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Greener semiconductors

The road to 450 mm

How clean are your seals

Building the superhighway

Camstar Enterprise MES

Taking charge of change

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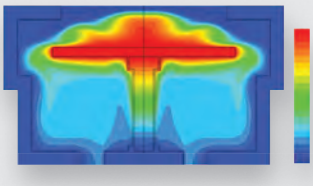

executiveview

by Mark Andrews Technical Contributor Silicon Semiconductor

Our changeable world

MANAGING change has become big business. Each time electronic devices grow smaller and more complex, changes are introduced that must be tracked and communicated throughout supply, manufacture and distribution. If your company hasn't adopted change management tools, it should be looking at options.

Successfully managing change is critical for businesses expanding beyond their original borders. Global markets necessitate product variances. Multiply level of complexity by interfaces by distribution countries to derive a 'change index.' The larger the index, the more change-intensive the company.

Semiconductor manufacturers contend with change more than most due to product sophistication and the fact they can be used in a wide range of end-use devices. This need is compounded by environmental and safety compliance as well as seasonality, competition and fleeting customer preferences.

Since change is inevitable, why do we often avoid it? Most likely because we clearly recall some change incidents that went badly wrong. Vividly recalled, painful experiences discourage repetition. But as generalists, what gets stuck in our memories is more like 'change is bad.' But if we analyze a sample of bad and good occurrences, we will see that how we coped actually colored memory of the event. Our perspective and how we handled chaos made it more positive or negative. Coping with change in business carries the same baggage.

In this edition of Silicon Semiconductor we explore different views of change and how managing it affects the global

electronics business. At Siemens PLM Software, seeing change as a valuable ally of innovation has led to sophisticated applications that help manufacturers productively manage change. Elsewhere, major silicon OEMs are putting resources into the F450 and G450 consortia to manage creating technology to double silicon IC capacity. Across supply chains, the ability to harness changes' creative qualities is gaining recognition as a critical differentiator among competitors.

Manage change, or be managed. It is that simple. Look to examples of how productively managing change assists business by identifying problems early; re-work can be avoided. Customers see a proactive change manager as their best partner.

Embrace change. Manage it. Optimize change for profitable results.

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US mailing information: Silicon Semiconductor (ISSN 1096-598X) is published four times a year for a subscription of $198 by Angel Business Communications Ltd, Hannay House, 39 Clarendon Road, Watford, Herts WD17 1JA, UK. Periodicals postage paid at Rahway, NJ. POSTMASTER: send address changes to: Silicon Semiconductor, c/o Mercury International Ltd, 365 Blair Road, Avenel, NJ 07001. Printed by: Pensord Press. © Copyright 2015. ISSN 2050-7798 (Print) ISSN 2050-7801 (Online).

contents

CONNECTING THE SILICON SEMICONDUCTOR COMMUNITY

Volume 37 Issue IV 2015

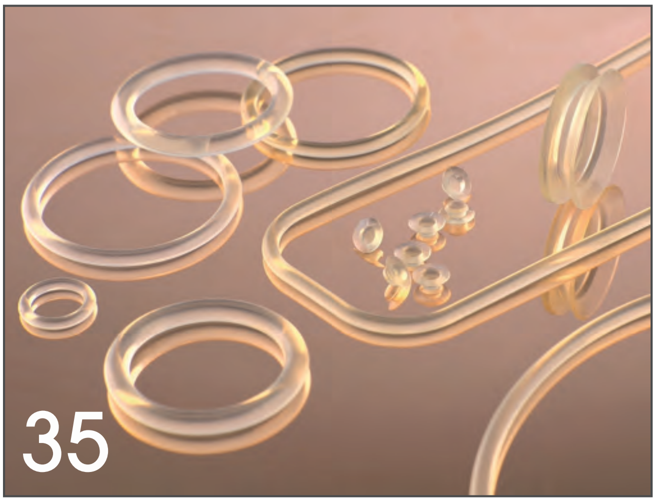
features

24

38

30

44



35

SPTS Technologies achieves $1billion export sales

SPTS TECHNOLOGIES, supplier of advanced wafer processing solutions has announced that it has surpassed U.S. $1 billion in cumulative export sales of semiconductor processing equipment from its manufacturing headquarters in Newport, South Wales. This milestone was achieved over the past six years since the founding of SPTS in 2009.

SPTS has been pioneering advanced wafer processing technologies for semiconductor and microelectromechanical systems (MEMS) device manufacturing from its headquarters in Newport. With support from the Welsh Government Research, Development and Innovation ("RD&I") funding, SPTS continues to develop its industry leading process solutions for Advanced Packaging applications, including Fan-out Wafer Level Packaging and Plasma Dicing of wafers for higher yield device singulation.

Commenting on this achievement, Kevin Crofton, President of SPTS Technologies and Corporate VP at Orbotech, remarked: "SPTS has a long history of innovation in the new wafer processing technologies for the global semiconductor and micro-electronics manufacturing industries, with Advanced Packaging remaining a strategic and high growth segment of our business. Our proven ability to develop and commercialize new products and solutions has been key to achieving our first billion dollar export sales milestone. In 2014, SPTS was awarded significant research and development funding from the Welsh Government in support of a three-year project, which will assist us in ensuring that the Advanced Packaging solutions developed in Newport by our research and development team will continue to provide customers around the world with the most technically advanced and low-cost-of-ownership solutions available in the marketplace."

Welsh Minister for Economy, Science and Transport Edwina Hart said, "SPTS Technologies has a track record of identifying niches and successfully exploiting them, and was awarded Anchor Company status by the Welsh Government in recognition of its strategic importance to the Welsh economy in terms of exports, job creation, R&D investment and supply chain support. This $1 billion exports milestone is a tremendous achievement, and I congratulate the company on not only reaching, but surpassing, this significant milestone which represents a major boost for Welsh export sales and the economy."

Mrs Hart added, "SPTS is a significant contributor to the UK economy. The company spends over £50m a year on materials and the impact of its 'buy local' policy means that three of their top ten supplier are Welsh firms and 80 percent of its annual spend goes to firms in an 80-mile radius of SPTS. Each £1m it spends supports 10 jobs in the local economy which represents a considerable indirect economic benefit for Wales. By providing support to anchor companies such as SPTS, we are enhancing the economic and industrial development in the region."

Infineon extends lead in power semiconductor market

INFINEON TECHNOLOGIES AG is the world market leader in power semiconductors for the twelfth consecutive time. After acquiring International Rectifier at the beginning of the year, Infineon's 19.2 percent market share now makes it the market leader.

In comparison, both companies' market share in 2013 summed up to approximately 17.5 percent, according to the results of a study by the US market research institute. IHS Inc. for 2014. Infineon's closest competitor lags behind with 7.0 percent.

Energy-saving power semiconductors can be found in a wide variety of devices ranging from the kitchen microwave oven all the way to large-scale wind power turbines. They help to efficiently generate, transport and convert power. IHS shows the world market for power semiconductors growing by 6.3 percent in 2014 to 16.2 billion US dollars.

"Through organic growth and the acquisition of International Rectifier we've made our leadership position for power semiconductors even stronger compared to the global competition," says Dr. Reinhard Ploss, CEO of Infineon Technologies AG. "Our leading technology expertise and our system understanding mean we will profit disproportionately from the forecasted growth."

The IHS study predicts a growing demand for power semiconductors particularly in the automotive and industry business sectors through 2019.

A look at the sub-markets for IGBT modules, discrete IGBTs and MOSFETs shows how robust Infineon's position is: In these segments Infineon was the sole player to significantly increase market share.

During the report year 2014 Infineon's MOSFET market share grew from 26.4 to 27.8 percent, while the second largest competitor reached 10.5 percent. Infineon grew its stake in the discrete IGBT market from 34.7 to 38.5 percent, with its nearest competitor trailing behind with 14.1 percent of the market.
And as the second-ranked player in the IGBT module segment, Infineon raised its market share from 21.4 percent to 23.2 percent, narrowing the gap to the segment leader by slightly more than two to now only about three percentage points.

Entegris expands CMP filtration technology solutions

ENTEGRIS, INC has announced at the SEMICON Taiwan tradeshow, the development of a platform of CMP filtration solutions using nano-melt-blown (NMB) filtration technology, as well as the expansion of its CMP research, analytical services and manufacturing capabilities in Taiwan. These investments enable the company to further serve the growing demand for advanced CMP filtration solutions.

"CMP processes continue to grow in complexity in both the materials used and the need for greater planarity in each layer of today's devices," said Entegris Vice-President of the Liquid Microcontamination Control business unit, Clint Haris.

"Entegris continues to invest in people, technology and facilities in Asia to introduce new solutions for the semiconductor market. As our customers produce integrated circuits with smaller feature sizes, our nano-fiber technology reduces the number of defect-causing contaminants from reaching the wafer."

The Entegris filter platform using NMB media now includes the Planargard bulk, Solaris point-of-tool and Planarcap point-of-dispense families to provide contamination control solutions throughout the CMP process area. Developed and manufactured in Taiwan, the NMB media utilizes the increased porosity of the nano-fibers to reduce shear stress placed upon the slurry during transport and filtration operations.

These innovations result in extended filter lifetime and greater removal of defect-causing contaminants.

GLOBALFOUNDRIES launches 22 nm FD-SOI technology platform

GLOBALFOUNDRIES has launched a new semiconductor technology to meet the ultra-low-power requirements of the next generation of connected devices.

The "22FDX platform delivers FinFET-like performance and energy-efficiency at a cost comparable to 28nm planar technologies, providing an optimal solution for the rapidly evolving mainstream mobile, Internet-of-Things (IoT), RF connectivity and networking markets.

While some applications require the ultimate performance of three-dimensional FinFET transistors, most wireless devices need a better balance of performance, power consumption and cost.

22FDX provides the best path for cost-sensitive applications by leveraging the industry's first 22nm two-dimensional, fully-depleted silicon-on-insulator (FD-SOI) technology. It offers industry's lowest operating voltage at 0.4 volt, enabling ultra-low dynamic power consumption, less thermal impact, and smaller end-product form-factors. The 22FDX platform delivers a 20 percent smaller die size and 10 percent fewer masks than 28nm, as well as nearly 50 percent fewer immersion lithography layers than foundry FinFET.

"The 22FDX platform enables our customers to deliver differentiated products with the best balance of power, performance and cost," said Sanjay Jha, chief executive officer of GLOBALFOUNDRIES.

"In an industry first, 22FDX provides real-time system software control of transistor characteristics: the system designer can dynamically balance power, performance, and leakage. Additionally, for RF and analog integration, the platform delivers best scaling combined with highest energy efficiency."

SUSS MicroTec launches semi-automated high-force wafer bonder

SUSS MICROTEC has launched the new bonding platform XB8. The XB8 wafer bonder is designed for a wide range of bonding processes. It supports substrates with a wafer size of up to 200 mm. Key process parameters can be adjusted in a wide range, which makes the system ideal for advanced process development. In a production environment, the high level of automation and reliability of the XB8 ensure a high level of process stability.

Typical applications include advanced packaging, MEMS, 3D integration and LED manufacturing. Suss say the XB8 wafer bonder offers a broad parameter window and is therefore suitable for carrying out all bonding processes. Bond force up to 100kN is available with a temperature range of up to 550°C. Different substrate shapes and wafer sizes are processed in specifically adapted fixtures. A multi-bond fixture, for example, enables the maximum possible throughput increase by bonding up to eight wafers at once.

"In addition to the high precision and the repeatability of the bonding process from wafer to wafer, a uniform process result across the wafer is essential for achieving a high yield.", says Stefan Lutter, General Manager of the bonder product lines. "The independent new heaters guarantee an even temperature distribution and also ensure an optimal bonding force homogeneity within the entire temperature range. The innovative mechanical and thermal structure of the XB8 wafer bonder enables optimal bonding force and temperature distribution across the wafer, resulting in a high product quality and yield."

Tessera to acquire Ziptronix for $39 million

Tessera Technologies, Inc has announced the acquisition of Ziptronix, Inc. for $39 million in cash. The acquisition expands on Tessera's existing advanced packaging capabilities by adding a low-temperature wafer bonding technology platform that will accelerate delivery of 2.5D and 3D-IC solutions to semiconductor industry customers.

Ziptronix's patented ZiBond direct bonding and DBI hybrid bonding technologies deliver scalable, low total cost-of-ownership manufacturing solutions for 3D stacking. Ziptronix's intellectual property has been licensed to Sony Corporation for volume production of CMOS image sensors – an estimated $8.3 billion market according to Gartner. Ziptronix's technology is also relevant to next-generation stacked memory, 2.5D FPGAs, RF Front-End and MEMS devices, among other semiconductor applications.

Inclusive of CMOS image sensors, Tessera expects the annual market size to which this technology applies to exceed $15 billion by 2019.

"With this acquisition we're gaining best-in-class technology, along with exceptional people, know-how in the 3D-IC market and a significant patent portfolio," stated Tom Lacey, CEO of Tessera.

"With the escalating cost for each node of semiconductor lithography, it remains very clear to us that our R&D spend on semiconductor packaging will only become more important and valuable to our customers. Ziptronix has commercially licensed the ZiBond and DBI technologies and they stack up very well alongside our extensive portfolio of 2.5D and 3D intellectual property. I'm confident that aligning our respective capabilities with our development expertise will help create a multi-hundred million dollar revenue opportunity for Tessera over the next decade as the industry continues to shift toward 3D-IC architectures."

"ZiBond and DBI bonding are enabling technologies that provide significant cost and performance benefits," said Craig Mitchell, President of Invensas, a Tessera subsidiary. "There is a great opportunity to further develop these platforms with our technology partners, and we're very excited about their market potential."

Dan Donabedian, President and CEO of Ziptronix added, "We've taken our technology from concept to commercialization in the backside illuminated image sensor and RF markets. Joining the Tessera family of companies combines our efforts with a proven leader in technology development and licensing in the semiconductor industry. This is a great alignment of companies that can address rapidly expanding 2.5D and 3D-IC markets."

Microcontroller unit shipments surge but falling prices sap sales growth

MICROCONTROLLERS are in the middle of an incredible wave of unit growth, but unprecedented price erosion is keeping a lid on the increase of revenues, according to IC Insights' Mid-Year Update to its 2015 McClean Report on the integrated circuit industry. The mid-year forecast shows microcontroller shipments rising 33 percent in 2015 to 25.4 billion MCUs worldwide as a result of a tremendous upsurge in units for smartcards and 32-bit applications – many of which are aimed at the Internet of Things (IoT) market.

Despite the blistering pace of unit growth, dollar-volume sales of MCUs are now expected to rise by just 4 percent in 2015, reaching a new record high of $16.6 billion from about $15.9 billion in 2014, when total MCU revenues also increased 4 percent. As seen in Figure 1, average selling prices for microcontrollers are expected to continue plunging with ASPs nose-diving 21 percent in 2015 to $0.65 compared to $0.83 in 2014, when the ASP for MCUs fell 12 percent. IC Insights' Mid-Year Update forecasts a 14 percent drop in MCU ASPs in 2016 with microcontroller revenue growing 7 percent to $17.7 billion and unit shipments climbing 25 percent to 31.6 billion worldwide.

Starting in 2014, microcontroller unit growth accelerated, driven by rocketing shipments of low-cost MCUs used in smartcards for protection in electronic banking and credit-card transactions, mass-transit fares, government IDs (such as electronic passports), medical records, and security applications. After a 26 percent increase in 2014, smartcard MCU shipments are now expected to surge by 41 percent in 2015 to 12.9 billion units worldwide, followed by 25 percent growth in 2016 to 16.1 billion.

The mid-year forecast significantly raises the projection for smartcard MCU shipments through 2019 as U.S. credit card companies, banks, retailers, government agencies, and other industry sectors begin to broadly adopt secure "chip-card" technology, much like Europe and other country markets have done since the 1990s.

