Agency for Science, Technology and Research
SINGAPORE

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Press Release

A*STAR Showcases a Variety of Capabilities in Semi-conducting and the Micro-Systems Packaging at this year's SEMICON 2005

Four research institutes from the Agency for Science, Technology and Research (A*STAR) are showcasing a variety of capabilities in semi-conducting at this year's largest expo on the semiconductor industry.

In addition, to capitalize on the collective strengths of its research institutes towards conducting leading edge R&D and supporting the Singapore industry in electronics packaging, A*STAR has also set up the Micro-Systems Packaging Initiative (MSPI) with these four institutes namely, Institute of Microelectronics (IME), Institute of Materials Research and Engineering (IMRE), Institute of High Performance Computing (IHPC) and Singapore Institute of Manufacturing Technology (SIMTech). The exhibits are on display at this year's SEMICON at Suntec Convention Center Level 4, hall 401 from 4 – 6 May.

The relevant strengths of the institutes are:

- IME – microelectronics
- IMRE – materials
- IHPC – modeling and simulation
- SIMTech – manufacturing technology

"The collaborative work and advent of the MSPI amongst the research institutes means that the industry need not "hop" from one institute to another to have its needs answered. Rather, the needs maybe expressed to any of the member institutes and they will be addressed by the team as an entity. In this way, besides improving the quality of work, the all important project turn around time and overall efficiency is also significantly reduced", says Professor Chong Tow Chong, Executive Director for the Science and Engineering Research Council, A*STAR.

The MSPI initiative brings together more than 50 full-time multi-disciplinary experts in various aspects of micro-systems packaging residing in the four institutes to a single team. The mission of the MSPI is to help enhance the competitiveness and sustain the growth of the Singapore electronics industry by:

- Conducting leading edge and application driven R&D in micro-systems packaging technology
- Technology transfer to the industry
- Developing skilled R&D personnel

A*STAR envisions making Singapore a global technology leader in specific areas by collaborating with the academia in upstream R&D, and engaging with industry.

Some of the exhibit highlights are listed below. They range from nanotechnology to mechatronics and industrial informatics.

Highlights of Exhibits by the Research Institutes:

Institute of Microelectronic (IME)

Nano Wafer Level Packaging

Advances in nanotechnology are demanding new paradigms both in IC and systems packaging. In a groundbreaking research – an interactive collaboration between IME and NUS in Singapore and Georgia Tech of the USA – Nano Wafer Level Packaging (N-WLP) is being pursued as the new paradigm, by applying nanomaterials for fine pitch off chip wafer level interconnects and assembly.

Unlike current solder interconnects, such "nano interconnects" can offer a new opportunity for the best electrical properties at the lowest cost, and at the same time, guaranteeing mechanical integrity with their greatly improved mechanical strength and fatigue resistance. Successful proof of concept will lead to a new generation of even smaller products with almost limitless connections between the devices and the rest of the system, providing higher performance and newfound applications.

The work of the team has resulted in three invention disclosures, three patent filings, and numerous papers in prestigious journals and conferences.

Wafer Transfer Technology

Although silicon is the current 'gold' standard in semiconductor fabrication, silicon as a circuit carrier has its shortcomings. The bulk of silicon merely serves as a mechanical carrier with the actives/passives confined to the top few microns of the wafer.

Researchers at IME are working on a unique wafer transfer technology (WTT) know-how to transfer submicron circuits, fabricated with standard IC processing, onto flexible plastic substrates with the electrical and mechanical integrity of the circuit unaffected. This technique developed at IME offers competitive economies of scale and good yield. By using FR-4, a common PCB material, as one of the materials for the prototyping

work, it leverages on its low cost and renders better performance as compared to silicon as a carrier.

Institute of Material Research and Engineering (IMRE)

A "Greener Way" of Growing Compound Semiconductor Crystals

Compound semiconductor crystals are widely used in high frequency electronics such as signal amplifiers for handphones as well as high power radar and radio station transistors, and light emission and detecting devices, such as optical communication (light source, fibre amplifier, receiver), optical data storage (CD/DVD), data processing (printer, code reading), solid state laser source (laser pumping), detector (IR camera) and displays (LED).

