

**MEDIA RELEASE
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**A*STAR'S IME AND INDUSTRY PARTNERS TO ENABLE HIGH DENSITY /
LOW-COST PACKAGING TECHNOLOGY FOR SYSTEM SCALING WITHIN
SMART DEVICES**

New capabilities in high-density fan-out wafer level packaging will heighten system performance in smart devices

Singapore—A*STAR's Institute of Microelectronics (IME), together with Amkor Technologies, NANIUM, STATS ChipPAC, NXP Semiconductors, GLOBALFOUNDRIES, Kulicke & Soffa, Applied Materials, Inc., Dipsol Chemicals, JSR Corporation, KLA-Tencor, Kingyop Optronics, Orbotech and Tokyo Ohka Kogyo have formed a High-Density Fan-Out Wafer Level Packaging (FOWLP) consortium to extend FOWLP capabilities for applications in devices such as smart phones, tablets, navigation tools and gaming consoles.

These devices call for application processors with greater system capabilities such as increased memory and bandwidth, as well as faster processing speed to support myriad demanding applications and functions, while consuming low power. At the same time, the sheer market volume¹ for such devices necessitates system cost reduction.

FOWLP is a low-cost packaging technology for system scaling which enables multiple chips to be integrated in a small form factor on a single package. However, the adoption of conventional FOWLP technology for high performance, multi-functional devices is being challenged by pin-count density of a few

¹ The worldwide combined shipments of devices (PCs, tablets, ultramobiles and mobile phones) for 2015 are estimated to reach 2.5 billion units, an increase of 3.9 per cent over 2014.
Source: <http://www.gartner.com/newsroom/id/2954317>

hundreds of I/Os per device package. These limitations have a direct impact on its capability to support increased system requirements and performance.

The consortium aims to provide solutions to overcome these limitations. It will develop a High-Density FOWLP test vehicle capable of supporting thousands of I/Os and characterising the package for die shift, die protrusion and wafer warpage analysis that will enable system scaling for smartphones and mobile tablets. Concurrently, tight wiring to accommodate increased pin counts using fine pitch multi-layer redistribution layer technology will be demonstrated for large area FOWLP while maintaining its signal/power integrity and reliability.

“System integration is necessary to enable diverse functionalities with high performance in future applications across a wide spectrum of industries including computing and networking, healthcare, consumer electronics, transport and automotive. With the High-Density Fan-Out Wafer Level Packaging consortium, IME continues to add to its portfolio of advanced packaging platforms so as to provide wide-ranging solutions for the continued evolution and different needs of complex and demanding devices,” said Prof. Dim-Lee Kwong, Executive Director of IME.

“Amkor is pleased to participate in the High-Density FOWLP consortium to help accelerate the adoption of this next-generation package platform technology. As a leader in the space, working to drive packaging and test technologies forward is one of our core objectives. We expect advanced platforms like High-Density FOWLP to become the prevailing packaging format for much of the advanced integration market, including mobile and high performance products,” said Mr. Ron Huemoeller, Senior Vice President, Advanced Product & Technology Development, IP of Amkor Technology, Inc.

“Market applications will always be our industry’s main drivers,” commented Mr. Armando Tavares, President of the Executive Board at NANIUM. “In times of More-than-Moore, I/Os requirements have been increasing steadily, as they translate into higher integration, improved performance, minimal form-factor and cost-effectiveness. The development of High-Density Fan-Out Wafer-Level Packaging technology represents a step towards fine-pitch multi-layer redistribution, which in turn will allow us to build higher-density structures. These will significantly increase the amount of interconnects enabled by FOWLP, turning this technology into an IC packaging platform for chip-to-chip interconnect with a higher I/O and at a competitive cost.

NANIUM regards IME's initiative of creating a consortium as a very insightful one. Through the combination of our know-how and manufacturing capabilities with IME's technology development expertise, we will surely contribute to the development of our FOWLP technology roadmap, to the benefit of our customers."

"High-Density Wafer-Level Fan-Out Packaging technology enables advanced system scaling for form factor limited and cost challenged applications," said Mr. Ramakanth Alapati, Director of Package Architecture and Customer Technology at GLOBALFOUNDRIES. "GLOBALFOUNDRIES appreciates IME's effort to identify robust solutions needed for a cost-effective high volume manufacturing approach to wafer level packaging."

"The strong collection of companies who have joined the consortium and our shared commitment to expanding the capabilities of FOWLP reflects the promising value of this technology for a wide range of high performance applications. This collaboration will accelerate the important development activities we have been focusing on such as ultra thin package profiles, finer line/space widths down to 2µm/2µm and multi-layer redistribution in order to achieve smart system integration at a lower cost for our customers," said Dr. Han Byung Joon, Executive Vice President and Chief Technology Officer, STATS ChipPAC.

