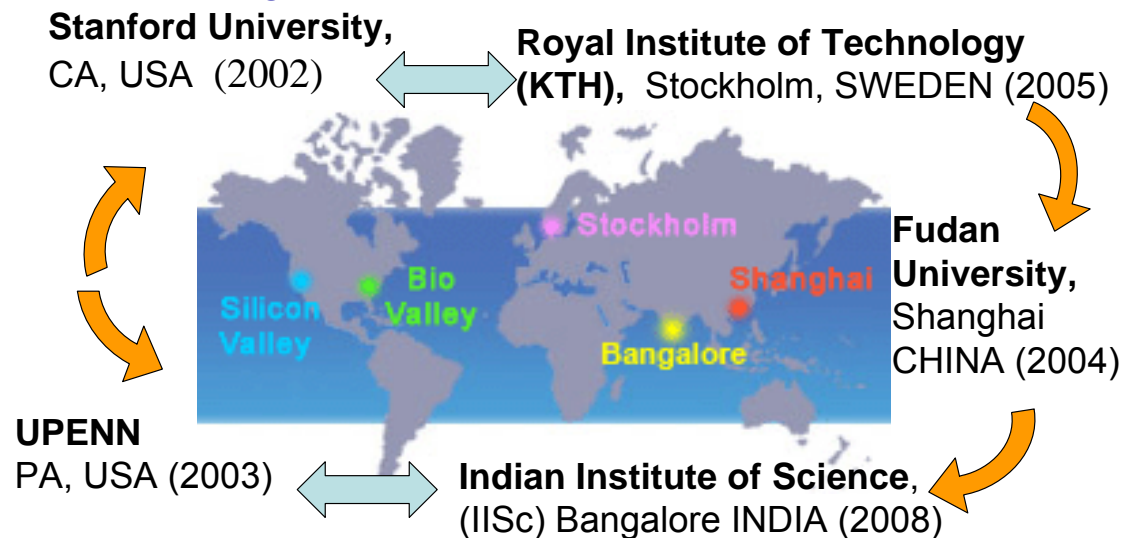
Example of NanoSingapore Companies

- **AMR Technologies** -- Rare-earth nano particles R&D
- **NanoScience Innovation** – Manufacture of nano-composite powders using plasma technology
- **NanoMaterials Technology** -- Development of process technology for controlled production of nanoparticles of electronic materials and pharmaceuticals
- **BASF** – Corporate lab doing R&D on nanostructured surfaces for application in materials and electronics.
- **Oxonica** – Fuel borne nanocatalyst for diesel engines which reduce fuel consumption and emissions
- **WET** (Water and Environmental Technologies Pte Ltd) -- Use of nano-structured photocatalyst in conjunction with UV radiation for disinfection in water treatment
- **Singular ID** -- Nanostructured magnetic tags for anti-counterfeit applications
- **Quantum PI** – Develops atomic precision and sub-nanometer metrological devices and sensors
- **Atomistix** -- Development team for software simulation tools for nanotechnology and nanodevices
- **STMicroelectronics** – Corporate lab doing R&D for carbon nanotubes to be used in microelectronics
- **NanoFilm** -- Nanocoatings on slider head, disk media, using tetrahedral amorphous carbon (ta-c) film via filtered cathodic vacuum arc (FCVA) tech
- **i-Nano** – Nanofibre applications to face masks and food packaging
- **BioNano** – Bionanotechnology R&D (now using carbon nanotubes)
- **Inspiraz** – Nanocoatings for various applications
- **ShayoNano Chemicals** – Development of nanoclay applications
- **NanoFrontier** – Nanotech incubator, R&D centre
- **Nanotechnology Manufacturing Pte Ltd** – Design and manufacture of ultra-precise tooling
- **Qtech Nanosystems** – Developing nanopositioners (metrology)
- **NanoGlobe Pte Ltd** – Nanotech consulting firm
- **Zyvex Asia Pte Ltd** – Atomically precise R&D and nano-precision tools.
- **Innovative Polymers Pte Ltd** – Developing plastics for hard-disk drive and semiconductor industry
- **Microspace Rapid Pte Ltd** – Nano- and microsystem technologies for aerospace and sensors

**Human Resource (NUS
NOC, Attracting Leaders
and Researchers, Students
world)**

NUS Overseas Colleges (NOC, www.nus.edu.sg/enterprise/noc)

- ❖ Experiential education programme
- ❖ Students are immersed in leading entrepreneurial-academic hubs around the world to develop global outlook
- ❖ Students spend one year as interns in technology startups, to gain first-hand, practical insights into startup operations
- ❖ At the same time, they take entrepreneurship-related courses in partner universities
- ❖ 5 overseas colleges in leading entrepreneurial hubs
- ❖ 200 students a year to participate in this program



**Visiting Singapore-Seeing
is Believing**



NanoEquity Asia 2008 (May 28-29th 2008, www.nano-globe.biz/nanoequity08)

- Asian chapter of Nanostart's NanoEquity
- Meet leaders in Nanotech investors in the region
- Learn and be inspired by success of Nanotech start ups and IPOs
- Funding Raising for start ups

2008 Asian Conference on Nanoscience and Nanotechnology 2008 (Nov. 3-7, 2008, www.asianano2008.org)

- International conference covering research development in areas including CNT, Graphene, Bionano, Fabrication, Nanomagnetism, Nanoassembly, simulations etc)
- Networking with the leaders in the research in Asia

Hints for Nanobusiness

- **Government Support Schemes**
- **R & D Infrastructure Access**
- **Team Building – Find Passionate People**
- **Private Financing & Get Help with Management (willing to let go)– Strategic Partner (customer), Angel and Non conventional VC**
- **IP Management – Focusing on Making stuff and Sale stuff instead of sitting on IP**
- **Marketing- Local and Global, Partner with Customers and companies with distribution/sales channels**
- **Asia Business Characteristics – based on trust and relationships, less formality, more focusing on substance**
- **Society Issues –Nanostandard is premature, Avoid Nanoword, compliance to standard safety issues.**



From UDA