In the U.S., massive data breaches in credit card transactions at retail stores and growing concerns about identity theft have finally resulted a major move to smartcards for higher levels of security, anti-fraud encryption, and greater protection of lost or stolen debit and credit cards.

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Manz AG expands with printed circuit acquisition

MANZ AG has acquired KLEO Halbleitertechnik GmbH, a ZEISS Group company, as of June 1, 2015. As part of a share deal, Manz AG acquires patents and copyrights for the technology developed by KLEO for laser direct imaging of printed circuit boards (Laser Direct Imaging – LDI).

In addition, all 20 employees at the Tettnang location in southern Germany will also be assumed. As a fully consolidated company of the Group, the subsidiary will already make a positive contribution to Manz AG's year-end result in the current 2015 fiscal year. The acquisition is being financed by funds from the capital increase, which was successfully carried out in April 2015. The parties have agreed not to disclose the purchase price.

Dieter Manz, CEO and founder of Manz AG, commented: "The expansion of our range of services through the technology KLEO Halbleitertechnik GmbH has been developing since it was founded in 2001 is an important milestone for us. Through the use of laser direct imaging based on an innovative multi-beam laser lithography using blue laser diodes, our customers can achieve cost savings of up to 75 percent in the imaging of printed circuit boards.

At the same time, the increase of the level of integration in the production process will lead to a shortening of the overall production cycle by approximately half. With this acquisition, we are once again significantly improving our market position and thereby opening up additional potential for growth. Further diversification within our Electronics division furthermore ensures the sustainable stabilization of our business model."

In the medium term, Manz AG also sees great opportunities for applications of the LDI technology which extend beyond the production of high resolution printed circuit boards. In particular, the production of touch sensors and displays harbors significant potential, particularly in the case of flexible and bendable substrates.

MEMS foundry selects ClassOne for electroplating

Semiconductor equipment manufacturer ClassOne Technology has announced that X-FAB has just purchased a new Solstice S8 Electroplating System. The 8-chamber, fully-automated tool will be installed at the X-FAB facility in Erfurt, Germany.

"X-FAB selected ClassOne from a field of major equipment vendors after an in-depth evaluation that compared plating technology, price and overall value," said Win Carpenter, ClassOne's V.P. of Global Sales. "X-FAB was particularly interested in process performance, so our advanced and flexible chamber design gave ClassOne a strong advantage."

"We see the MEMS market growing significantly," said Kevin Witt, ClassOne's V.P. of Technology. "However, one of the fundamental challenges is that MEMS users need to be cost sensitive, so they generally cannot afford the large, expensive tools that were developed for CMOS technology. This is why Solstice has become very attractive to many emerging markets like MEMS: It gives them the advanced processing technology they want at a price they can afford."

ClassOne Technology introduced its Solstice family in 2014 as an electroplating solution for users of <200mm wafers, in MEMS and other emerging markets. Solstice systems are priced at less than similarly configured plating systems. These tools can electroplate different metals and alloys in a broad spectrum of processes, either on transparent or opaque substrates. Solstice models are available for development use and for fully-automated, cassette-to-cassette production, with throughput of up to 75 wph.

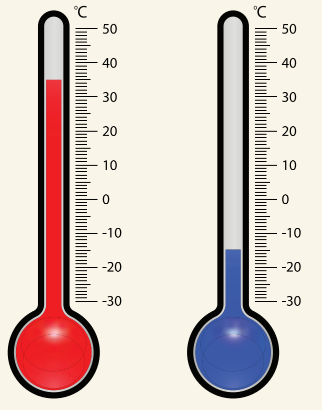
New tool for absolute temperature measurement

K-SPACE ASSOCIATES has announced the worldwide release of its newest product, kSA SpectraTemp, a self-calibrating absolute source temperature measurement tool.

k-Space CEO, Darryl Barlett, commented, "Absolute temperature is a very difficult parameter to measure. With kSA SpectraTemp, if the source radiation is blackbody-like, an absolute temperature is instantly determined."

kSA SpectraTemp is a non-contact, optically-based technique for measuring the temperature of semiconductor wafers, metals, ceramics, and more. It is based on patented technology that analyzes the spectral radiation profile utilizing a solid-state spectrometer, resulting in, the company says, fast data acquisition and real-time temperature measurement. The user simply reads the temperature from the screen.

MOCVD and other thin-film deposition facilities can use it to measure absolute temperature on wafer carriers, providing more accurate and reliable temperatures and tool-to-tool matching. As production facilities adopt this technology and gain better temperature control, device yield and quality will improve.



SICK Glare sensor puts the gloss on high-performance detection

SICK has developed the Glare sensor to deliver effective glossy material detection and discrimination for a wide range of automation, product handling and packaging processes, including electronics and solar panel manufacture.

High-gloss materials or finishes can cause conventional optical sensors to fail. With SICK Glare, electronics and solar products manufacturers can reliably detect gloss finishes, paints and varnishes.

"The innovative detection concept of Glare turns a weakness of most sensors into a strong function for manufacturers and machine builders," explains David Hannaby, Product Manager at Sick for Presence Detection "Instead of sensors being dazzled by glare, it uses glare to do the sensing to achieve a highly-reliable process for detecting and assessing the gloss properties of shiny materials. It can easily be configured to discriminate between different degrees of gloss to obtain precisely the required results."

The SICK Glare is a compact (42.5 x 44 x 43.4mm wxhxl), all-in-one IP67 unit. It delivers robust presence detection and exceptional gloss optical property and discrimination performance even with high ambient light levels, deep colour, transparent tape, text and shiny or holographic finishes.

Primarily designed to detect and discriminate between gloss levels on flat surfaces, the SICK Glare is able to cope with ±5o misalignment and variation, adding to its effectiveness – a function which other gloss sensors cannot match; the detection rate is highly resistant to vibration, too.

The SICK Glare comprises a central strip of eight LED emitters surrounded by two receiver lines, which enable its unique misalignment and tilting tolerance and vibration resistant performance, backed by the patented Delta-S sensor technology.

Installation and configuration are easy with the integral three button pad, allowing simple teach-in on the spot with typical objects, and several operating modes; a security key prevents operative override to eliminate 'false nuisance' readings.

Alarm levels can be set to indicate contamination, declining standards and other parameters.
Light levels and sensing modes are adjustable to suit the application. The integrated I/O link facilitates integration with PLC and servo motor control and allows remote diagnostics and programming/reprogramming.

SICK Glare settings and programming are remotely held on PLC, enabling rapid switch-in if the sensor needs replacing.

Alchimer rebrands and secures $13.5 million in funding

ALCHIMER S.A., a provider of metallization technologies for damascene, through silicon vias (TSVs), MEMS and other electronic applications, has announced that the company has been renamed aveni. The change signals a significant shift, moving from proving out its technology to full readiness for volume manufacturing.

"We have reached a significant point in our company's history," said Bruno Morel, CEO of aveni. "We have the technology, partners and funding in place that make us ready for commercialization. Our innovative technologies have been successfully demonstrated in multiple customer engagements as a manufacturing-ready path forward for metallization processes at and below 14nm. As a company, we are now extremely well-positioned for the future, which drove our rebranding under the name aveni."

Continuing under the same ownership and leadership, the company also announced that it has secured $13.5M in funding from a variety of sources, including a semiconductor chipmaker, ALIAD (Air Liquide Venture Capital), Idinvest Partners, CEA Investissement, Auriga Partners, Panasonic and a private investor.

This investment ensures the company's ability to grow to meet future market demand for its novel metallization products. The company also announced the formation of its U.S.-based subsidiary, based in Silicon Valley, California, to support the U.S. market.

"ALIAD's (Air Liquide Venture Capital) role is to take minority equity stakes to support the growth of innovative startups, while encouraging them to establish R&D and business partnerships with Air Liquide," said Pierre-Etienne Franc, VP Air Liquide advanced Business & Technologies.

"aveni technology perfectly suits our strategy to partner with innovative companies that excel at addressing emerging manufacturing challenges faced by the semiconductor industry."

aveni's novel wet deposition technology is currently in the qualification phase for the dual-damascene process at the 10nm node at three of the leading worldwide logic manufacturers.

At the same time, the technology has been named best-known method for TSV manufacturing at two different customer sites. It is in production at one site and finishing qualification currently for an anticipated ramp to production later this year.

"We are the only company in the industry currently able to support dual-damascene and TSV metallization at 10nm and below, and that does so at better yield than competitive technologies, using existing process equipment.

We are truly positioned for the future, and we look forward to engaging with our customers moving forward under the name aveni," said Morel.

Dialog to acquire Atmel for $4.6 billion

DIALOG SEMICONDUCTOR and Atmel Corporation have announced that Dialog has agreed to acquire Atmel in a cash and stock transaction for total consideration of approximately $4.6 billion. The acquisition creates a global leader in both Power Management (2) and Embedded Processing solutions. The transaction results in a fast growing and innovative powerhouse, supporting Mobile Power, IoT and Automotive customers.

The combined company will address an attractive, fast growing market opportunity of approximately $20 billion by 2019.

Dialog will complement its leadership position in Power Management ICs with a leading portfolio of proprietary and ARM based Microcontrollers in addition to high performance ICs for Connectivity, Touch and Security. Dialog will also leverage Atmel's established sales channels to significantly diversify its customer base. Through realized synergies, we expect the combination will deliver an improved operating model and enable new revenue growth opportunities.

"The rationale for the transaction we are proposing today is clear – and the potential this combination holds is exciting. By bringing together our technologies, world-class talent and broad distribution channels we will create a new, powerful force in the semiconductor space. Our new, enlarged company will be a diversified, high-growth market leader in Mobile Power, IoT and Automotive.

We firmly believe that by combining Power Management, Microcontrollers, Connectivity and Security technologies, we will create a strong platform for innovation and growth in the large and attractive market segments we serve. This is an important and proud milestone in the evolution of our Dialog story," said Jalal Bagherli, Dialog Chief Executive Officer."This transaction combines two successful companies and will create significant value for Atmel and Dialog shareholders, customers and employees. Adding Dialog's world-class capabilities in Power Management with Atmel's keen focus on Microcontrollers, Connectivity and Security will enable Dialog to more effectively target high-growth applications within the Mobile, IoT and Automotive markets," said Steven Laub, Atmel President and Chief Executive Officer.

New fault detection and classification software from Rudolph Technologies

RUDOLPH TECHNOLOGIES, INC has introduced Equipment Sentinel, an automated fault detection and classification (FDC) software solution that combines key wafer-level data with high-fidelity tool signal and event data into a single framework, giving users a comprehensive, view of their processes and equipment.

Currently installed at multiple beta sites worldwide, fab personnel will use Equipment Sentinel software to extract the maximum value from the voluminous amounts of data generated in today's semiconductor operations.

"Many applications have been developed over the years to address advanced tool monitoring and control for semiconductor manufacturing, but they are typically focused on either wafer or equipment state information, not both," said Thomas Sonderman, vice president and general manager of Rudolph's Software Business Unit. "Equipment Sentinel integrates these formerly independent data streams into a powerful monitoring and control engine to enable timely actionable intelligence, greatly enhancing optimization capabilities with predictive analytics in the fab."

Rudolf say that Equipment Sentinel is the only process control software with a framework that provides global manufacturers of semiconductors, compound semiconductors, LEDs, and flat panel displays with a detailed snapshot of the performance for the process and of all the equipment in their fab.

Its bi-directional data flows enable both sensor and product data to be tightly correlated into a single knowledge computing engine, maximizing signal-to-noise ratios, and thus, avoiding the false positives that typically plague many traditional FDC solutions. This is one of the many differentiating capabilities that allow users to quickly detect and resolve actual issues that impact operational performance and product yield.

"The ability to quickly detect, isolate and correct actual tool excursions provides unparalleled value to a manufacturing operation. In many cases, the detection of a single critical incident more than offsets the total cost of this type of system," added Sonderman.

"Equipment Sentinel is capable of acquiring, processing and analyzing the massive amounts of data generated in today's high-tech manufacturing environments, providing a new avenue for corrective actions to ensure the maximum return on investment for semiconductor manufacturers."

ARM announce agreement with Fulcrum Technologies

ARM, Inc. has announced the appointment of Fulcrum Technologies as its Eastern US Distributor for its point-of-use purifier product line, including the popular Nova and Pro-Panel series purifiers. Fulcrum Technologies, Inc. is a stocking distributor company serving the microelectronics, nanotechnology, bio-pharmaceutical industries since 1986.

"Fulcrum Technologies, Inc. has extensive sale experience and technical knowledge in high purity gas purification equipment and processes. We are very pleased to be working with Fulcrum in the eastern US, and are looking forward to sustained growth in both sales and brand recognition in their territory" said Steve Wright, North American Sales Manager for ARM, Inc.

ARM Inc. designs and manufactures high purity gas purifiers and associated gas handling equipment for the semiconductor, energy, medical and pharmaceutical markets in the US and around the world.

Mersen acquires ASP

MERSEN has announced that it is to acquire ASP, a Chinese supplier of overvoltage protection (surge protection devices).This deal is part of the strategy to expand the presence of Mersen's electrical segment in the overvoltage protection market. Mersen's goal is to achieve close to €40 million of sales in this segment by 2018.

This deal follows the acquisition of a majority stake in Cirprotec (Spain) in February 2014, which provided the Group with a strong expertise in IEC standards. Mersen will now build on the recognized ASP brand in China and an efficient industrial platform to roll out across the Asian region which is currently adopting predominantly a technology already deployed in Europe. ASP has been majority owned by a Taiwanese group (CIMIC) since 2009.

The company has a sales network covering the whole China territory and a manufacturing facility in Guangzhou. This business will be integrated into Mersen's Electrical segment and will contribute some €6 million to the Group's annual sales. This deal is scheduled to be completed by September, following approval by the Chinese authorities. Gilles Boisseau, Group Vice-President Electrical Protection, said:

"This deal allows the Group to pursue its growth in the power quality and safety area, benefiting from this market's attractive growth. I would like to extend a warm welcome to ASP employees and I am delighted they will be joining the Mersen teams based in China. Together, we will continue to offer our clients the best solutions tailored to their needs".

Taking charge of change

Handling product and process change on an industrial scale is no simple subject. But there are solutions to manage change that semiconductor manufacturers have embraced as both effective and profitable. By Mark Andrews, technical contributor from Silicon Semiconductor.

CHANGE IS DISRUPTIVE. As a species, humans tend to oppose it since eons ago 'change' often meant danger. Even though we now live in a world free of saber toothed tigers, we are still beset with change that can be good, or bad. It's a touchy subject. Thankfully, humans have the ability to adapt, which is a key concept behind effective change management.

It's time to embrace change, manage it; make it work for us (for a change.) As every manufacturer knows, change is central to product lifecycles. Yet we often struggle with it. Manufacturing has become so fast-paced that some wonder whether they are managing change, or change is managing them.

Every manufacturer has to manage manufacturing process change in some form or fashion, whether a new product introduction or a continuous improvement; but not every manufacturer manages it effectively.

There is a lot to be gained from managing change beyond keeping one's sanity. The Change Management process in Systems Engineering is the process of requesting, determining attainability, planning, implementing and evaluating changes to a system. It has two main goals: supporting the processing of changes and enabling traceability of changes.

There are many components of managing change: ECR (Engineering Change Request), ECN (Engineering Change Notice), ECO (Engineering Change Order). Regardless of the term or the component, the goal is to manage and implement changes in a controlled fashion. Those who master changing products and processes as-needed / when needed will succeed. Those who stumble over change tend to fail.

Managing change is a core requirement of achieving a productive 'fast future' in which development times shrink, product lifecycles compress, manufacturing occurs globally and decentralized control, design and strategy become common corporate practices.

Central to winning in a Fast Future economy is realizing that managing change is not only doable, but can fit into a smoothly flowing factory floor, and can be highly profitable.

