

2012 PSTA WINNER CITATIONS

PRESIDENT'S SCIENCE AND TECHNOLOGY MEDAL 2012



Professor Dim-Lee Kwong
Executive Director,
Institute of Microelectronics
Agency for Science, Technology and Research

“For his distinguished, sustained and exceptional contributions to Singapore’s science and engineering landscape, particularly in advancing the semiconductor industry through R&D and the forging of strategic research partnerships between industry and public sector agencies”

Professor Dim-Lee Kwong, the Executive Director of the Institute of Microelectronics (IME), has played a pivotal role in developing the science and engineering landscape in Singapore since 2001. An exceptional researcher and research leader, he has contributed extensively to cultivating a vibrant microelectronics research environment that has raised the level of public sector R&D in Singapore. He is instrumental in fostering important industry collaborations, bridging the gap between the laboratory and industry, and between the public and private sectors, as well as developing highly skilled R&D talent for the semiconductor industry. Through his efforts he has reaped significant benefits for Singapore.

Prof Kwong’s sustained contributions to Singapore’s R&D scene began in 2001 when he was appointed the Temasek Professor at the National University of Singapore (NUS). Then, he was tasked to set up the Silicon Nano Device Laboratory (SNDL). Under his capable leadership, SNDL was publishing and presenting papers in top journals and conferences respectively in a mere two years. It ranked top three in the world, which greatly boosted the reputation of NUS and Singapore.

When he took the helm at IME in 2005, he worked steadily to transform the research institute into a world class institute. His efforts were recognised internationally by the Institute of Electrical and Electronics Engineers (IEEE), which presented him with the prestigious IEEE Frederik Philips Award for his “leadership in silicon technology and excellence in the management of microelectronics R&D”.

Prof Kwong believes that R&D has to meet the needs of industry so that the economy of the country can be boosted as a result. He is convinced that the key to attracting industry investments to Singapore is to ensure that the R&D carried out here is the top of the league. To that end, he has been leading IME to constantly push the envelope. He systematically developed multi-disciplinary research programmes that would establish core competencies in emerging areas of microelectromechanical systems (MEMS), three-dimensional integrated circuits (3D ICs), silicon photonics, bioelectronics and miniaturised medical devices.

Under his able leadership, IME's research has become leading-edge. IME researchers clinched the coveted IEEE awards such as the IEEE George E. Smith Award, the IEEE Electron Device Society Paul Rappaport Award and the IEEE Roger A. Haken Best Student Paper Award. Winning these prestigious international awards placed IME firmly on the world map. On the home front, IME researchers also won the National Technology Award 2008 and President's Technology Award 2010.

A major outcome of IME's research is the establishment of the US\$100 million Centre of Excellence (COE) in Advanced Packaging in Singapore in 2012. This COE is jointly established by IME and Applied Materials Inc., and it is the first R&D facility that Applied set up outside of the United States. The COE will not only tap into IME's research capabilities in complex high value manufacturing, but will also create jobs for locals over the next five years, including high value jobs and other non-technical jobs. That Applied chose to set up a centre here in Singapore is indeed a nod to IME's R&D capabilities and Prof Kwong's leadership and vision.

In addition to Applied, Prof Kwong has also led IME to foster strategic partnerships with more than 50 multinational companies, ranging from multi-billion dollar Japanese conglomerates to Forbes 500 companies, with his innovative three-party R&D foundry business model.

In this model, IME provides these semiconductor companies with access to cutting-edge foundry-compatible technologies developed at IME and helps them prototype small scale pilot runs. Upon the success of the pilot runs, IME also connects these companies with foundries established in Singapore for mass production. This model not only makes it possible for the companies to shorten the product development cycle and bring their products to market quickly, but it also generates new businesses and manufacturing activities for Singapore foundries, which in turn creates jobs. A case in point is Lightwire, Inc., a US-based provider of high-bandwidth interconnects. Lightwire's silicon photonics process was jointly developed with IME and GLOBALFOUNDRIES Singapore to produce ultra-high speed devices of 10 to 100 Gbps. This new silicon photonics process was transferred from IME's development fabrication to GLOBALFOUNDRIES' manufacturing facility, opening the door for GLOBALFOUNDRIES to participate in the high-volume markets for ultra-high speed silicon photonic devices. This new technology would meet the high-speed, low-power and low-cost requirements of high-performance interconnects for computing and communications.

Besides engaging MNCs, Prof Kwong has also devoted much of his efforts in integrating companies across the semiconductor supply chain. He piloted key consortium programmes in 3-D Through-Silicon Via (3D TSV) and Micro-Electro-Mechanical-Systems (MEMS), as well as strengthened the Electronic Packaging Research Consortium. The consortia integrate key companies across Singapore's semiconductor supply chain and promote pre-competitive collaborations among industry, research organizations and academia. They are vital first-steps to establishing and catalysing new industry value-chains in Singapore and generate sufficient critical mass for Singapore to be a launch pad for emerging technologies. To date, more than 53 companies including Singapore-based companies have benefited from IME's consortia.

A firm believer in the importance of talent development for R&D and industry, Prof Kwong has been relentless in training promising young people for industry. Since 2005, IME has also trained more than 90 PhD students who are cognizant of the latest industry trends and standards, and spun out 15-20% of its staff to the local industry.

For his distinguished, sustained and exceptional contributions to Singapore's science and engineering landscape, particularly in advancing the semiconductor industry through R&D and the

forging of strategic research partnerships between industry and public sector agencies, Professor Dim-Lee Kwong is awarded the 2012 President's Science and Technology Medal.