"This consortium has members from the entire supply chain, and with the combined experience and knowledge of all the members, the solution developed will be industry leading and targeted for high volume manufacturing benefiting the industry as a whole," said Mr. Cheam Tong Liang, Vice President, Advanced Packaging Business Line & Corporate Strategy of Kulicke & Soffa.

Enclosed:

ANNEX A – About the High Density Fan-Out Wafer Level Packaging Consortium Members

For media queries and clarifications, please contact:

Lynn Hong
Senior Officer, Corporate Communications
Agency for Science, Technology and Research
Tel: +65 6419 6597

Email: hongxl@scei.a-star.edu.sg

About A*STAR's Institute of Microelectronics (IME)

The Institute of Microelectronics (IME) is a research institute of the Science and Engineering Research Council of the Agency for Science, Technology and Research (A*STAR). Positioned to bridge the R&D between academia and industry, A*STAR IME's mission is to add value to Singapore's semiconductor industry by developing strategic competencies, innovative technologies and intellectual property; enabling enterprises to be technologically competitive; and cultivating a technology talent pool to inject new knowledge to the industry. Its key research areas are in integrated circuits design, advanced packaging, bioelectronics and medical devices, MEMS, nanoelectronics, and photonics.

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

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

The Agency for Science, Technology and Research (A*STAR) is Singapore's lead public sector agency that fosters world-class scientific research and talent to drive economic growth and transform Singapore into a vibrant knowledge-based and innovation driven economy.

In line with its mission-oriented mandate, A*STAR spearheads research and development in fields that are essential to growing Singapore's manufacturing sector and catalysing new growth industries. A*STAR supports these economic clusters by providing intellectual, human and industrial capital to its partners in industry.

A*STAR oversees 18 biomedical sciences and physical sciences and engineering research entities, located in Biopolis and Fusionopolis, as well as their vicinity. These two R&D hubs house a bustling and diverse community of local and international research scientists and engineers from A*STAR's research entities as well as a growing number of corporate laboratories.

For more information on A*STAR, please visit www.a-star.edu.sg.

**ABOUT THE HIGH DENSITY FAN-OUT WAFER LEVEL PACKAGING
CONSORTIUM MEMBERS**

1. Amkor Technology

Amkor is a leading provider of semiconductor packaging and test services to semiconductor companies and electronics OEMs. More information about Amkor is available from the company's filings with the Securities and Exchange Commission and on Amkor's website: www.amkor.com.

2. Applied Materials, Inc.

Applied Materials, Inc. (Nasdaq: AMAT) is the global leader in precision materials engineering solutions for the semiconductor, flat panel display and solar photovoltaic industries. Our technologies help make innovations like smartphones, flat screen TVs and solar panels more affordable and accessible to consumers and businesses around the world. Learn more at www.appliedmaterials.com.

3. Dipsol Chemicals Co. Ltd.

Surface Finishing Technology is an integral part of modern life whose ubiquitous existence is made evident in a broad range of trades including the thriving automotive industry and the faced-paced IT industry, as well as the home appliance, aerospace, railway systems and nautical industries, all considered vital to people and business worldwide. Dipsol Chemicals is dedicated to providing top quality, environment-conscious products to fulfill the diverse Surface Finishing needs of our valued customers.

4. GLOBALFOUNDRIES

GLOBALFOUNDRIES is the world's first full-service semiconductor foundry with a truly global footprint. Launched in March 2009, the company has quickly achieved scale as the second largest foundry in the world, providing a unique combination of advanced technology and manufacturing to more than 160 customers. With operations in Singapore, Germany and the United States, GLOBALFOUNDRIES is the only foundry that offers the flexibility and security of manufacturing centers spanning three continents. The company's three 300mm fabs and five 200mm

fabs provide the full range of process technologies from mainstream to the leading edge. This global manufacturing footprint is supported by major facilities for research, development and design enablement located near hubs of semiconductor activity in the United States, Europe and Asia. GLOBALFOUNDRIES is owned by Mubadala Development Company. For more information, visit <http://www.globalfoundries.com>.

5. JSR Corporation

JSR Corporation is a multinational company employing a little less than 6,000 people worldwide and a leading materials supplier in a variety of technology driven markets. JSR's global network is headquartered in Tokyo (Japan) and has factories and offices in Europe, US, China, Taiwan, Korea, Singapore and Thailand. JSR is a research-oriented organization that pursues close collaborations with leading innovators in a number of industries that are a key to the present and future welfare of human society: life-sciences, energy storage, synthetic rubbers, electronic materials, display and optical materials.

