Agency for Science, Technology and Research
SINGAPORE

Press Release

R&D + Technology = Manufacturing for the Future

Research Institutes exhibit their R&D capabilities at SEMICON 2006.

SINGAPORE, 9th May 2006 – At SEMICON 2006, the Agency for Science, Technology and Research (A*STAR) is showcasing a suite of cutting edge technologies and initiatives that will add a boost to the local electronics/ semiconductor industries. Participating in SEMICON 2006 are several of A*STAR-funded public sector research institutes which have core competencies in microelectronics (the Institute of Microelectronics - IME), materials research (the Institute of Materials Research and Engineering – IMRE) and manufacturing technology (the Singapore Institute of Manufacturing Technology – SIMTech).

A*STAR's research institutes are constantly pushing the frontiers of research, to achieve new possibilities and perpetuate the growth of Singapore's electronics industry. The integration of capabilities of A*STAR's research institutes creates many opportunities for collaboration with the industry, to spawn innovative solutions to help local companies build up their competitive advantage and create new markets.

"The electronics and semiconductor industry continues to face increasing pressures and complexities of global competition. Scientific and technological discoveries will be key to creating new knowledge and intellectual property for companies in this cluster to generate innovative products so as to remain relevant in the regional and global economy. A*STAR's research institutes are constantly pushing the frontiers of research and collaborating in areas that will support Singapore's economic competitiveness." said Professor Chong Tow Chong, Executive Director for A*STAR's Science and Engineering Research Council (SERC).

R&D Foundry

IME's R&D Foundry is the first silicon wafer fabrication facility in the region offering its customers access to advanced wafer fabrication facilities as well as manpower expertise for prototype development and small volume pilot production in a cost effective manner. They will be able to take advantage of IME's years of experience in CMOS and MEMS technology development. IME's new R&D Foundry service aims to help encourage new product development and nurture technology entrepreneurship in Singapore.

Electronics Packaging Research Consortium (EPRC)

The Electronics Packaging Research Consortium (EPRC) – an A*STAR Micro-Systems Packaging Initiative (MSPI) led by IME, IMRE, IHPC (the Institute of High Performance Computing) and SIMTech, recently started its eighth programme to develop new packaging methodologies for optimised electrical, thermal, optical and reliability performance. 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.

IMRE's nanofabrication and characterisation facilities

The Science and Engineering Research Council's (SERC) Nanofabrication and Characterisation (SNFC) Facility aims to make accessible A*STAR's state-of-the-art research facilities in nanofabrication and characterization, to researchers in Singapore. The user facility, located at IMRE, hosts tools and instruments for the fabrication and characterisation of non-Silicon based materials at the sub-micro and nanometer scales. The facility also supports a cadre of experts to aid the user community and provides easy access for users via an open booking system (http://www.imre.a-star.edu.sg/rnd/snfc/Equipment.asp).

Manufacturing Technologies

SIMTech is equipped with capabilities covering the full spectrum of manufacturing activities for the semiconductor industry. For process, material or equipment manufacturing, SIMTech provides advanced substrate-based platform solutions and automation technologies. In the area of inspection and measurement, SIMTech has a suite of methodologies to provide strategic analysis and interpretation. It also supports manufacturing operations through an integrated platform of infocommunications technologies (ICT) which integrates and automates processes and equipment for better visibility on the shop floor.

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ANNEX A

About Agency for Science, Technology and Research

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 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; microsystems, modules and components, and bioelectronics.

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

About the Institute of Materials Research and Engineering (IMRE)

The Institute of Materials Research and Engineering (IMRE) is a member of the Agency for Science, Technology and Research (A*STAR). Established in 1996, its mission is 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. The research institute's innovations and discoveries are constantly being explored to further the applications of advanced materials and processes.

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

About the 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 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, aerospace, automotive, logistics, marine and other sectors.