PRESIDENT'S SCIENCE AWARD 2012



Professor Wang Yue
Institute of Molecular and Cell Biology
Agency for Science, Technology and Research

“For his ground-breaking discoveries in the biology and virulence of the fungus *Candida albicans*, a leading cause of serious hospital-acquired infections”

Over the past 15 years, Professor Wang Yue's research has significantly advanced the understanding of the mechanisms underlying the human fungal pathogen, *Candida albicans*. *Candida albicans* is the most prevalent fungal pathogen in humans, ranking among the top four microbial pathogens in hospital-acquired infections of the blood that has a mortality rate of as high as 45%. Choice of drugs for treating *Candida albicans* infection is limited, and drug-resistance has emerged worldwide, posing a great challenge to medicine. To effectively combat this pathogen, it is necessary to identify the virulence determinants in both the pathogen and the host that promote the infection. Prof Wang's efforts led to the discovery and functional characterization of several such determinants and opened numerous opportunities for developing new therapeutic agents.

Professor Wang and his group have made many major discoveries, including the following:

- (1) Identifying a key virulence gene (FTR1) that is activated only when *Candida albicans* enter the host tissues. This gene enables *Candida albicans* to defeat the host's defence mechanism.
- (2) Discovering a master regulator (Hgc1) that transforms *Candida albicans* from a benign to virulent form upon entering the host blood stream.
- (3) Solving the long-elusive identity of the molecules in human blood responsible for promoting *Candida albicans*' virulence. Unexpectedly, these molecules were found to be a universal component of bacterial cell wall (peptidoglycan). Prof Wang further discovered the mechanism of how these molecules enter the *Candida albicans* cells to activate genes that are responsible for virulence.

Professor Wang's achievement also includes novel discoveries in fundamental biology associated with the transformation of *Candida albicans* from the benign to virulent form, such as the establishment and maintenance of cell polarity, cell cycle control, and mechanisms of signal sensing, processing and integration. He is a leading authority in this field and his studies have led to dozens of

publications in prestigious international journals. Prof Wang has received international recognition in and beyond the *Candida albicans* field.

For his ground-breaking discoveries in the biology and virulence of the fungus *Candida albicans*, a leading cause of serious hospital-acquired infections, Prof Wang Yue is awarded the 2012 President's Science Award.

PRESIDENT'S TECHNOLOGY AWARDS 2012



(from left to right)

Associate Professor Louis Phee
School of Mechanical & Aerospace Engineering
Nanyang Technological University

Professor Lawrence Ho Khok Yu
Department of Gastroenterology & Hepatology
National University of Singapore

“For the development of a novel flexible endoscopic robotic system that enables intricate surgical procedures to be performed without the need for external incisions”

Mechanical engineering research scientist Associate Professor Louis Phee and clinician scientist Professor Ho Khok Yu joined hands to successfully drive a paradigm shift in the field of surgery and endoscopy - to move from 'keyhole' to 'no hole' surgery.

With their novel invention, the Master and Slave Transluminal Endoscopic Robot (MASTER), the duo is incorporating cutting edge robotics technologies and innovative engineering technologies to push the frontier of endoscopic surgery for the benefit of both patients and clinicians. Their vision is for surgical procedures involving organs in the peritoneal cavity (e.g. liver, pancreas, gall bladder) to be performed using robotic devices like MASTER, entering through natural orifices, without the need of making an external incision. This is particularly pertinent as the future for gastrointestinal cancer is early detection and complete endoscopic resection of the early lesions, and the future of surgery for the aging population is minimally invasive surgery.

MASTER is highly accurate, reliable and easy to use. The tube-like robot snakes its way through natural openings (e.g. mouth, anus) to reach tumours inside the digestive tract. Two miniature robotic arms from the end of the device are carefully controlled by the surgeon, who could be stationed a distance away from the patient. Using these dexterous arms, the surgeon would safely cut away the tumour. For added safety, haptics technology has been implemented to enable the doctor to 'feel' the tissue as the robotic arms perform the surgical procedure.

Using the first prototype of MASTER, the team successfully performed first-in-man trials in India and Hong Kong in 2011. The cancer tumors in the stomach of all five patients were removed effortlessly by MASTER. The patients experienced less pain and faster recovery. In addition, no scars were left behind as the surgical procedures were performed without the need for an external incision.

As the trials were novel procedures, the team was rapidly recognised as world leaders in robotic endoscopy, and they were widely covered by local and international media including Reuters, BBC and National Geographic. To push the technology all the way to commercialisation, the team incorporated EndoMaster Pte Ltd in late 2011. They have successfully filed for US patents on this device. In addition, they have proceeded with the national phase filing of a patent in USA, Japan, China, Europe and Singapore since late 2011.

Since 2004, the team has contributed substantially to high impact engineering and medical publications, and made numerous presentations on this project. In recognition of their cutting-edge invention, their robotic paper was featured as the top article in the official newspaper of the American Gastroenterology Association (AGA), which is the world's premier gastroenterology association. Their robot image was selected for the cover of the Clinical Gastroenterology & Hepatology, the official journal of the AGA. The accompanying video-abstract was also broadcasted on Youtube to all journal readers.

For the development of a novel flexible endoscopic robotic system that enables intricate surgical procedures to be performed without the need for external incisions, Associate Professor Louis Phee and Professor Ho Khok Yu are awarded the 2012 President's Technology Award.