To see how vital dealing with change truly is for industry, consider the complexities of semiconductor products. Consumer devices today are created in shorter development cycles across different continents and distributed globally. The size of semiconductor markets keeps growing because they are in products that never had them previously while the population of people who can afford advanced products is also growing.

Manufactured products today are more likely to contain semiconductor components due to the versatility, control and functionality that they enable.

Consider major categories that did not have semiconductor components originally, but now rely upon them: light bulbs, automobiles, refrigerators, and telephones; hand tools with electric motors; not to mention the computers, smartphones and tablets that started life as semiconductor aggregations.

Products with logic/memory circuits are among the most complex. They must meet rising consumer expectations by being smaller, thinner and more capable; this elevates the need for integrated change management applications to the highest level.

Every single product that relies on semiconductors can have many variations driven by customer requirements such as geography, user interface, power types, privacy safeguards, RF links, materials composition and other differences including environmental and safety regulations as well as planned obsolescence. Research organizations like Gartner forecast that semiconductor sales will grow more than 5 percent in 2015.

Successful semiconductor manufacturers today have had to expand in order to sustain product development and withstand downward ASP pressure while meeting rising consumer expectations. Products that once were designed, manufactured and distributed from a single point are now multinational. Distribution can involve thousands of outlets; each point has the potential to impact a company's brand image thanks to millions of social media 'reviewers.'

More often than not, semiconductor manufacturers today rely on sophisticated manufacturing execution system (MES) applications to track and control every aspect of product

lifecycles. Particularly in the case of complex devices with multiple digital control, memory and RF interfaces, the manufacturing process involves hundreds if not thousands of steps, all orchestrated across distance and time. Changes occur by the hundreds each month; mistakes are costly. Big mistakes can be fatal.

While the pitfalls of manufacturing in a 'fast future' may seem daunting, the rewards can be equally amazing. Success means achieving superior quality while taking every practical step to improve manufacturing processes, embrace customer feedback and manage change.

Leading semiconductor manufacturers are making change work to their advantage by investing in unified MES applications that are capable of managing end-to-end processes including changing designs and other qualities. Those with multiple sites, complex products and global customers have led the charge to invest in modern MES technology. They are no longer hindered by islands of automation, legacy paper-based systems and disjointed operations; they can now innovate, adapt and succeed.

While every manufacturing process plays a role in delivering high quality / competitively priced finished goods, managing change is often one of the most difficult tasks to master. No matter the product, and no matter how automated and well-attuned the workplace might be, factories function best once stable processes and material flows are achieved. Factories love stability. Anything that disrupts stability effects productivity, yields and is a risk for creating waste, rework and shut-downs. But since change is inevitable, it's equally clear that enabling smooth and orderly change is most likely to return a factory to an optimal state.

Expert at helping manufacturers realize the benefits of MES and its attendant change management capabilities is the PLM Software Group of Siemens Corporation. The company's Camstar Product Management group focuses on assisting their industrial customers thrive while managing change.

Camstar Product Director Silvio Saouaf has seen almost every level of need and urgency as he has guided customers to choose change management applications and put them into practice. While no single customer story is exactly like another, semiconductor manufacturers typically appreciate that they need a software system that can help their factories function more smoothly. But they are not always sure just how powerful a well-integrated system can be until they see it in operation.

"Anyone who has had a costly 'excursion' in their plant is aware of how expensive it can be in terms of lost productivity and actual cash loses," He explained. "In cases where outmoded or siloed systems are in use, one side of the factory literally can't tell what the other is doing; that's when mistakes can start piling-up and (customers) typically realize very fast why they need a system to manage change at every level."

Globalized semiconductor manufacturing has created great opportunities. But at the same time it has created more risk for the manufacturer.

"The global consumer market has created greater demand for products with more capabilities. Manufacturers are having to manage this with larger product portfolios and increasingly complex devices. It's a two headed dragon of opportunity and risk. If you're doing this without a change management system you are at risk of hurting your brand all the way down to liability for consumer safety in some cases."

Saouaf explained that while some manufacturers still try to manage change with a paper approach, most have found this too ineffective and resource intensive. Paper systems hitched to siloed inventory or product lifecycle applications can severely limit a company's ability to retrieve, track and manage data real-time.

The move towards integrated MES applications that work across all aspects of manufacturing has taken hold. But all applications are not created equal. He sees a number of manufacturers with an MES paired with product lifecycle management (PLM) based applications as well as enterprise resource planning (ERP) products that don't talk to each other, which creates bottlenecks.

The key to success is an integrated approach that also empowers the manufacturing team to deal with change. How manufacturers handle change is increasingly a make-or-break point for successful globalization, he said.

"A fact you have to remember about some applications is they started out as tools for accounting or 'just the engineers.' They weren't conceived as tools to be used by everyone that needs access," He said. "What amazes people when they see a truly integrated approach is how easy it can make the whole process."

"If everything you have is siloed, it gets more complex to manage change, especially when you involve more people and different languages," he said. "Success requires targeted collaboration, integration of the right facts and on the timeline the customer needs while allowing for localized inputs. An application like Camstar Change makes it easy for people to collaborate with the right individuals overseeing the process, all from one central authoring system. All parties have the correct input. And it is not just a document (they see,) they can look at the actual products that are going to change and how the changes will appear; there is no guesswork."

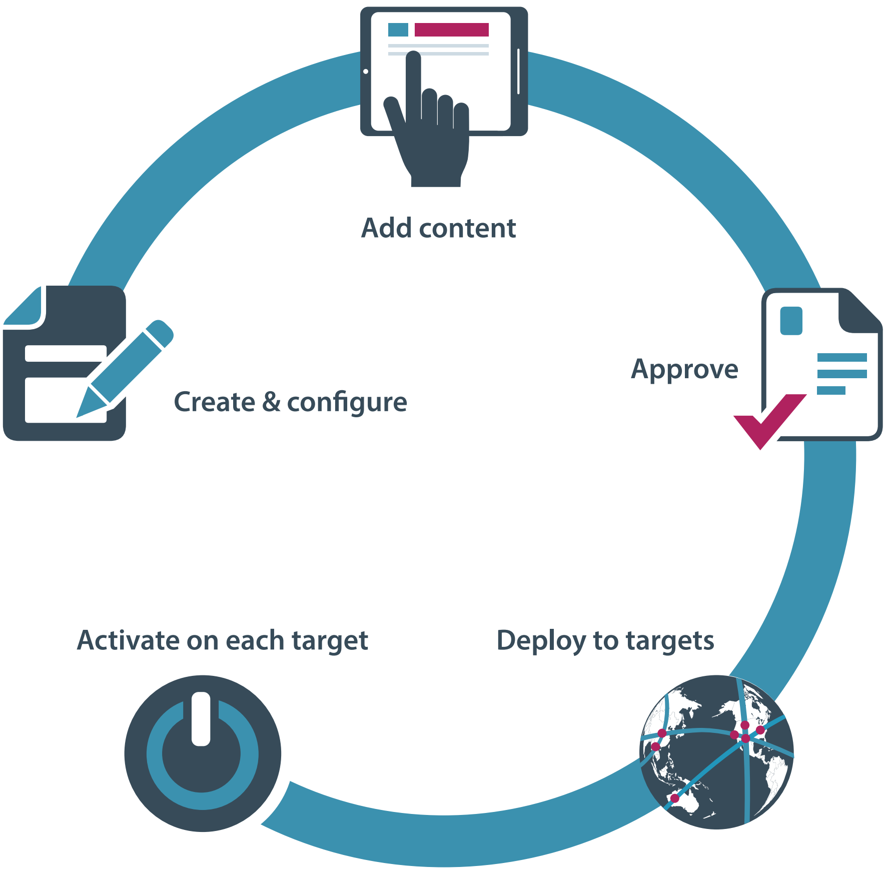
When considering applications that can increase productivity across multiple manufacturing, design and engineering teams in multiple locations, the ideal change management program should offer these capabilities:

Create and configure

- Plan changes by creating the change package at the authoring site
- Assign ownership, approvers and content editors as well as the target systems and sites
- Select a business process workflow from a configurable range of options

Add content

- Identify new products to manufacture, and/or products and processes that have changed
- Track modeling changes to determine which products and processes the



"Every manufacturing plant encounters quality issues of varying size and complexity, but those using advanced MES with change management capabilities are able to track, isolate and rectify problems more quickly for a return to smooth operation"

change(s) affects
- Automatically organize dependencies and sequences

Approve changes
- Route the change package for review and approval, following the business process that the author models within the change management application
- Enable reviewers to assess the changes and their impact using the application's analysis tools
- Import approvals from the product lifecycle management (PLM) system

Deploy targets
- Perform one-click distribution to targeted sites and systems
- Easily deploy details of the changed process/procedure across one site or multiple global locations

Activate on each target
- Accept and activate changes according to a schedule that works for local environments
- Enable users to make changes to meet their local needs (within parameters that the author establishes.)

Globalization has accelerated the need for change management. As globalizing involves more widely-dispersed design, engineering and manufacturing locations, the need to effectively manage change is accelerating in-step. Semiconductor market growth is driven by expanding populations that can afford more advanced products.

Advanced devices today often adopt semiconductor based memory, logic and digitized control because these systems are more dependable, flexible and capable, which enables greater product diversity through software or firmware tweaks. Product lifecycles are also changing (usually shorter,) while design and manufacturing speeds-up to meet consumer expectations.

Any way that a manufacturer looks at the future, it's clear that 'fast' is a factor. The ability to quickly implement change and manage it will be decisive.

To stay ahead of consumer demands, manufacturers need complete control and visibility into the myriad of process steps each product requires. Achieving this requires integrated manufacturing execution systems (MES) applications that contain effective change management modules like the Camstar Change process offered by Siemens PLM. While it is possible to operate a manufacturing plant with siloed applications, an integrated approach not only saves time and increases productivity, it provides the level of traceability and accountability needed across large organizations.

Every manufacturing plant encounters quality issues of varying size and complexity, but those using advanced MES with change management capabilities are able to track, isolate and rectify problems more quickly for a return to smooth operation.

"The goal ultimately is a closed loop system with visibility up and down the line. It should incorporate all the available information to connect design and execution in a way that is not only functional but highly usable—it should deliver a great user experience. It should proactively prevent errors, yet be flexible enough to handle rework, scrap, warranty, recalls, and provide audit trails.

"For manufacturers that achieve an optimized level of change management, they can build any product in any plant throughout their system, at any time. They will lead their market and handling change will no longer be something to worry about, it will just be one more part of a well-managed product lifecycle," Saouaf said.

Footnote: Annie Mullen of Siemens PLM Software contributed to this article.

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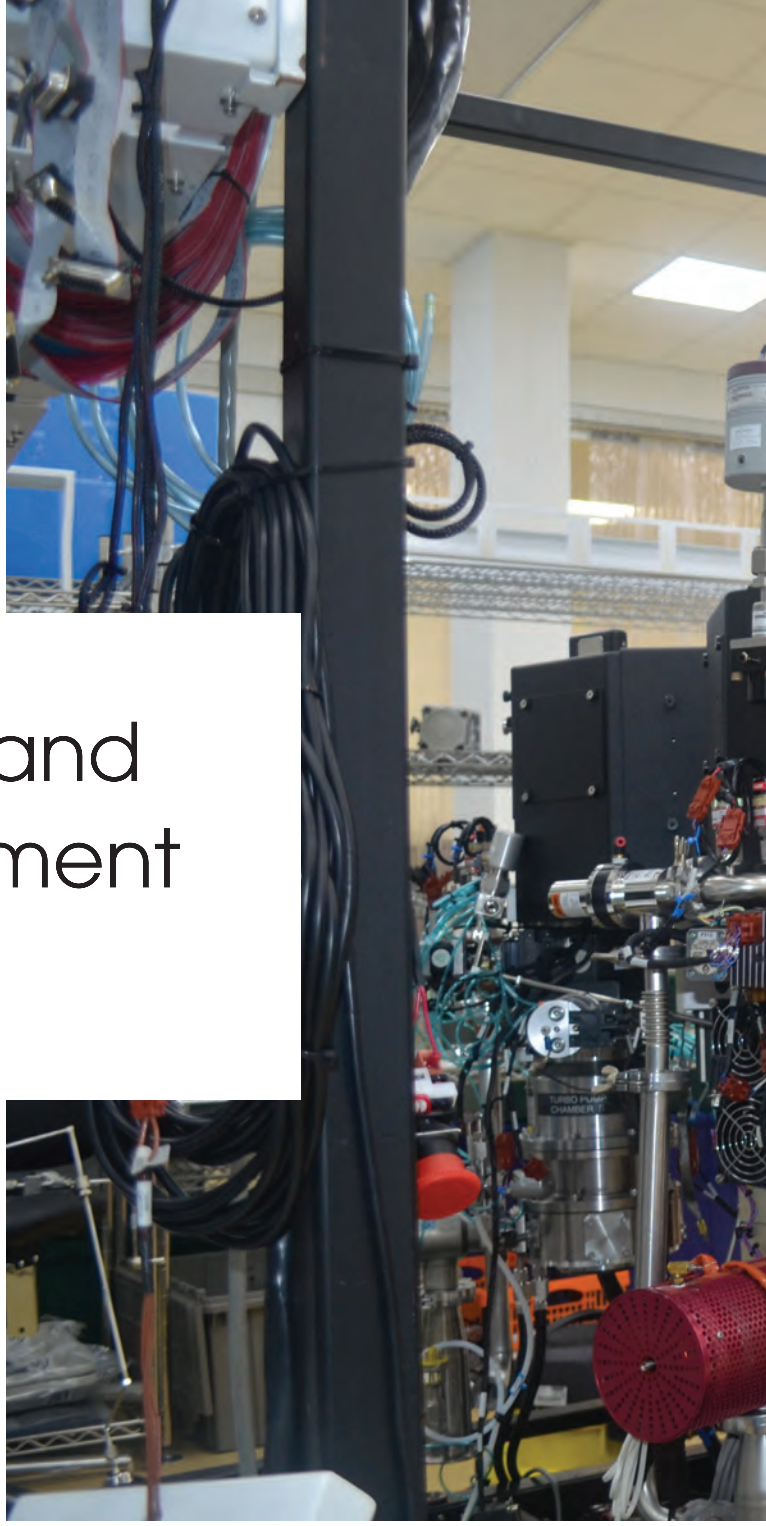


The role of OEMS and secondary equipment in the new IoT fab

To be competitive in the IoT market, cost is key and making the successful adaptation of secondary equipment is paramount. Tony McKie, CEO, memsstar tells Silicon Semiconductor why.

EVERYWHERE WE TURN, we see reference to the Internet of Things – or IoT – as the driver of future innovation, with the promise of making the world a better place. Perhaps more importantly, the IoT represents a significant market opportunity for a large portion of the electronics supply chain.