6. Kingyoup Optronics

Kingyoup Optronics Co., Ltd. (KYO) is a world-class supplier of temporary bonding/de-bonding and thin film coating equipment and services for the semiconductor, flat panel display, solar photovoltaic, and touch panel industries. Being spun off in 2013 from Kingyoup Enterprises Co., Ltd., a 41-year distributor for precision equipments in Taiwan, KYO establishes joint-development cooperation with IBM to provide innovative bonding/de-bonding system for FOWLP, 2.5D/3D IC, and MEMS applications. Its thin film coating equipment supports production of some well-known consumer electronic products. Headquartered in Taipei, Taiwan, KYO has distributor network over all continents and operation facilities in Taiwan and China.

For more information on Kingyoup Optronics, please visit <http://www.kyopt.com>.

7. KLA-Tencor

KLA-Tencor Corporation, a leading provider of process control and yield management solutions, partners with customers around the world to develop state-of-the-art inspection and metrology technologies. These technologies serve

the semiconductor, LED and other related nanoelectronics industries. With a portfolio of industry-standard products and a team of world-class engineers and scientists, the company has created superior solutions for its customers for more than 35 years. Headquartered in Milpitas, California, KLA-Tencor has dedicated customer operations and service centers around the world. For more information on KLA-Tencor, please visit www.kla-tencor.com.

8. Kulicke & Soffa

Kulicke & Soffa (NASDAQ: KLIC) is a global leader in the design and manufacture of semiconductor, LED and electronic assembly equipment. As a pioneer in this industry, K&S has provided customers with market leading packaging solutions for decades. In recent years, K&S has expanded its product offerings through strategic acquisitions and organic development, adding advanced packaging, advanced SMT, wedge bonding and a broader range of expendable tools to its core ball bonding products. Combined with its extensive expertise in process technology, K&S is well positioned to help customers meet the challenges of assembling the next-generation semiconductor and LED devices. (www.kns.com)

Contact:

Kulicke & Soffa Industries, Inc.

Joseph Elgindy

Investor Relations & Strategic Planning

P: +1-215-784-7518

F: +1-215-784-6180

jelgindy@kns.com

Sheila Frese

Public Relations

P: +1-949-399-2930

F: +1-949-660-0444

sfrese@kns.com

9. NANIUM

NANIUM is a world-class provider of semiconductor assembly, packaging, test, engineering and manufacturing services. The company started as Siemens Semiconductors back in 1996 and nowadays is a leader in 300mm Wafer-Level Packaging (WLP), both Fan-In/WLCSP and Fan-Out/eWLB. NANIUM offers in-house capabilities for the entire development chain, from design to multiple Wafer-Level Packaging technologies, and the flexibility to tailor and test solutions that respond to the most demanding customer requirements. The company is based near Porto, Portugal, and has sales offices in Dresden, Germany and Boston, USA. More information on NANIUM is available at www.nanium.com.

10. NXP Semiconductors

NXP Semiconductors N.V. (NASDAQ: NXPI) creates solutions that enable Secure Connections for a Smarter World. Building on its expertise in High Performance Mixed Signal electronics, NXP is driving innovation in the application areas Connected Car, Security, Portable & Wearable and Internet of Things. NXP has operations in more than 25 countries, and posted revenue of \$5.65 billion in 2014. Find out more at www.nxp.com.

11. Orbotech Ltd.

Orbotech Ltd. is a global innovator of enabling technologies used in the manufacture of the world's most sophisticated consumer and industrial products throughout the electronics and adjacent industries. The Company is a leading provider of yield enhancement and production solutions for electronics reading, writing and connecting, used by manufacturers of printed circuit boards, flat panel displays, advanced packaging, micro-electro-mechanical systems and other electronic components. With the acquisition of SPTS Technologies, Orbotech is able to offer a broader range of process solutions for Advanced Packaging applications. Today, virtually every electronic device in the world is produced using Orbotech systems. For more information, visit www.orbotech.com and www.spts.com.

12. STATS ChipPAC Ltd.

STATS ChipPAC Ltd. (SGX-ST Code: S24) is a leading service provider of semiconductor packaging design, assembly, test and distribution solutions in diverse end market applications including communications, digital consumer and computing. With global headquarters in Singapore, STATS ChipPAC has design, research and development, manufacturing or customer support offices throughout Asia, the United States and Europe. STATS ChipPAC is listed on the SGX-ST. Further information is available at www.statschippac.com.

13. Tokyo Ohka Kogyo

Tokyo Ohka Kogyo (TOK) Co., Ltd. was established in 1940. It has subsidiaries in Singapore, Taiwan, Europe, USA, Korea and China. TOK's main business domain lies in the manufacturing of materials, mainly photoresists and high purity

chemicals for photolithography process of semiconductor and liquid crystal display. Microprocess technology, such as photoresist, is supporting advancement in the electronics field. From micrometer to cutting-edge nanometer features, TOK provides optimal photoresists and related equipment tailored to the production of various semiconductor devices.

For more information, visit www.tok.co.jp/