Researchers in IMRE have developed a method of growing high quality crystals using new sources such as tertiarybutylphosphine (TBP) and tertiarybutylarsine (TBA). This method, compared to existing ones, is safer, cleaner, less toxic and produces less harmful chemical. Various semiconductor lasers fabricated in IMRE have shown that crystals grown using this "greener" technique have the potential to be as efficient as those currently in the market.

Developing New Materials and Processes for Future Nano-scale MOSFET Device

Due to their higher low-field carrier mobility compared to conventional Si MOSFET[1], new germanosilicide and germanide materials and their processes have good potential applications in future nano-scale Si(Ge)- and Ge-based CMOS devices. CMOS technology is the dominant semiconductor technology for microprocessors, memories and application specific integrated circuits (ASICs) in electronics. In recent developments, the metal source/drain (S/D) Schottky Barrier MOS (SBMOS) architecture provided numerous and broad benefits over conventional silicon CMOS technology, according to the International Technology Roadmap for Seminconductors (ITRS), for the physical gate length technology nodes below 45 nm.

IMRE has been working on developing new germanide/germanosilicide SBMOS technology by combining the technology advantages of both germanide/germanosilicide and SBMOS. We are presently carrying out research on both N-type (based on RE germanide/germanosilicide S/D) and P-type (based on Ni germanide/germanosilicide S/D) SBCMOS via S/D materials engineering and channel stress modification. The research will focus on the materials characterisation of the relevant germanosilicide and germanide material systems, combined with engineering of material properties, device fabrication, process integration, and characterisation.

[1] A chip technology where the transistors are implemented as Field Effect Transistors. MOSFETs are useful for high-speed switching applications and also on integrated circuits in computers.

Singapore Institute of Manufacturing Technology (SIMTech)

1. Micro-joining and substrate technologies

- Micro power generation system gas turbine engine

The micro-power generation system is suitable for applications in portable electronics, micro robots and micro/nano-satellites. The micro gas turbine engine which uses hydrogen or hydrocarbon fuel addresses the major disadvantages associated with batteries in energy density, power density and cost. Potential applications range from the military to medical industries.

- Advanced thermal management solutions with micro thermoelectric cooler (μTEC)

Thermoelectric coolers (TECs) can cool or heat with precise temperature control. They are light-weight, compact with no moving parts and environmentally friendly. SIMTech showcases a highly effective and cost competitive thermal management module which integrates the micro heat pipe and a micro TEC into a LTCC (Low Temperature Co-fired Ceramics) substrate. Applications of TECs for temperature control include high density, high power electronics for military, aerospace, consumer as well as scientific equipment.

- LTCC substrate design and validation

SIMTech offers solutions in LTCC (Low Temperature Co-fired Ceramics) substrate design and manufacturing. Competencies include design, process development, prototyping and performance validation of high performance substrates and modules for digital, mixed-signal, RF and broadband applications. These technologies are available for licensing.

2. Configurable controller technology

- Message discovery for plug ‘n’ play equipment integration

Semiconductor equipment builders face challenges in equipment integration as the implementation of user-defined SECS-II (Semiconductor Equipment Communication Standard 2) messages varies from vendor to vendor. SIMTech has created a “discovery algorithm” which allows builders of semiconductor equipment to perform on-site equipment integration. The software discovers subsets of standard messages and user-defined messages implemented in the equipment. Integration can be done by an individual with only basic knowledge of SEMI (Semiconductor Equipment and Materials International) standards and computer programming skills. As equipment integration can be done on the factory floor, the ramp-up time for a new production facility is significantly shortened. The solution is unique in being vendor and equipment independent.

Institute of High Performance Computing (IHPC)

Electromagnetic Modelling of Multilayered Circuits

Electromagnetic(EM) modeling of multilayered circuits are carried out to enhance the efficiency of the Finite Difference Time Domain (FDTD) method and the Method of Moments (MoM) for high speed multilayered circuits modelling and system-level SI analysis, as well as to develop new methodologies for EM analysis of passive multilayered circuits. This can be applied to :

- High-speed interconnect (on/off chip) modeling and simulation
- Characterisation of passive multilayered circuits (Spiral inductor, Dielectric resonator etc.)
- EM analysis of Packaging structures, and
- system-level analysis of medium to large multilayered circuit systems

Development of Smaller and More Powerful Flash Memory Devices

With the progressive advancement of electronic technologies in recent years, there is increasing pressure on manufacturers of modern memory devices to make these devices smaller, more powerful with higher data capacity and more reliable. To account for this trend of development, nanocrystal-based non-volatile memories, employing isolated semiconductor or metal quantum dots as discrete charge storage elements, have been proposed. This can also be used for future applications in the flash memory industry.