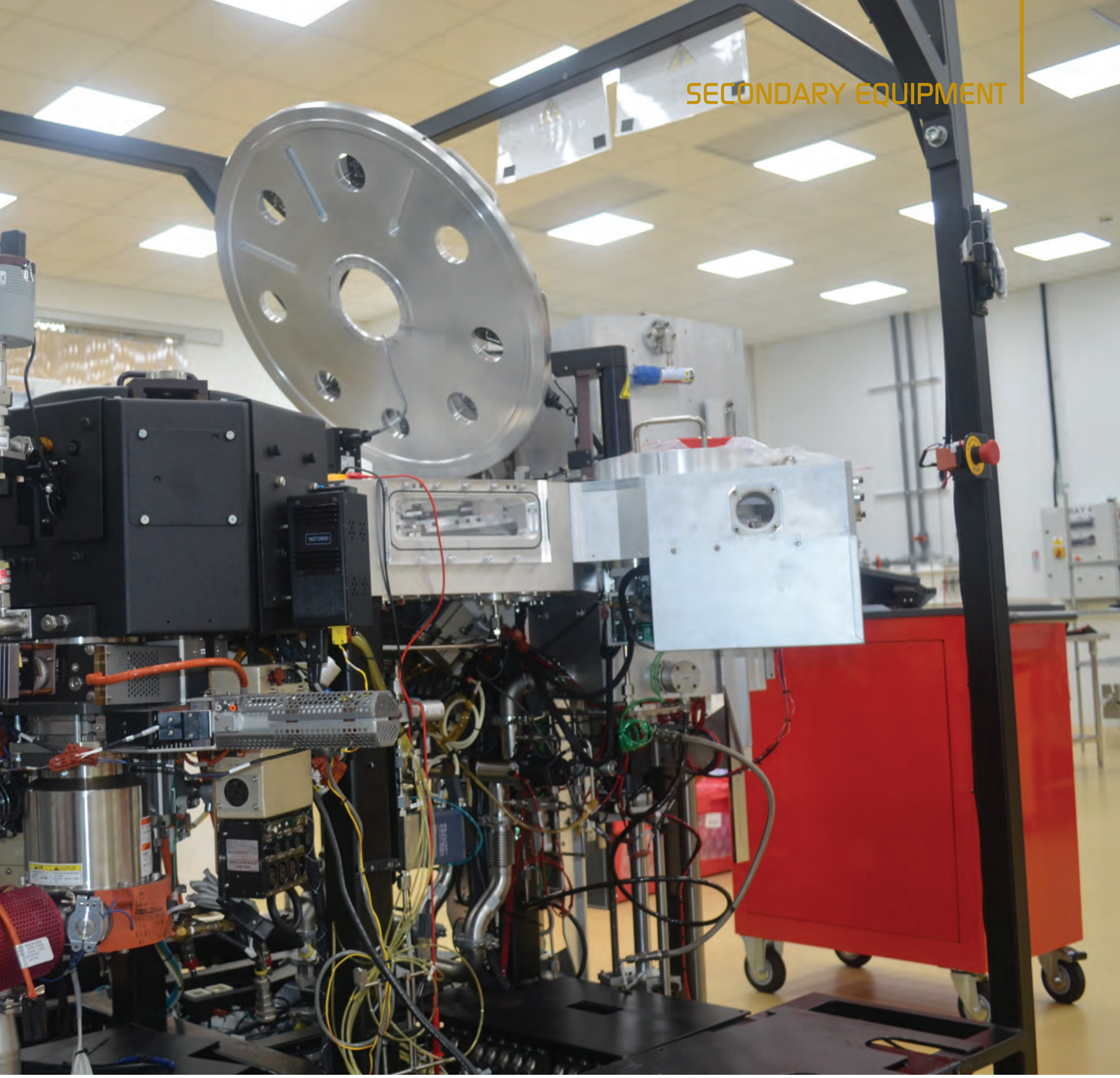
Gartner has defined the IoT as the network of physical objects that contain embedded technology to communicate and sense or interact with their internal states or the external environment. [1] Exploding at an exponential rate, the IoT is expected to grow at a CAGR of 31.72 percent by 2019 due to the vast number of integrated electronic devices that will be required in a huge range of products designed to inform, measure, control, record, and report.

This has resulted in a massive outflow of new systems and applications to be delivered faster, smaller and at very low cost. To meet these demands, there is pressure on industry suppliers to increase capacity and throughput on new processes while working with lower technology equipment, in many cases at 200mm.

IoT driving growth

There is no market segment left untouched by the IoT; industrial, healthcare, automotive and consumer products are all embracing the opportunities it will afford. According to Yole Développement, the timeline for IoT applications is underway, with consumer and home automation applications already being implemented. By 2016, we can expect to see the IoT affecting retail and logistics. By 2018, it will be enabling health, life science, and industrial applications. By 2020, we can expect to see it implemented in transportation, security and public safety, and environmental applications. [2]

The semiconductor and related industries (e.g. MEMS, sensors, and compound semiconductors) provide the underpinnings



that enable the IoT. Predictions on the numbers of connected devices required for the IoT range from 25 to 35 billion. As such, the weight of its successful implementation falls squarely on the shoulders of industry suppliers to increase capacity and throughput on new processes.

Furthermore, the low cost and low-power requirements of these devices calls for legacy node silicon, rather than leading edge CMOS. Gartner research predicts we will need 100K wafers/month to meet these requirements, with supply coming from both 200mm and 300mm wafer fabs to reach this target.[3]

Impact on 200mm fabs

According to the SEMI 2015 Secondary Fab Equipment Report, 150mm and 200mm fab capacity represents approximately 40 percent of the total installed fab capacity. Additionally, 200mm fab capacity is on the rise, led by foundries that are increasing 200mm capacity by about 7 percent through to 2016, driven by new applications related to mobility, sensing and IoT. In 2014, 200mm fab investments by leading foundries and IDMs resulted in a 45 percent increase in spending for secondary 200mm equipment. [4]

In particular, the IoT provides a significant opportunity for second-tier manufacturers that have fully capitalized wafer fabs and are looking to add diversity to their product lines without investing in leading-edge silicon. Not all products will be manufactured in silicon, but increasingly also in alternative materials such as gallium arsenide that aren't suited to 300mm wafer sizes. Additionally, there is an increase in "More than Moore" class devices, as many of the IoT devices involve heterogeneously integrating analog chips, power management devices, image sensors, biomedical, MEMS and other technologies. Most of these are manufactured at 200mm, leaving 300mm wafer starts for leading edge CMOS and memory.

As such, 200mm fabs are experiencing a renaissance, particularly in Europe, where the offshore migration of leading-edge silicon manufacturing left behind legacy fabs searching for purpose. Many of these smaller companies have invested in technologies that aren't mainstream, but rather classified as more niche market. Although Europe has been doing this for a long time, these niche markets, such as MEMS, automotive, and medical devices, are now being captured under IoT.

SEMI market research shows that investment in "legacy" fabs is important in manufacturing semiconductor products, including the emerging Internet of Things (IoT) class of devices and sensors, and remains a sizeable portion of the industries manufacturing base:

- 150mm and 200mm fab capacity represent approximately 40 percent of the total installed fab capacity
- 200mm fab capacity is on the rise, led by foundries that are increasing 200mm capacity by about 7 percent through to 2016 compared to 2012 levels
- New applications related to mobility, sensing, and IoT are expected to provide opportunities for manufacturers with 200mm fabs [5]

Used, refurbished, remanufactured, certified and other classes of secondary equipment remain essential to the production strategies for these 200mm fabs. A recent survey by SEMI of top 200mm fab managers indicated that secondary equipment was the number one source for productivity improvements in the future. While the total secondary market is growing, the most popular tool sets are still in short supply. [6]

OEMs vs. Secondary equipment suppliers

One challenge of the anticipated IoT explosion and the impact it's having on 200mm fabs is how to cost effectively add capacity with tools that have 10-15 year old processing capabilities. Most OEMs have focused new process development on 300mm toolsets, looking to capture high-volume manufacturing at 300mm. While they still provide parts and service for 200mm tools in the field, very few are actually developing new processes on 200mm tools. This means that many fabs are turning to secondary equipment suppliers for the solution. For European-based companies in particular, establishing a partnership with a European-based secondary equipment supplier is particularly appealing.

Why is that? 10 years ago, as 300mm wafer shipments began to outpace 200mm platforms, the major OEMs enabled the transition with the availability of the comprehensive 300mm toolset and began a new 300mm technology race, meaning these tool suppliers limited their activities to service and spares for the now legacy 200mm toolsets.[7] Additionally, many of these OEMs shifted R&D efforts into developing 450mm toolsets, LED and solar panel manufacturing, rather than developing new 200mm processes for innovative legacy nodes. For IoT fabs, the question is not only can the industry withstand 200mm equipment at new prices, but also would the new tools provide new capabilities to accommodate the diversity of More-than-Moore class devices?

Customer requirements for secondary equipment are changing dramatically. It's no longer sufficient to simply deliver a used tool, or refurbish or make small modifications to older equipment for IoT device fabrication. Now, these tools have to be adapted to provide customized solutions for a wide variety of applications, as well as extending the life span and evolving the functionality of older equipment. This isn't without its challenges such as the availability of donor tools, where to source legacy components, the provision and knowledge transfer of

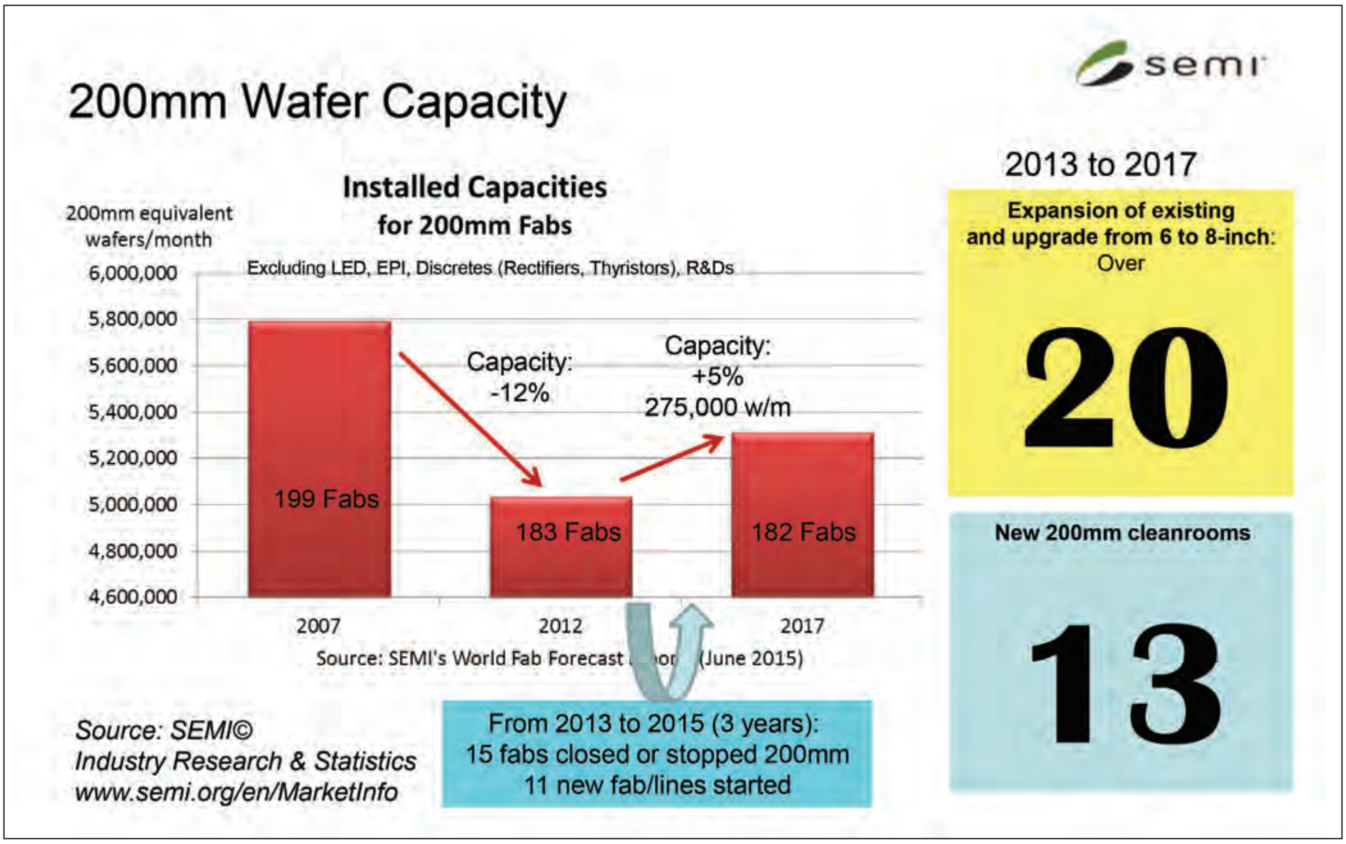


Image courtesy of SEMI

> While many OEMs have an interest in supplying toolsets to the IoT market and have remanufacturing capability, their legacy 200mm OEM tools were designed specifically for processing silicon. IoT devices call for processing on exotic materials such as compound semiconductors and glass for optical applications, which calls for re-engineering, particularly with regard to handling

engineering and process expertise in older technologies, and ensuring standards and quality to satisfy a demanding and extremely high volume industrial environment.

There are two viable options for sourcing semiconductor equipment: OEMs or secondary equipment suppliers. While many OEMs have an interest in supplying toolsets to the IoT market and have remanufacturing capability, their legacy 200mm OEM tools were designed specifically for processing silicon. IoT devices call for processing on exotic materials such as compound semiconductors and glass for optical applications, which calls for re-engineering, particularly with regard to handling. Additionally, the cost of procuring a tool with installation, full service support and training from an OEM, is typically much higher than securing the same from a company specializing in remanufacturing secondary equipment.

When sourcing secondary equipment for IoT fabs, it's important to look for the full solution. This goes well beyond just a piece of used equipment, and includes developing and implementing new process capabilities specific to IoT devices. A full service provider of secondary equipment not only refurbishes a tool, it remanufactures it to either original, or in many cases, new specifications, while providing full service support, installation, and training. The best-case scenario is for an IoT fab to engage in a long-term partnership with a secondary equipment manufacturer that understands the processes required for IoT device manufacturing, from developing the specialized tool processes, to adapting the tools themselves to handle new requirements or exotic materials. These companies can supply a full line, or fill in the gaps with tools that are engineered and customized to the fab's requirements and support technology transfer.

It's also important to consider tool knowledge. Many engineers and technicians working for secondary equipment suppliers have worked on four or five generations of these tools, since the time when they were state-of-the-art. They are able to transfer this knowledge and train customers on the tools.

Conclusion

To be competitive in the IoT market, cost is key and making the successful adaptation of secondary equipment is paramount. A supply chain that can quickly fulfill the need for re-purposed equipment, support, and services is critical. Choosing an equipment partner that can fulfill these needs will be vital for the success of the IoT fab.

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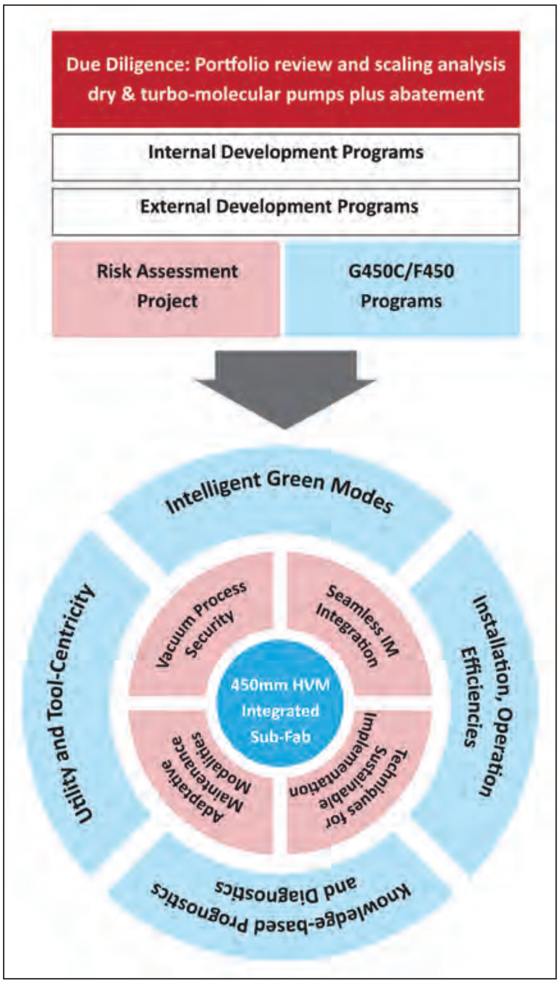
New paths to
greener semiconductors

Manufacturers are working to reduce the environmental impacts of next-generation technologies by challenging common practices in today's semiconductor plants. Mike Czerniak, Environmental Solutions Business Development Manager, and David Hacker, Strategic Marketing Manager, at Edwards UK, Hartmut Schneider, Technology Manager Semiconductor, from M+W Group, Stuttgart, Germany discuss their solution.