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

ANNEX B

IME Exhibits

R&D Foundry

Companies with innovative product ideas that require hi-tech research need not be daunted and restrained anymore by their lack of capabilities or the potential high cost of such R&D work. IME's state-of-the-art research infrastructure is now available to the technology start-ups, small and medium-sized enterprises, fabless companies, research organisations and universities – at affordable rates. IME's new R&D Foundry service aims to help encourage new product development and nurture technology entrepreneurship in Singapore.

IME's R&D Foundry is the first silicon wafer fabrication facility in the region offering its customers access to advanced wafer fabrication facilities as well as manpower expertise for prototype development and small volume pilot production in a cost effective manner. They will be able to take advantage of IME's years of experience in CMOS and MEMS technology development.

Occupying a floor space of 21,000 sq. feet, IME's class 10/100 clean room facility is equipped with industry compatible process, metrology and defect inspection equipment for advanced CMOS and MEMS device fabrication. Customers can utilise IME's baseline processes on industry standard equipment to develop production-ready process modules and integration schemes for product prototyping. The development work can be carried out together with IME or qualified customers can also have access to IME's facilities. Customers who wish to carry out small volume pilot production can also do so using IME's fabrication facility until they are ready to transfer the technology to a commercial manufacturing site. IME can assist its customers in technology transfer if required.

Electronics Packaging Research Consortium (EPRC)

The Electronics Packaging Research Consortium (EPRC) – an A*STAR Micro-Systems Packaging Initiative (MSPI) led by IME, IMRE, IHPC and SIMTech, recently completed its seventh programme to develop new packaging methodologies for optimised electrical, thermal, optical and reliability performance.

After a 20-month period investigating chip and substrate design with structural optimisation, and evaluating underfill and thermal interface materials and assembly process optimisation, the EPRC VII Consortium team delivered a reliable Flip Chip Ball Grid Array (FCBGA) package with high density multi-layered build-up substrate for 17.5mm x 17.5mm chip size and 150um bump pitch with SnAg solder. The FCBGA package is capable of achieving stringent JEDEC reliability test requirements for moisture sensitivity under Pb free reflow condition and temperature cycling test.

For the Silicon-Stacked Module, a new approach of stacking modules was adopted, using silicon as carrier. Silicon carrier stacking is a step towards wafer level stacking, which offers the potential for reduced manufacturing cost, good solder interconnect reliability and high packing density. The developed Silicon-Stacked Module, with three stacks, flip chip and glass cap assembled on the PCB, met signal transmission up to 2.5GHz bandwidth, 5 watts heat dissipation in natural convection environment and 20 watts with air cooled solution; and demonstrated improved solder joint fatigue life by five times with board level underfill.

The technologies developed take functional integration to a higher level, enabling more sophisticated features in electronic gadgets. The EPRC will take systems integration even further in its eighth consortium programme with three projects for System-in-Package application: fine-pitch large die FCBGA, stacked silicon module with embedded passives, and Cu/low-k Wafer Level Package.

Drop Impact
IME has been collaborating with the National University of Singapore, University of Cambridge and Instron Singapore in various research studies to understand what causes failure as well as how to test and design against such failure. The study of such drop impact phenomenon will help manufacturers improve their ability to 'shock-proof' or 'drop-proof' their portable devices such as mobile phones and PDAs.

IME's research on drop impact reliability of electronic packages has resulted in two major inventions - a high speed impact shear tester including a commercial model, the Micro Impactor licensed by Instron, and a high speed bend tester capable of simulating the loading experienced by a PCB in a product drop impact. The knowledge gained in the physics of failure also contributed to new JEDEC test standards.

IMRE Exhibits

IMRE's nanofabrication and characterisation facilities
The SERC Nanofabrication and Characterisation Cluster (SNFC) aims to make the Agency for Science, Technology and Research (A*STAR) extensive research facilities in nanofabrication and characterisation accessible to all researchers in Singapore. The facility that is operationally located at IMRE forms the hub of this user facility network and provides easy access to a wide range of research facilities and expertise particularly for non-Silicon based materials. Facilities in SNFC is accessible by all A*STAR Institutes, local universities and industry. The facilities include a variety of different characterization techniques for different materials and an impressive range of major equipment as well as a large clean room Class 100 & 1000, which was purpose-built for research work.