IHPC, together with the National University of Singapore and the Institute of Microelectronics, are looking at the development of a device/process simulator for flash memories with nanocrystal quantum dots embedded in high-k gate dielectric region between the channel and the control gate. The developed simulator will have the capability to predict memory performance limits and provide valuable insights into device behaviour. Also, it is a useful tool in guiding the design of quantum dot flash memory devices.

The use of quantum dots as discrete charge storage elements which are embedded in high-k dielectric, for example HfO2 or HfAlO, reduces the problem of charge leakage and at the same time, enhances the device scalability without sacrificing its non-volatility. Such memory structures offer the advantages of low power consumption, better endurance and lesser attempts needed to write-erase.

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About the Agency for Science, Technology and Research (A*STAR)

A*STAR's mission is to foster world-class scientific research and talent for a vibrant knowledge-based Singapore. The Agency comprises the Biomedical Research Council (BMRC), the Science and Engineering Research Council (SERC), the A*STAR Graduate Academy (A*GA), the Corporate Planning and Administration Division (CPAD) and a commercialisation arm, Exploit Technologies Pte Ltd (ETPL).

The Science and Engineering Research Council (SERC) funds and oversee 7 public research institutes in areas such as chemical sciences, materials, high performance computing, information technology and communications, manufacturing technology, microelectronics and data storage.

For more information, please visit: www.a-star.edu.sg

About Singapore Institute of Manufacturing Technology (SIMTech)

The Singapore Institute of Manufacturing Technology (SIMTech) is a member of the Agency for Science, Technology and Research (A*STAR). Established in 1993, its mission is to enhance the competitiveness of the local manufacturing industry. SIMTech contributes to the competitiveness of the Singapore industry through the generation and application of advanced manufacturing technology and development of human capital. It has collaborated with multinational and local companies in the electronics, semiconductor, precision engineering, automotive, aerospace, marine, logistics and other sectors.

For more information, please visit: www.SIMTech.a-star.edu.sg

About the Institute of High Performance Computing (IHPC)

The Institute of High Performance Computing (IHPC) is a national research institute and a member of Singapore 's Agency for Science, Technology and Research (A*STAR). Its research thrust is in computational science and engineering (CSE). The Institute places great emphasis on furthering CSE through the development of human capital, intellectual capital and industrial capital. It also aims to help Singapore-based companies gain competitiveness through the promotion, development and application of CSE technologies. With a current staff strength of 165 research scientists and engineers, IHPC is well-placed to spearhead research and development in CSE across a broad range of disciplines, such as manufacturing, electronics, chemical applications, precision engineering, virtual reality and advanced product design.

For more information, please visit: http://www.ihpc.a-star.edu.sg

About the Institute of Materials Research and Engineering (IMRE)

The Institute of Materials Research and Engineering (IMRE) was established in 1996 to create materials knowledge, develop human capital and to transform technology through innovative research. IMRE undertakes research in selected fields of materials science and engineering, including optoelectronics, nanomaterials, chemicals and polymers. Our new innovations and discoveries are constantly being explored to help further the applications of advanced materials and processes.

For more information, please visit www.imre.a-star.edu.sg

About the Institute of Microelectronics (IME)

The Institute of Microelectronics (IME) is a member of the Agency for Science, Technology and Research (A*STAR). Established in 1991, its mission is to increase value-add to the electronics industry in Singapore by engaging in relevant R&D in strategic fields of microelectronics; supporting and partnering the electronics industry; and developing skilled R&D personnel. Its key research areas are in integrated circuits and systems; semiconductor process technologies and microsystems, modules and components.

For more information, please visit: www.ime.a-star.edu.sg