THE SEMICONDUCTOR industry is constantly striving to reduce the environmental footprint of chip manufacture. This goal is especially true as manufacturers contemplate 450 mm wafer production. A key feature of the rationale for introducing 450 mm wafers will be scaling utility consumption at a slower rate than the surface area increases (i.e. 2.25x compared to current state-of-the-art 300 mm wafers), as reflected in the ITRS roadmap [1]. Scaling back utility consumption would have the complimentary benefits of reducing manufacturing cost and, at the same time, reducing CO2 footprint, which is becoming increasingly important as "green labelling" is more widely deployed. Yet several factors have conspired to actually increase energy-per-unit-area (kW/cm^2) in recent times. Energy saving during periods of wafer inactivity is one route towards off-setting this trend, but requires standardised signalling before it can achieve widespread adoption.

Another factor to be considered is the decreasing size of semiconductor devices themselves. As dimensions approach levels where atomic-scale factors come into play, some devices may require fine-tuning during manufacture. This will result in a need for a greater degree of data collection and analysis, and increased data connectivity within the fab environment to achieve the adaptive control required to maintain high process yields in a more flexible real-time environment. This is another area where standards and protocols are necessary for significant deployment of the latest prognostics and diagnostics. These concepts can be summarised as seen in Figure 1.



Right: Fig 1 Edwards phased development towards 450 mm

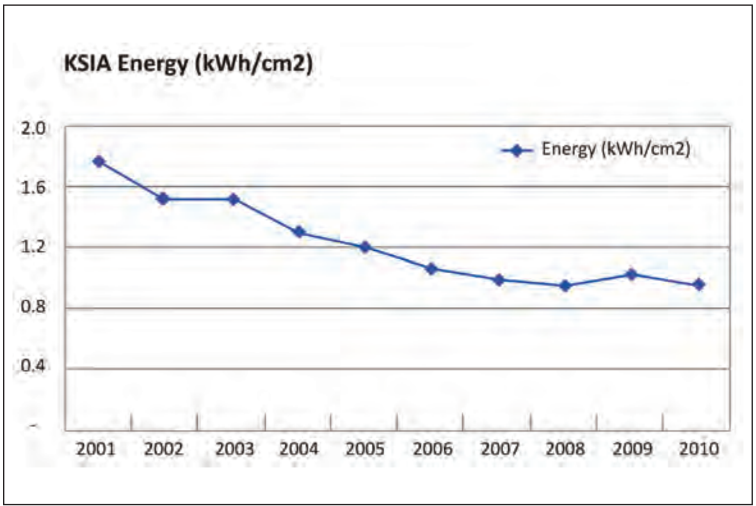


Fig.2 Energy use/wafer area in Korea [2]

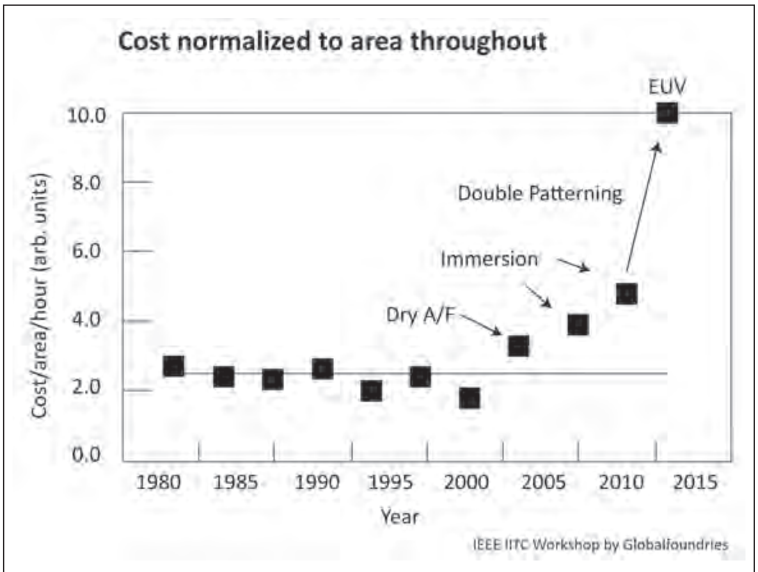


Fig.3 Cost/wafer area for 300 mm wafers [3]

Wafer size	Pitch	# Processing steps
200	0-1μm	~100
300	23nm	~1000
Future	Future	>1000

Fig.4 Table illustrating the impact of reduced feature size and increased wafer diameter on number of processing steps [4]

Drivers for utility consumption reduction

Since about 2005, the semiconductor industry has been steadily decreasing its kW/cm^2 footprint. But in recent times this trend has been in reverse, as shown in Figures 2 and 3.

In addition to the factors cited in Fig 2, the number of process steps required to manufacture leading-edge chips is trending upward, so even if an individual process step becomes more efficient, the net effect of more steps results in an overall increase. The table in Figure 4 illustrates this point:

Given the goal to support environmentally sound practices, the semiconductor industry is looking for ways to offset these trends and reduce utility consumption per unit area, which would also have the benefits of reducing overall cost while shrinking the carbon dioxide (CO2) footprint (6.89551×10^{-4} metric tons CO2/ kWh[5]). The latter is important to help reduce Green House Gas (GHG) emissions from the industry. Many manufacturers are already auditing emissions throughout the entire production process to enable using one of the many “Green Labels” currently available[6] a selection is illustrated in Figure 5.

Idle mode as a route to utility savings

Many automobiles save fuel (and CO2 emissions) by automatically switching off the engine whenever the vehicle is temporarily stationary, e.g. at red traffic lights; the engine automatically re-starts when the gas pedal is pressed.

This concept is the basis of an “Idle Mode” that can be replicated in a semiconductor fab by reducing the rotational speed of a vacuum pump and reducing the fuel or electrical power draw of a gas abatement system at times when the process tools are not actually running wafers, where a significant proportion of the fab’s power is consumed, according to a 2012 ISMI energy study [7].

This study concluded that 300 mm Fab process equipment consumes 43 percent of the total power budget, and of that figure process pumps consume 41 percent and load-lock/transfer pumps consume a further 10 percent. Savings in these areas could substantially affect energy costs.

The issue of realising such savings in practice has been the lack of standardised signals to pumps, abatement systems and so forth to initiate and end periods of energy saving. Much equipment has had this capability for many years, so a SEMI task force was initiated to tackle the issue. It was agreed to split the work into two parts to simplify the task. Phase 1 would cover host to process tool communications,

Fig.5 A selection of International Green Labels

resulting in the publication of SEMI E167. Phase 2, covering tool to sub-fab equipment (e.g. pumps and abatement), is currently a work-in-progress. In both phases the process tool 'decides' when to initiate and end energy-saving idle modes because the tool knows when wafers are present and also when vacuum and/or abatement are required when wafers are not present, e.g. during maintenance activities.

Modelling 450 mm energy saving potential in EEM450PR consortium

Having established a potential pathway to idle mode energy savings for 450 mm wafer manufacture, the opportunity to model and test its potential impact on a 450 mm fab presented itself as part of the European EEM450PR project, part of Eniac [8].

In this consortium Edwards, M+W Group, Intel, IMEC, Artemis, Recif, Asys, Fraunhoffer, XYCarb and AIS Automation collaborated in Work Package 4.2, Factory Integration.

A Fab model was developed by M+W Group, based on 300 mm, 40k m^2, 120k WPM, 1400 tools (using IC Knowledge data regarding the toolset), 85 percent utilisation, and was populated with pumps and abatement systems appropriate to each

System	Actual Consumption with Green Mode		Saving	Baseline
Power	Actual Power Consumption	11,377 kW	17%	Aux Tools Total
			5%	Tools Total (BM)
PCW	Actual PCW Consumption	2,646 m³/h	17%	Aux Tools Total
			6%	Tools Total (BM)
Exhaust	Actual Exhaust Consumption	152,103 Nm³/h	0%	Aux Tools Total
			0%	Tools Total (BM)
N2	Actual N2 Consumption	7,862 Nm³/h	20%	Aux Tools Total
			11%	Tools Total (BM)
O2	Actual O2 Consumption	254 Nm³/h	23%	Aux Tools Total
			19%	Tools Total (BM)
NG	Actual NG Consumption	1,196 Nm³/h	23%	Aux Tools Total
			n.a.	Tools Total (BM)
UPW	Actual UPW Consumption	103 m³/h	23%	Aux Tools Total
			6%	Tools Total (BM)
WWT	Actual WW Consumption	106 m³/h	20%	Aux Tools Total
Source: M+W Group			6%	Tools Total (BM)

Figure 6 Potential utilities savings in a 300 mm fab using idle mode

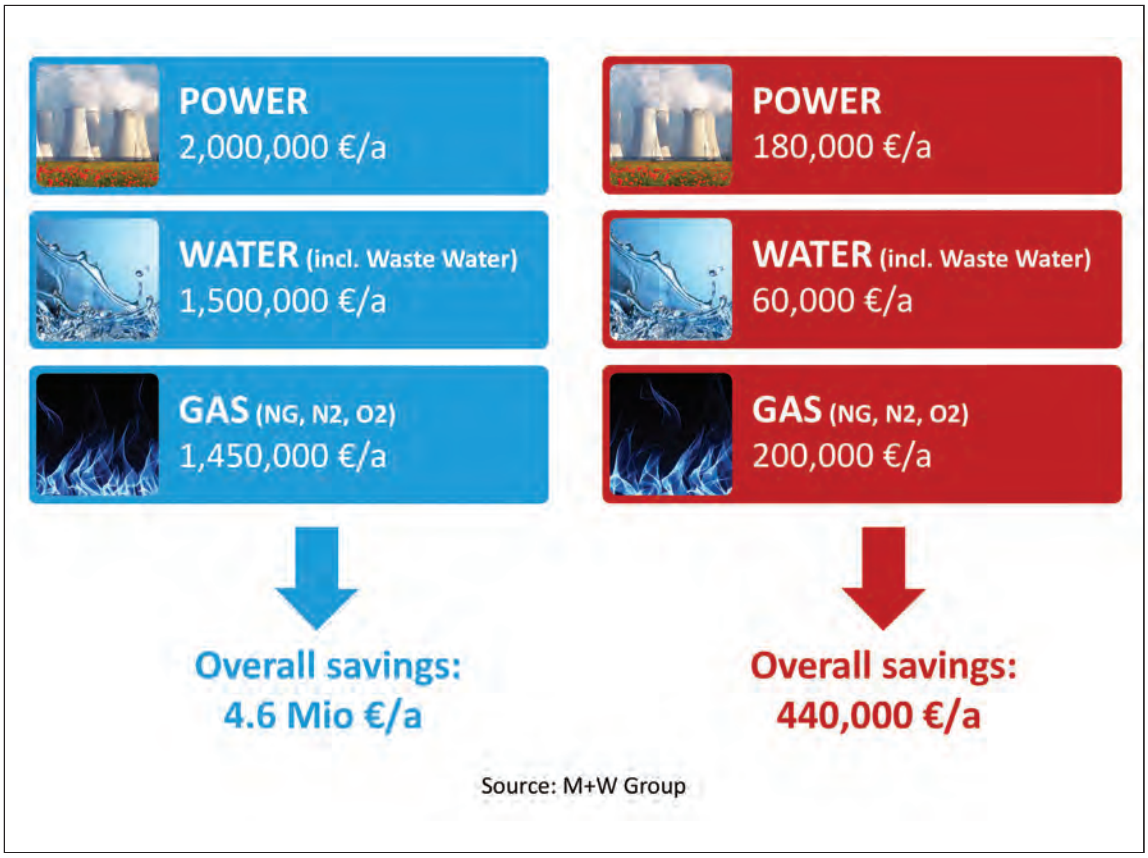


Figure 7 Potential utilities savings in R+D & HVM 450 mm fab scenarios

process application by Edwards, including their utility consumption. The potential savings are summarised in Figure 6. Using a similar methodology, 450 mm wafer fabs were populated and modelled for both High Volume Manufacturing (HVM) and R+D scenarios. The potential savings at 85 percent fab utilisation are summarised in Figure 7.

Testing the 450 mm energy saving model in EEM450PR consortium

Having constructed a 450 mm Idle Mode model, it was then tested in two scenarios, namely R+D and HVM. In the case of R+D, a pump and abatement system were connected to a CVD tool and utilities were monitored in process and idle modes initiated by an idle mode signal, as shown in Figure 8.

Fig 8 Idle mode savings at a 300 mm R+D fab

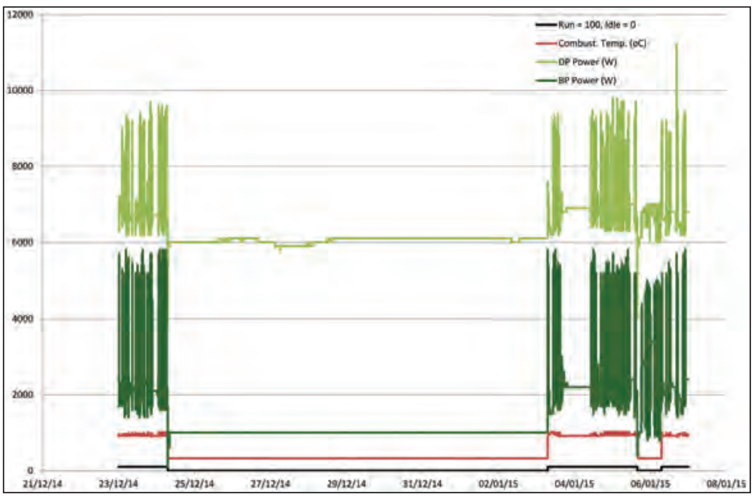
To check the HVM model, data from nine process tools including CVD and etch in a 300 mm fab was analysed over a one year period.

Potential savings were recorded if (a) neither vacuum nor abatement were required by the tool (e.g. for MFC calibration, etc.) and (b) the idle time was greater than 100 seconds (anything less than this can actually increase overall energy consumption due to the tools' operational practices and requirements.) Reviewing the data led participants to conclude that that an overall potential energy savings of ~17 percent could be achieved; representative graphs are shown in Figure 9.

Fig 9 Potential Idle modes in a 300 mm HVM fab

It is planned to cross-check these results with G450C on an actual 450 mm tool as a final model verification.