Inkjet printing
The application of inkjet printing in Organic Light Emitting Device (OLED) manufacturing is one of the research areas being developed in IMRE. Using IMRE's well established OLED technologies as test bed vehicles, we are taking the first steps towards providing a technology resource in this area. Printing methods such as screen printing, inkjet printing and nanoimprinting can potentially provide cost effective, environmentally friendly solutions in many fields.

Nanoimprinting - Next generation lithography technique for semiconductor processes
Nanoimprint lithography (NIL) is a potentially low cost manufacturing technique for next generation semiconductor processes. The resolution of NIL is determined by the mould or template. Unlike conventional methods such as optical lithography, the pattern resolution in NIL is not limited by optical diffraction. The resist used in NIL does not require complex chemistry to achieve the necessary optical properties. At IMRE, researchers have been investigating and developing unique NIL techniques to enable the fabrication of 2-D and 3-D submicrometer (10-6m) and nanometer (10-9m) scale structures. These techniques and the resultant structures have applications in microelectronics, micro/nano-electro-mechanical systems (MEMS/NEMS) and optical devices.

MOCVD growth of III-V semiconductor materials and fabrication of photonic devices
TBP (Tertiarybutylphosphine) and TBA (Tertiarybutylarsine) have been considered as alternative sources to phosphine and arsine in fabricating photonic devices. This is due to their lower vapour pressure, lower toxicity, and lower decomposition temperature. High quality crystals and quantum well structures have been grown using TBP and TBA as the organic source. High performance semiconductor lasers with a wide range of emissions and multi-quantum well structures have been successfully fabricated. These lasers are widely used in CD/DVD players, solid state laser pumping, Er-doped fibre amplifiers and optical communication light sources.

ITO layer deposited by low processing temperature

Next-generation flexible electronics are made of functional polymers on plastic substrates. As plastic foils are not compatible with conventional high temperature plasma processing, a low temperature process ITO deposition technology is needed. We have obtained ITO with a smooth surface, high electric conductivity and optical transparency at a deposition temperature less than 60○C. ITO films with a thickness of 130 nm and sheet resistance of 25 ± 5 W/sq were fabricated.

GaN-based LEDs

The research group in IMRE focuses on GaN epitaxial growth using various substrates (sapphire and Si being the most popular) and using Metal-Organic Chemical Vapor Deposition (MOCVD) production platforms. To date, blue, green and violet LEDs have been developed. Researchers in IMRE have also developed a cheaper and more efficient method to make all-in-one white LEDs by incorporating novel materials engineering into GaN-based devices. Unlike other white LEDs in the market that use colour-conversion materials to emit white light, IMRE uses a single material (Indium Gallium Nitride) to achieve white light. In addition to white light, IMRE's LED can emit different colours by adjusting the compositions and structures of the GaN-based materials.

Carbon nanotubes – Tiny tubes for application as interconnects

Carbon nanotubes (CNTs) are tiny tubes about 10,000 times thinner than a human hair. It is equivalent to a two-dimensional graphene sheet rolled into a single tube. CNTs exhibit extraordinary mechanical and electrical properties. One impact of this material is in current silicon chip manufacturing where the CNTs can be used as interconnects to replace copper. At dimensions below 50nm, the scattering of conducting electrons and thermal dissipation can cause severe problems for copper interconnects. CNTs have the ability to conduct very high currents without any deterioration and do not suffer from electron migration. Vertically aligned multiwalled carbon nanotubes were synthesised by chemical vapour deposition. In IMRE, we have obtained a good control of the CNT diameter distribution by controlling the pre-treatment of the metal catalyst. SEM images show that the CNTs are long and vertically aligned and can be selectively grown on pre-patterned substrates. The length of the CNTs can be controlled by the deposition process and are typically 100 to XXm long.