Fig 8 Idle mode savings at a 300mm R+D fab



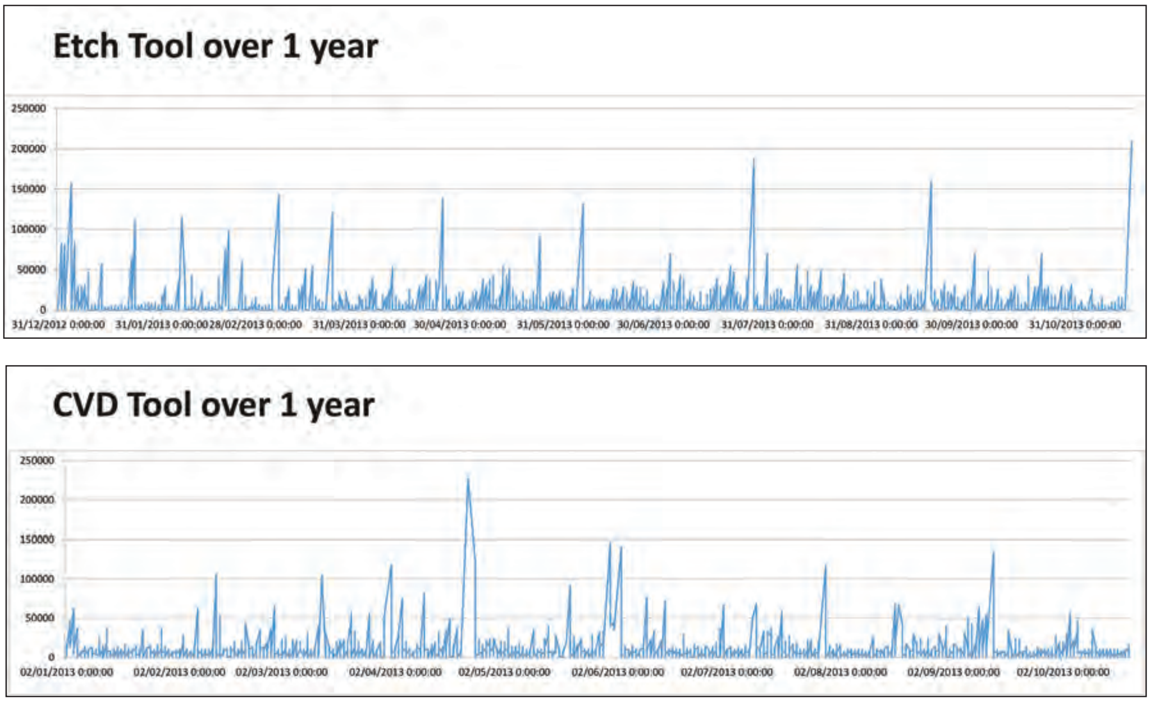


Fig 9 Potential Idle modes in a 300mm HVM fab

Summary and conclusion

By the time that 450 mm replaces current 300 mm wafers, HVM will need to adapt to meet the challenges these new technologies will introduce. A key element of this is increased data flow in general as individual processing steps need to be dynamically adapted so as to maintain consistent device performance as feature sizes continue to shrink towards the atomic scale.

Another aspect of future fabs will be the need to decrease utility consumption in order to: offset any increase in the number of processing steps, the introduction of new energy-hungry steps, and any increases in process gas flows associated with larger wafer diameters.

The most promising route to achieving such savings is to implement Idle Mode savings strategies. The potential to positively impact at 450 mm has been modelled and the model tested at 300 mm R+D and HVM.

Fundamental to the deployment of Idle Mode savings processes is the provision of suitable standardised signalling, between the HOST/MES system and the processing tool (SEMI E167[9]), and subsequently between the process tool and sub-fab equipment, such as pumps and gas abatement, which is currently a work-in-progress.

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Silicon tech
evolves to 450 mm

Manufacturers are pooling resources to double global IC capacity. Will achieving the next milestone in silicon evolution give members a competitive edge? Silicon Semiconductor's Mark Andrews spoke to Todd Fosler F450C new program manager.

WE HAVE all heard industry tales with a familiar backstory: entrepreneurs in Country X conceive a great new technology. Through tenacity and sleepless nights, these struggling geniuses create revolutionary new products. After a massively-successful IPO the founders buy super cars and retire to Tahiti.

While dreams of miraculous success may draw some to the industry, most Silicon Superstars won their fortunes by designing and selling innovative products that met needs/solved problems. For every celebrity CEO on a stage, there are armies of scientists, engineers and manufacturers backing them up.

Consider the 300 mm silicon wafer, now the largest substrate in high-volume manufacturing (HVM). Fabs didn't jump to 300 mm wafers overnight, nor have they abandoned 200 mm, which is surging for MEMS and other applications suited to their size. Work continues on both wafer types to improve yields and performance. Technologies evolve over time. Each cutting-edge breakthrough arrived after many steps.

Costly investments are made and risks are taken to achieve new semiconductor milestones. While the business of technology rewards innovation, it can just as easily crush a company. This adage holds true: risk nothing/win nothing.

Manufacturers saw 450 mm wafers as challenging from the outset. Today's successful 300 mm technology was created through 'institutional entrepreneurship'—companies worked solo or in limited partnerships to innovate. Pieces of the puzzle fit together and are still evolving. While foundational work that achieved 300 mm success might see repurposing in 450 mm, many separate issues need to be resolved, so manufacturers saw that a new risk-reducing approach was needed.

A consortium of companies dedicated to facilitating 450 mm fabrication formed in 2011 with the backing of New York Governor Andrew Cuomo who offered seed money and a home at the Colleges of Nanoscale Science and Engineering (CNSE) housed at the State University of New York (SUNY) Polytechnic Institute campus in Albany. The Global 450mm Consortium (G450C) was created first. It focuses on the tooling and

process challenges of manufacturing with 450 mm wafers. It was followed in 2013 by the Facilities 450 Consortium (F450C), which was chartered to overcome the infrastructure-related hurdles of 450 mm fabrication.

Silicon Semiconductor's Mark Andrews recently spoke to Todd Fosler who joined the F450C earlier in 2015 as its new program manager. Fosler brings 20 years of semiconductor manufacturing experience to the partnership. While with Intel, he managed and developed implementation of new manufacturing capabilities that enabled the transition to 300 mm wafers for functions including sort, assembly and test. He had previously focused on fab design, construction and conversion methods in various engineering and leadership posts. He specializes in how to integrate the demands of new tools and process technologies into a facility design that is optimized for sustainability and affordability.

Fosler considers the F450C a first-of-its-kind partnership that is leading the global effort to design and build next generation 450 mm facilities. He said that 12 companies serving various functions and processes in semiconductor manufacturing comprise the consortium's roster: Air Liquide, Busch Vacuum Pumps and Systems, CH2M, CS Clean Systems, Ceres Technologies, Edwards, Haws Corporation, Mega Fluid Systems, M+W Group, Ovivo, Pfeiffer Vacuum and Swagelok.

Q Transitioning from one wafer size to another has in the past been an evolutionary process. How does the F450C see itself enabling the move? The consortia are housed on a SUNY campus; does the State of New York hope new 450 mm fabs will be built there?

A F450C was formed to enable the world's leading semiconductor facility companies to collaborate and develop the 450 mm high-volume facility construction standards. This is so that when the industry is ready to pull the trigger on the 450 mm transition, the time to get the first production wafers out is not gated by facility construction standards or uncertainty about fab infrastructure solutions.

SULY Poly CNSE have been a great home for both consortia.

> Anytime you are working with the leading edge of technology, there is a lot of experimentation with successes and failures, but we learn from the failures and move forward

The promotion of STEM education locally has made it a perfect home that aligns with the general push to make upstate NY a high-tech hub. While I can't speak for NYS, I do think they are making it an attractive location for companies to create new employment opportunities as these fabs are constructed and ramped into production.

Q Public/private partnerships are not new. How does the consortium's partnership with the State of New York differ from others?

A This collaboration is unique because the industry understands that 450 mm facility challenges require collaboration across the entire value chain. Working alongside each other at the CNSE, G450C and F450C can more effectively explore options and align on facility standards with industry partners. Without this collaboration, our goals of developing viable 450 mm standards and technology solutions would not be possible.

Anytime you are working with the leading edge of technology, there is a lot of experimentation with successes and failures, but we learn from the failures and move forward. The companies in this consortium, along with SULY Poly CNSE, are working together to find the best way to move forward and develop the technology the semiconductor manufacturers need to enable the 450 mm transition.

Q It seems almost any technology conference focused on the needs of silicon semiconductor manufacturing has tracks about challenges tied to the move from 300 to 450. What areas are the F450C focused upon?

A Our members' priorities for facilities-related projects are: utility right-sizing, standardize tool install procedures and minimizing the number of points-of-connection; improve AMC detection/response, helium recovery/recycling and green-mode systems usage. Equally important to the work we do in 450 mm technology is the work of the Global 450 Consortium (G450C). G450C members consist of Intel, TSMC, Samsung, IBM and GLOBALFOUNDRIES.

Q The equipment being installed in the new SULY Poly CNSE fab, is it 300 mm-based with adaptations for 450 mm, or is new equipment created specifically for 450 mm?

A Within the consortium, we encourage our members and the sub groups to concentrate on technologies that are scalable between wafer sizes so that fabs can benefit today regardless of which wafer size they produce. However, our main objectives and timelines deal with 450 mm tools, as evidenced by milestones like Nikon's lithography tool being delivered to the Albany Campus (http://bit.ly/1CKkTA3), which joined existing 450 mm infrastructure. According to CNSE, the investment in tools on the campus has surpassed the $700 million mark (http://bit.ly/1L0de8Z).

Q Can you give us a better indication of what members are focusing on right now?

A Recently, F450C hosted an interactive panel featuring five representatives from F450C and G450C. The discussion centred on two main recurring themes: access to manufacturing information; and manufacturing sustainability and resource conservation. The event reflected the spirit of collaboration essential in this transition and in developing technology that can scale between wafer sizes, a current focus of F450C's members. Full footage of the panel can be found here: http://www.f450c.org/f450c-hosts-panel-semicon-west-2015/

Q Are there advantages to making the move to 450 mm wafers that the consortium feels don't get enough discussion and should be more widely considered by the industry as a whole?

A Yes. This will certainly be the most efficient wafer-size transition when it does reach that point. Until then, members of the consortium are not waiting for 450 mm to drive the need for more efficient systems and tools. The recent R&D efforts signal the movement toward technologies that can be used in existing production lines, but that can also be scaled-up for the first 450 mm fabs. Speaking to efficiency and the aforementioned resource management, the work being done at SULY Poly CNSE highlights some of the most technologically advanced methods of conservation and monitoring. Consortium members Haws

Corporation and Ovivo focus their efforts on water consumption and waste stream management, knowing how important those will be in relation to a larger wafer size. Additionally, our members are directly addressing power management issues that fabs face today, but that will also be useful as we ramp to high-volume manufacturing in 450 mm in the future, specifically our vacuum manufacturers. Abatement systems will continue to be extremely important regardless of wafer size. Joe Guerin of CS CLEAN SYSTEMS often speaks of the need to strike a balance for each process technology and wafer size, and emphasized that during our panel.

Q I heard one technologist say that no one wants to be the last person to build a totally new 300 mm plant, yet no one wants to be the very first to build a 450 mm plant. Do we need 450 mm technology right now?

A Part of F450C's mission is to reduce the cost risk for the first 450 mm fab to be built. We are aiming to make this the most efficient transition in industry history. This hasn't always been the case. In earlier transitions, one company carried most of the risk by building the first new wafer size fab and working out the technology startup issues alone. Through collaboration, we are taking the burden off one player as the entire industry comes together to anticipate, plan and support the transition.

Q It is interesting to see the semiconductor industry take this approach. Historically, companies have wanted to pioneer new technology to be first to market – Is being first too risky in 450 mm?

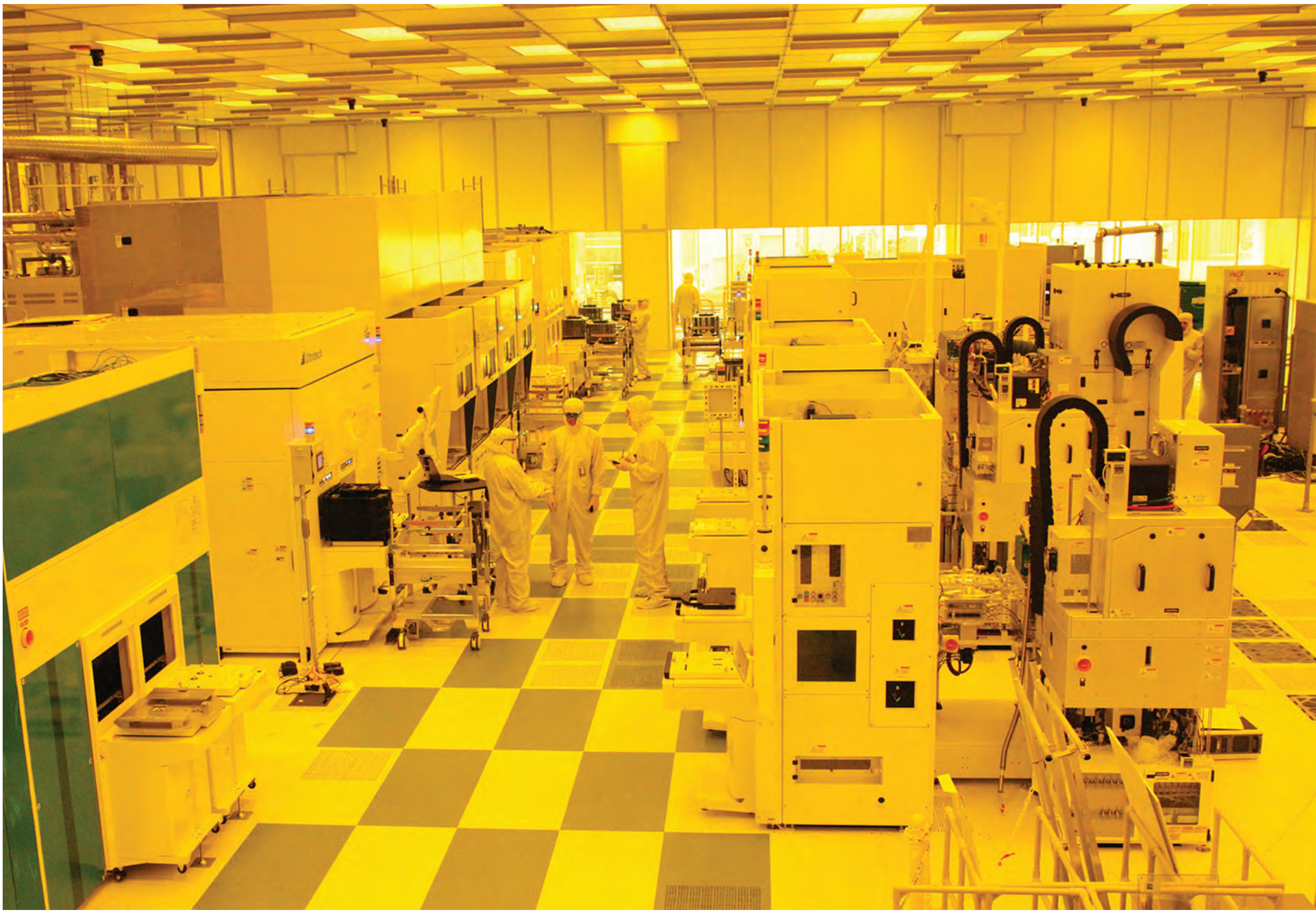
A Cooperation between different companies and suppliers will reduce risks of major manufacturers when the first 450 mm fabs are built. It's a business decision to join the F450C or G450C (depending on the company's function) and less risk typically garners more participation from the industry.

Q Consolidation remains an industry reality. At the same time some medium-sized fabs are becoming 'Mega Fabs'—all are still using 300 mm. Does consolidation paired with fab expansion underscore the need for 450 mm?

A A company's market forecast and need for cost-effective manufacturing capacity expansion will drive the decision on when to build a 450 mm fab to meet market demand. 300 mm fabs continue to be built around the world, and many of them are 450 mm capable, so the industry is indicating it's prepared to convert when the supply chain is ready to deliver.

Q Can you summarize the general feeling of the consortium's members with regard to 450 mm and the technical achievements we've seen so far?

A The consortium is working collaboratively, and the developments we have already achieved in power management, wafer handling, waste containment, green mode and many



(From our SEMICON West Panel - (from Right to left) moderated by F450C Program Manager Todd Fosler, and consisted of five panelists: David Skilbred, Director of Program Coordination/Management, G450C.

more are not just for 450 mm, but will be applied in existing 300 mm fabs and other size fabs as well.

Overall, the companies involved with both consortiums see the value in investing in R&D for this technology, much of which can be applicable to today's technology. Our members are working to enable the transition to the 450 mm wafer, in line with G450C members so that the transition is as smooth as possible for the entire industry.

Q Please explain what the consortium feels should be known about itself, its charter or operation. How do the G450C and F450C groups work together?