High sensitivity permeation measurement system

A highly sensitive water vapour permeation measurement technique for OLEDs has been developed at IMRE. Calcium is used as a sensor to detect water vapour. The electrical properties of the calcium sensor are measured to monitor the calcium degradation. The amount of the calcium hydroxide is detected by measuring the change in the electrical properties of calcium. The sensitivity of this system for the measurement of water vapour or oxygen transmission is less than 10-8g/m2/day and can be carried out in a wide temperature range; from 30□C to 95□C and up to 95% relative humidity. The water vapour or oxygen transport rates and diffusion coefficients of flexible plastic and glass-based packaged OLED structures can be quantified, giving data on device lifetimes or shelf life. This measurement system is suitable for measuring the permeability of thin film encapsulation, conventional packages and barrier plastic substrates used in food, medicine and electronics.

SIMTech Exhibits

MICRO-JETTING, IMPRINTING AND LTCC

Micro-jetting, also known as Ink-Jet Processing is an additive micropatterning technology that can be used to print micron sized conducting, semiconducting and passive circuitry for low cost applications in flexible electronics, RFID (Radio Frequency Identification) and solar cell applications and an alternative to expensive conventional patterning techniques such as photo-lithography. The additive and non-contact nature of the process coupled with low capital equipment costs, low operating and maintenance costs and the absence of vacuum/deposition systems make micro-jetting a flexible manufacturing tool. Imprinting, also a cheaper alternative to conventional photolithography, is a simple way of patterning features at low cost and high resolution using a mould with a desired pattern that is imprinted into a polymer substrate. With imprinting, micrometer- and nanometer-sized features can be combined.

Low Temperature Co-Fired Ceramic (LTCC) materials are used to manufacture advanced multilayer substrates that integrate circuitry into the layers, which reduces substrate size and increases functionality compared with cheap substrates using surface mounted components. Integrated LTCC substrates require fewer solder and wirebonded interconnect and are therefore inherently more reliable and have excellent electrical performance in high frequency wireless applications. Unlike other advanced substrates, LTCC raw material processing and circuit fabrication are integrated into the overall process, making it cheaper.
Each of these substrate-based platform technologies can be used stand alone or in combination for multi-functional and microsystem integration of digital electronics, fibre-optics, microwave and wireless systems. For example, combined micro-jetting and imprinting may enable low cost fabrication of holes, channels and other complex features into which ink can be deposited to define specific functional features. Micro-jetting may be used as a non-contact alternative to screen-printing in LTCC fabrication. Each of these technologies will be showcased with selected samples, and are available for licensing.

Configurable controller technology –
Message discovery for plug ‘n’ play equipment integration

Semiconductor manufacturers, system integrators and 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 assist system integrators and semiconductor manufacturers to perform on-site equipment integration. The software discovers SECS II standard messages and user-defined messages implemented in the equipment. Integration can be done by an individual who has only basic knowledge of SEMI (Semiconductor Equipment and Materials International) standards and computer programming skills. As equipment integration can be achieved on the factory floor, the ramp-up time for a new production facility is significantly shortened. The solution is unique because the vendor and equipment could be independent of each other. The booth will display SEMI message discovery and recipe management technologies.

Optical Interferometry Measurement

As component dimensions continue to decrease, the need for inspection at fine geometric scales and higher tolerances in manufacturing becomes ever more important. Optical interferometry is a technology capable of high accuracy optical measurements for a wide range of applications and diverse industries. The technology demonstration unit developed by SIMTech is for bench-top use in standalone laboratory environments or as an integrated component in an automated manufacturing system. Controlled by a single USB (Universal Serial Bus) interface, it can be conveniently driven from any host computer based on the personal computer architecture. The optical technology can be optimised for various measurement scenarios to produce application-specific versions. The system can be further enhanced by the addition of customised data analysis software to interpret the output into

strategic and meaningful measurements. The booth will feature optical interferometry equipment.