A The structure of the F450C and G450C creates an environment where we are working on early facilities technologies that will enable the introduction of 450 mm into HVM. We have an increased focus on facility and process sustainability and affordability and we have an opportunity through our collaboration at CNSE to advance the combined learnings of the consortia's membership into the 450 mm transition.

In my first couple of months as program manager I have witnessed the collaborative atmosphere of G450C, F450C and SULY Poly CNSE. To this point, there hasn't been a ton of surprises but there has been a staggering amount of information shared between each of the players that help in setting industry standards. Our members mostly work in subgroups that focus on a particular part of the 450 mm wafer manufacturing process. The research that is developed as part of the subgroups is then shared amongst the rest of the consortium members and, if relevant, with the G450C and SULY Poly CNSE.

Killer consumables:

How clean are your seals?

In semiconductor manufacturing the threat of particle and especially metallic contamination to transistor integrity is a significant and potentially costly threat. This is mainly true for front end processing but, due to the high mobility of many of these contaminants, it remains a threat at all stages of the manufacturing process flow.

KNUT BEEKMANN, MARKET MANAGER FOR SEMICON, PRECISION POLYMER ENGINEERING (PPE)

WHEN WORKING at the nano-scale of chip production, even the lowest trace metal levels have the capacity to alter the electrical characteristics of the device and/or affect the reliability of the end product.

Background

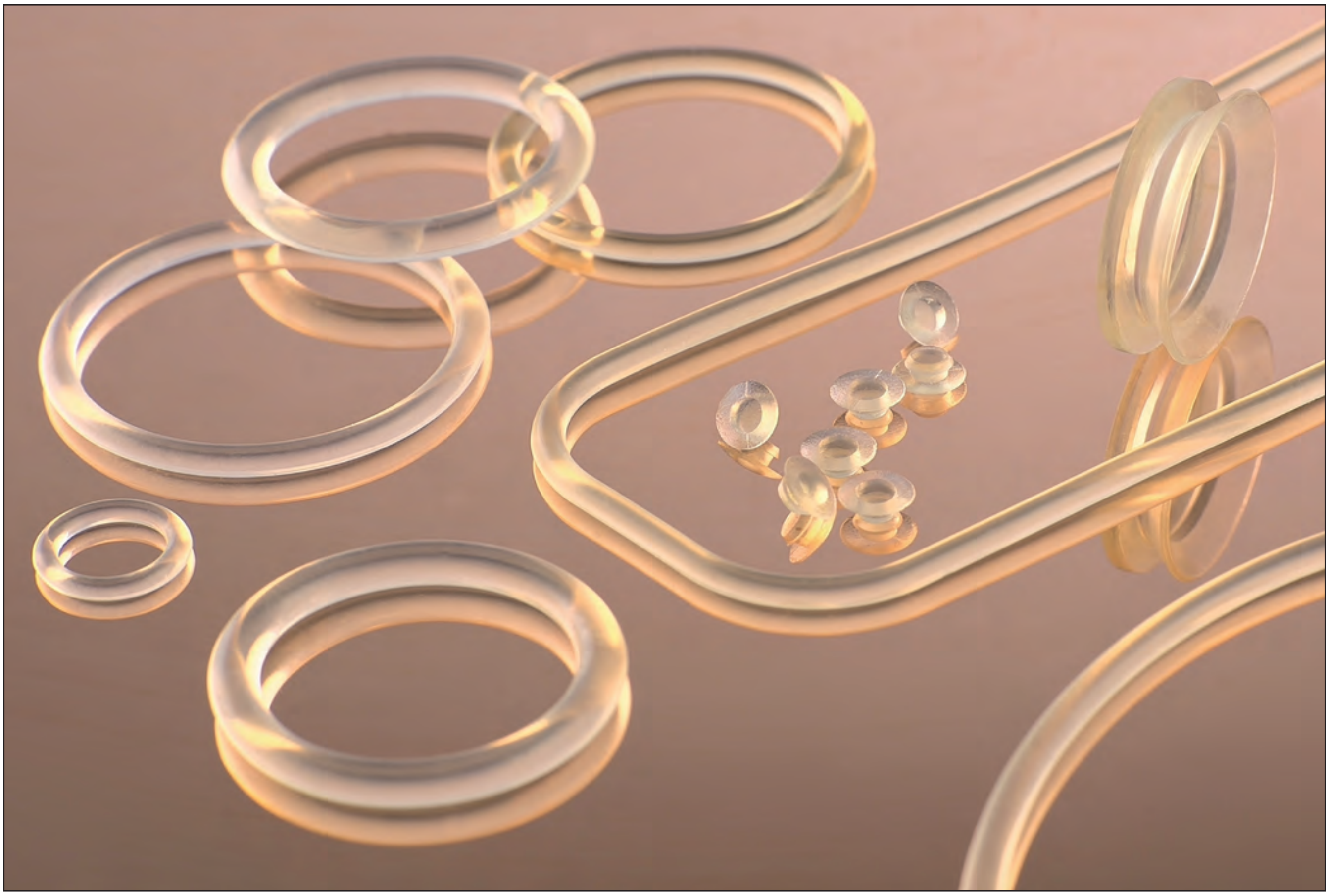
During routine operation, many components within the process tools and ancillary equipment will be subject to wear and abrasion, particularly those components within the process module that are directly exposed to harsh physical and chemical environments. The most critical locations are those where components are exposed to such environments and in proximity to the substrate being processed.

An equipment consumable item that can sometimes be overlooked is the elastomer seal or O-ring material. These seals have a certain lifetime proportional to the mechanical and chemical properties of the material and the physical constraints of the groove and location. Whilst an elastomer in a critical location may not actually determine the maintenance cycle of the process tool, byproducts and elastomer constituents will be released into the process environment during active operation. It's therefore clear that whatever is in the elastomer can contaminate the wafer and this applies equally to the trace metal content of the elastomer.

Trace metal contaminants fall broadly into two categories. Alkali metals which include elements such as sodium (Na), potassium (K) and lithium (Li) and heavy metals which include elements such as copper (Cu), iron (Fe), zinc (Zn), titanium (Ti) and chromium (Cr). The effects on the device of such contaminants vary depending on the type of the element. Sodium for example, can readily lose its outer electron to form an ion with charge +1. It can then readily diffuse through the oxide under the influence of an electric field even at room temperature, however; it cannot penetrate the silicon lattice which means that a charge can accumulate at the silicon/silicon dioxide interface. This in turn leads to unpredictable voltage threshold shifts and correspondingly random digital outputs from logic circuits.

Additional failure mechanisms include current leakage through the dielectric and reduced dielectric breakdown voltage, degradation of time dependent dielectric breakdown (TDDB), or complete breakdown of the gate[1].

Gettering layers are also no guarantee of eliminating the issue. PSG and BPSG layers are often used to getter sodium ions however; the presence of moisture either through integral process steps or atmospheric absorption can facilitate the release of trapped mobile ions in the getter[2]. Rather than accumulate at the semiconductor interface, heavy metals tend to diffuse through the semiconductor, where they effectively create energy states in the bandgap of the semiconductor causing changes in carrier lifetime or the diffusion length[3].



Consumer demands for faster, more powerful and portable technology with greater functionality is a key factor in driving the semiconductor manufacturing industry. Although the part of Moore's law that refers to shrinking technology remains largely intact, the pressure on cost reduction is rising throughout the whole value chain[4]. Reduced device dimensions and gate thickness leads to devices that become more sensitive to a number of factors including trace metal contamination.

It's clear that such contamination leads to unstable device performance, yield loss, device degradation with increased risk of reliability failures, potentially costing the fab in lost time, loss of revenue and wafer production capacity.

Purity in elastomers

When choosing elastomer materials for seals in process tools, manufacturers must decide on the appropriate material in accordance with the location in the tool and the chemistry involved. Critical locations where the elastomer is in contact with the chemistry or process media, where degradation takes place, and where the byproducts of this degradation can be transported to the wafer, require the highest quality seal material in order to avoid contaminating the device. The sealing product must precisely fit the characteristics of the operating equipment. Specialist sealing companies have significant experience and expertise in developing and customising elastomer seals and O-rings for use in semiconductor applications. There is often a large choice of products for any one particular application and "semiconductor compatibility" is often taken for granted especially in critical applications however; not all elastomer

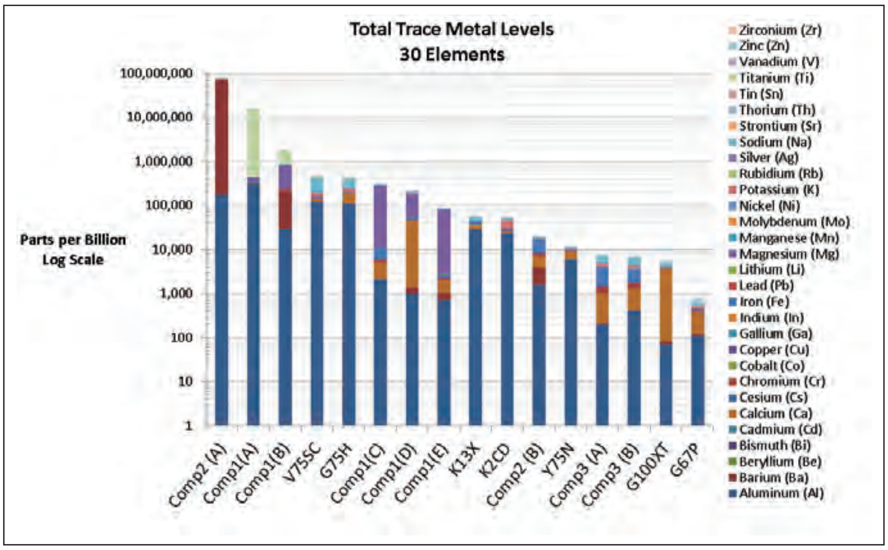


Figure 1. Comparative VPD ICPMS testing of elastomer materials

Figure 2. G67P trace metal content

Figure 3. G100XT trace metal content

materials are equal when it comes to the level of undesirable contaminants.

For many device applications, it is no longer adequate to measure contamination at the parts per million level. When analysing trace metal levels in elastomer materials, vapor phase decomposition (VPD) combined with inductively coupled plasma mass spectrometry (ICPMS) yields data down to parts per billion[5]. A number of different elastomer materials have been analysed by an independent test laboratory in order to quantitatively determine the amount of trace metal within each sample.

The materials analysed include the leading elastomer brands and the results are graphically represented in Figure 1. It should be particularly noted that In order to accommodate all the samples tested, a log scale was used. The results show that the elastomers that achieved the lowest trace metal content of all materials tested were entirely organic perfluoroelastomers or FFKMs with two Perlast® grades having the lowest levels and G67P in particular showing a factor 7 improvement over the next best grade. The cleanest fluoroelastomer or FKM material was found to be Nanofluor Y75N, again a fully organic highly fluorinated elastomer. Figures 2. and 3. above Illustrate the individual levels for several of the key contaminants that should be avoided for two of the cleanest materials tested.

Conclusion

During wafer processing, the inevitability of elastomer or seal wear in key tool locations during normal operation will expose the wafer to the degradation byproducts of the elastomer material, and therefore also the impurities contained within the elastomer. It becomes clear therefore, that the lifetime is not the only factor that should be considered when making elastomer choices for specific applications. FFKM elastomers are particularly suited to the most critical applications, and the harsh environments presented by higher temperatures, aggressive wet chemical and plasma processes. The more aggressive the environment and the more sensitive the device, the greater is the need to consider the degradation byproducts of the system components.

Use of high purity components becomes a preventative measure, guarding against costly transistor damage or increased risk of poor reliability. Contamination ultimately results in loss of yield, increased cost, or loss of reputation. Elastomer materials that contain only ultra-low levels of metallic contaminants are ideal for manufacturers of devices at advanced technology nodes and include all fabs wishing to minimise the risk of random changes to electrical characteristics and reliability failures.

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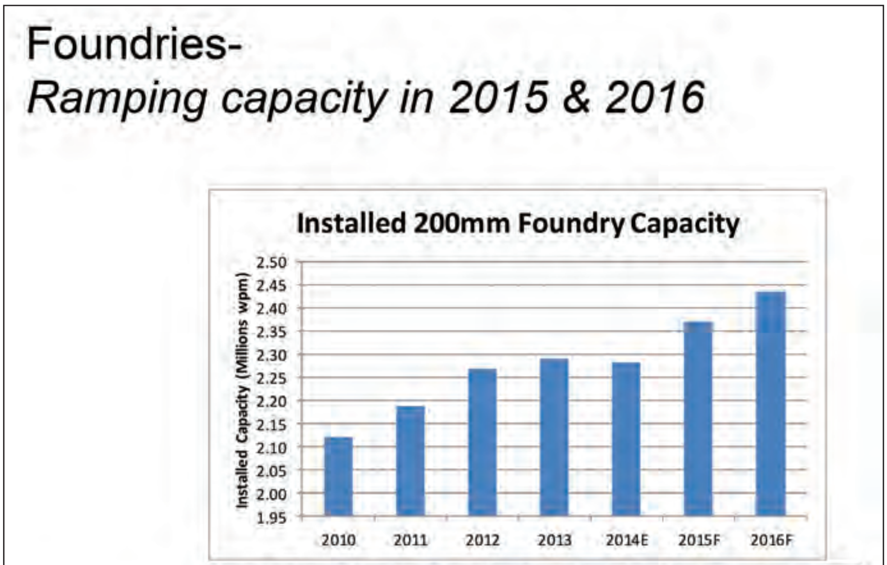
Sourcing refurbished
semiconductor equipment

Erik Hanson, Refurbished Products Manager, Cascade Microtech, Inc tells Silicon Semiconductor why going straight to the OEM for refurbished equipment reduces both the risk and cost.

WHILE ADVANCED node device manufacturing has transitioned to 300 mm equipment and the industry anticipates the transition – someday – to 450 mm, a quiet renaissance is taking place in the 200 mm equipment market. The Trillion Sensors initiative and the Internet of Things (IoT) are breathing new life into 200 mm fabs, especially in analog chips, power management devices, image sensors, and new emerging applications in biomedical, MEMS, and other areas. As many of these devices (destined for consumer markets) are based on mature technologies, there are significant advantages to outfitting 200 mm fabs with certified used test and measurement equipment that has been either refurbished or remanufactured, rather than purchasing new 200 mm equipment.

There are three main options for purchasing refurbished equipment:
1. Open market
2. Third-party vendor
3. Original equipment manufacturer (OEM)

Each option has its advantages and disadvantages. In this article, we will look at the market for refurbished semiconductor equipment, examining the three procurement options. Finally, through a brief case study, the best approach will be presented.



	2010	2011	2012	2013	2014E	2015F	2016F
Foundry only- 200mm	2.12	2.19	2.27	2.29	2.28	2.37	2.43

Figure 1. Chart from SEMI Secondary Equipment Market and Trends, February 2015
200 mm fab capacity is on the rise, led by foundries that are increasing 200 mm capacity by about 7 percent through to 2016, compared with 2012 levels. This is driven by new applications related to mobility, sensing, and IoT.

200 mm semiconductor fabrication capacity is on the rise

In January 2015, SEMI published its latest Secondary Fab Equipment Report to determine the market size and identify key trends and issues impacting this important industry segment. [FIG.1]

According to the report, 150 mm and 200 mm fab capacities represent approximately 40 percent of the total installed fab capacity in the world. Additionally, 200 mm fab capacity is on the rise, led by foundries that are increasing 200 mm capacity by about 7 percent through to 2016 compared with 2012 levels. This is driven by new applications related to mobility, sensing, and IoT. For 2014, 200 mm fab investments by leading foundries and independent device manufacturers (IDM) resulted in a 45 percent increase in spending for secondary 200 mm equipment.

While SEMI did not include test equipment and assembly and packaging equipment in this report, it's safe to assume that the ratio of used test equipment versus total used equipment sales is the same as the ratio of new test equipment versus new equipment sales. This gives us an indication of the volume of devices that are being fabricated at 200 mm, which will ultimately require 200 mm test equipment to characterize these devices quickly, at low cost, with minimal setup, and in parallel.

Despite the growing demand for capacity at 200 mm, the global economic climate and new production strategies have led to the consolidation of many semiconductor manufacturing companies, as well as the closing of many 200 mm fabs. This has contributed to an estimated 6,000 used tools now on the global market in various states of repair. Many of the tools on the market are incomplete, harvested for spare parts, and/or improperly maintained.

The majority of used equipment today is between 7-13 years old. Much of it has not been properly decommissioned and decontaminated, presenting further legal, environmental, and health risks for purchasers, shipping companies, installation and operations personnel. Clearly, the risk accompanying used equipment has increased exponentially. It is more critical than ever that purchasing agents apply their full due diligence to mitigate that risk.

Figure 2. Of the three procurement options for refurbished equipment, original equipment manufacturers are the logical choice to reduce risk and improve overall cost of ownership.

Why buy refurbished?

A number of factors come in to play when deciding where to spend equipment dollars. To remain competitive among the low-cost producers, legacy fab managers need to balance tight process and time-to-market budgets. In fact, according to a SEMI survey of top 200 mm fab managers, secondary equipment will be the number one source for future productivity improvements.

As major OEMs have shifted efforts to 300 mm and in some cases 450 mm, they have mothballed 200 mm tooling. Used 200 mm equipment that has been refurbished or remanufactured to meet new device requirements can be a very desirable way to upgrade legacy fabs while remaining competitive in the market.

Sourcing options and scenarios

Buying test equipment on the secondary market can be compared with purchasing a used car. It all comes down to buyer expectations and their willingness to take risks. Options range from eBay or other online resellers, used car dealers, or through a certified pre-owned program at new car dealership. This logic can be applied to the secondary equipment market as follows. [FIG.2]

The open market option

Purchasing used equipment on the open market through an online broker or an auction website is like buying a used car online. Generally, the ones who benefit the most from this option are mechanically inclined, and can handle the inevitable repairs. Many are engineers with years of experience using these systems. They are comfortable taking the risk on an "as-is" system. In these cases, the purchase is based purely on price, which is typically the lowest initial purchase price available. The only other clear advantage of purchasing used equipment through the open market is the equipment's availability for immediate pick up. However, it may be sitting in the previous owner's lab, or a reseller's warehouse.

The disadvantages far outweigh the advantages. There is no guarantee of the tool's functionality, or whether it will be suited to the customer's application. As-is means there are no software updates, and in all likelihood, electronics hardware is outdated. The customer has to arrange pick-up logistics including installation, and assume additional costs including packaging, freight, and import/export logistics and fees. The most a customer can hope for in the way of a warranty is a 14-day money-back guarantee. Essentially, the customer is on his/her own. They may rely on the OEM service provider to get a system up and running, and to obtain spare parts and service. This is, of course, not included in the purchase price. All things considered, it adds considerably to the total cost of ownership.

Third-party vendors

Slightly less risky than purchasing used test equipment on the open market is to purchase it through a third-party vendor. This can be compared with purchasing a used car from a used car dealership. Third-party equipment vendors frequently contract with former field service engineers of the OEMs whose tools they sell. These engineers install the equipment, put it through diagnostics, and make sure it's operational.

One advantage third-party vendors have is the ability to reconfigure an existing tool because they often purchase equipment in lots that include several stations complete with assembly parts and accessories. This allows them to swap out accessories sold with a probe station to cater toward a DC application or an RF application based on the customer's requirements. These third-party companies advertise they can guarantee some level of performance, but they typically don't employ

Figure 3. A refurbished Cascade Microtech SUMMIT™ semi-automated probe station with an eVue™ Digital Imaging System is a reliable, robust solution for today's 200 mm test and measurement requirements.

professionally certified installation and service experts. While they may have a certain level of experience working on tools, it is not necessarily with equipment from the specific OEM in question. With regard to warranty for purchase, the longest standard third-party warranty on the market is 90 days, and additional warranties for service and parts need to be considered as part of the tool's overall costs.

Online purchasing won't save you money

Take for example this actual situation of a purchase made from an online marketplace for a used wafer probe station originally manufactured by Cascade Microtech, a supplier of wafer probe equipment to the semiconductor test market.

The tool was sold by an online merchant for $25,000. The customer, a high-end semiconductor device designer and manufacturer, was looking for a tool for their Failure Analysis group. The tool was non-functional when it arrived at the customer site, so the customer spent an additional $2,500 with a third-party service provider to get the system up and running. Unable to successfully get the system running properly, they contacted the OEM – Cascade Microtech – who provided updated control hardware and software, as well as other components to replace those that were not well maintained by the previous equipment owner. After paying an additional $15,000 for necessary parts and service, the system was restored to full functionality. At the end of the day, the total out-of-pocket cost for the tool was $42,500.

Had the customer gone directly to the OEM (Cascade Microtech), the required replacement parts would be included as part of the standard certified refurbishment process. The price for a similarly equipped certified used system purchased directly from Cascade Microtech would have been approximately $32,000, and would include the company's standard warranty. The customer actually spent $10,500 more than if they had gone directly to the OEM, and could have avoided the headaches incurred. Additionally, the customer lost opportunities, time, and revenue while the tool was not operational.

The OEM advantage

Many semiconductor OEMs sell used systems that are fully factory refurbished. Parts that wear out are replaced, and the latest compatible control electronics and software are added. Each piece of equipment is fully tested and must pass the same functional specifications it did when it originally shipped as new. Professional packaging, transportation, and installation ensure equipment functionality at the customer site, not just the manufacturing facility. The tool comes with a standard warranty similar to the warranty provided with new equipment. The systems are certified-used and eligible for service contracts, and are serviceable by the OEM's field service engineers. [FIG.3]

The OEM will either use the same sales channel and sales process as with its new equipment, or it will have a separate selling organization for used equipment. Used equipment in stock is sold on a first-come, first-served basis, and is delivered in about half the time of new equipment. In many cases, the OEM is actively seeking used equipment and can pay cash or provide credit for returned equipment toward future products or services.

Go to the source

It's clear from this brief example that going straight to the OEM for refurbished equipment reduces both the risk and cost in comparison with the open market or third-party vendors. While the initial purchase price may be slightly higher than other options, the quality and support are superior, and overall cost of ownership is far less.

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Building the electron superhighway

Scientists invent new approach in quest for flexible electronics.

SCIENTISTS have invented a new way to view and create what they are calling 'an electron superhighway' in an organic semiconductor. This approach promises to allow electrons to flow faster and farther -- aiding the hunt for flexible electronics, organic solar cells, and other low-cost alternatives to silicon.

TV screens that roll up. Roofing tiles that double as solar panels. Sun-powered cell phone chargers woven into the fabric of backpacks. A new generation of organic semiconductors may allow these kinds of flexible electronics to be manufactured at low cost, says University of Vermont physicist and materials scientist Madalina Furis.

But the basic science of how to get electrons to move quickly and easily in these organic materials remains murky.
To help, Furis and a team of UVM materials scientists have invented a new way to create what they are calling "an electron superhighway" in one of these materials -- a low-cost blue dye called phthalocyanine -- that promises to allow electrons to flow faster and farther in organic semiconductors.

Their discovery, reported Sept. 14 in the journal Nature Communications, will aid in the hunt for alternatives to traditional silicon-based electronics.

Hills and potholes

Many of these types of flexible electronic devices will rely on thin films of organic materials that catch sunlight and convert the light into electric current using excited states in the material called "excitons." Roughly speaking, an exciton is a displaced electron bound together with the hole it left behind. Increasing the distance these excitons can diffuse -- before they reach a juncture where they're broken apart to produce electrical current -- is essential to improving the efficiency of organic semiconductors.

Using a new imaging technique, the UVM team was able to observe nanoscale defects and boundaries in the crystal grains in the thin films of phthalocyanine -- roadblocks in the electron highway. "We have discovered that we have hills that electrons

have to go over and potholes that they need to avoid," Furis explains. To find these defects, the UVM team -- with support from the National Science Foundation -- built a scanning laser microscope, "as big as a table" Furis says. The instrument combines a specialized form of linearly polarized light and photoluminescence to optically probe the molecular structure of the phthalocyanine crystals.

"Marrying these two techniques together is new; it's never been reported anywhere," says Lane Manning '08 a doctoral student in Furis' lab and co-author on the new study.

The new technique allows the scientists a deeper understanding of how the arrangement of molecules and the boundaries in the crystals influence the movement of excitons. It's these boundaries that form a "barrier for exciton diffusion," the team writes.

And then, with this enhanced view, "this energy barrier can be entirely eliminated," the team writes. The trick: very carefully controlling how the thin films are deposited. Using a novel "pen-writing" technique with a hollow capillary, the team worked in the lab of UVM physics and materials science professor Randy Headrick to successfully form films with jumbo-sized crystal grains and "small angle boundaries." Think of these as easy-on ramps onto a highway -- instead of an awkward stop sign at the top of a hill -- that allow excitons to move far and fast.

Better solar cells

Though the Nature Communications study focused on just one organic material, phthalocyanine, the new research provides a powerful way to explore many other types of organic materials, too -- with particular promise for improved solar cells. A recent U.S. Department of Energy report identified one of the fundamental bottlenecks to improved solar power technologies as "determining the mechanisms by which the absorbed energy (exciton) migrates through the system prior to splitting into charges that are converted to electricity."

The new UVM study -- led by two of Furis' students, Zhenwen Pan G'12, and Naveen Rawat G'15 -- opens a window to view how increasing "long-range order" in the organic semiconductor films is a key mechanism that allows excitons to migrate farther. "The molecules are stacked like dishes in a dish rack," Furis explains, "these stacked molecules -- this dish rack -- is the electron superhighway."

Though excitons are neutrally charged -- and can't be pushed by voltage like the electrons flowing in a light bulb -- they can, in a sense, bounce from one of these tightly stacked molecules to the next. This allows organic thin films to carry energy along this molecular highway with relative ease, though no net electrical charge is transported.

"One of today's big challenges is how to make better photovoltaics and solar technologies," says Furis, who directs UVM's program in materials science, "and to do that we need a deeper understanding of exciton diffusion. That's what this research is about."

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Silicon nanoparticle is a new candidate for an ultrafast all-optical transistor

Physicists have experimentally demonstrated the feasibility of designing an optical analog of a transistor based on a single silicon nanoparticle.

PHYSICISTS from the Department of Nanophotonics and Metamaterials at ITMO University have experimentally demonstrated the feasibility of designing an optical analog of a transistor based on a single silicon nanoparticle. Because transistors are some of the most fundamental components of computing circuits, the results of the study have crucial importance for the development of optical computers, where transistors must be very small and ultrafast at the same time. The study was published in the scientific journal Nano Letters.

The performance of modern computers, which use electrons as signal carriers, is largely limited by the time needed to trigger the transistor -- usually around 0.1 -- 1 nanoseconds (1/1,000,000,000 of a second). Next-generation optical computers, however, rely on photons to carry the useful signal, which heavily increases the amount of information passing through the transistor per second.

For this reason, the creation of an ultrafast and compact all-optical transistor is considered to be instrumental in the development of optical computing. Such a nanodevice would enable scientists to control the propagation of an optical signal beam by means of an external control beam within several picoseconds (1/1,000,000,000,000 of a second).

In the study, a group of Russian scientists from ITMO University, Lebedev Physical Institute and Academic University in Saint Petersburg put forward a completely new approach to design such optical transistors, having made a prototype using only one silicon nanoparticle.

The scientists found that they can dramatically change the properties of a silicon nanoparticle by irradiating it with intense and ultrashort laser pulse. The laser thus acts as a control beam, providing ultrafast photoexcitation of dense and rapidly recombining electron-hole plasma whose presence changes the dielectric permittivity of silicon for a few picoseconds.

This abrupt change in the optical properties of the nanoparticle opens the possibility to control the direction, in which incident light is scattered. For instance, the direction of nanoparticle scattering can be changed from backward to forward on picoseconds timescale, depending on the intensity of the incident control laser pulse. This concept of ultrafast switching is very promising for designing of all-optical transistor.

"Generally, researchers in this field are focused on designing nanoscale all-optical transistors by means of controlling the absorption of nanoparticles, which, in essence, is entirely logical. In high absorption mode, the light signal is absorbed by the nanoparticle and cannot pass through, while out of this mode the light is allowed to propagate past the nanoparticle.

However, this method did not yield any decisive results," explains Sergey Makarov, lead author of the study and senior researcher at the Department of Nanophotonics and Metamaterials. "Our idea is different in the sense that we control not the absorption properties of the nanoparticle, but rather its scattering diagram. Let's say, the nanoparticle normally scatters almost all incident light in the backward direction, but once we irradiate it by a control pulse, it becomes reconfigured and starts scattering light forward."

The choice of silicon as a material for the optical transistor was not accidental. Creating an optical transistor requires the use of inexpensive materials appropriate for mass production and capable of changing their optical properties in several picoseconds (in the regime of dense electron-hole plasma) without getting overheated at the same time. "The time it takes us to deactivate our nanoparticle amounts to just several picoseconds, while to activate it we need no more than tens of femtoseconds (1/1,000,000,000,000,000). Now we already have experimental data that clearly indicates that a single silicon nanoparticle can indeed play the role of an all-optical transistor. Currently we are planning to conduct new experiments, where, along with a laser control beam, we will introduce a useful signal beam," concludes Pavel Belov, coauthor of the paper and head of the Department of Nanophotonics and Metamaterials.

Journal Reference:
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First realization of an electric circuit with a magnetic insulator using spin waves

Researchers have found that it is possible to make an electric circuit with a magnetic insulator.

RESEARCHERS at the University of Groningen, Utrecht University, the Université de Bretagne Occidentale and the FOM Foundation have found that it is possible to make an electric circuit with a magnetic insulator. This was first deemed impossible. The circuit is realized using spin waves: wave-like perturbations in the magnetic properties of a material. Their discovery is interesting for the development of novel, energy-efficient electronic devices, particularly integrated circuits. A device based on spin waves could theoretically operate more efficiently than ordinary electronic circuits. The results of their research will be published online in Nature Physics on Monday 14 September.

In our current electronic equipment, information is transported via the motion of electrons. In this scheme, the charge of the electron is used to transmit a signal. In a magnetic insulator, a spin wave is used instead. Spin is a magnetic property of an electron. A spin wave is caused by a perturbation of the local magnetisation direction in a magnetic material. Such a perturbation is caused by an electron with an opposite spin, relative to the magnetisation. Spin waves transmit these perturbations in the material. This research demonstrates for the first time that it is possible to transmit electric signals in an insulating material.

Strong perturbation

So far, electrical circuits based on spin waves have not been realised, since it turned out to be impossible to introduce a perturbation in the system large enough to create spin waves. FOM workgroup leader prof.dr. Bart van Wees and his PhD student Ludo Cornelissen, both from the University of Groningen and FOM workgroup leader Dr. Rembert Duine from Utrecht University have succeeded to use spin waves in an electric circuit by carefully designing the device geometry. This allows them to make use of the spin waves that are already present in the material due to thermal fluctuations, which requires a much smaller disturbance of the system and hence enables the spin waves to be used in an electric circuit.

The spin wave circuit that the researchers built, consists of a 200 nanometre thin layer of yttrium iron garnet (a mineral and magnetic insulator, YIG in short), with a conducting platinum strip on top of that on both sides. An electron can flow through the platinum, but not in the YIG since it is an insulator. However, if the electron collides on the interface between YIG and platinum, this influences the magnetisation at the YIG surface and the electron spin is transferred. This causes a local magnetisation direction, generating a spin wave in the YIG.

Spin wave detection

The spin waves that the researchers send into the YIG are detected by the platinum strip on the other side of the YIG. The detection process is exactly opposite to the spin wave injection: a spin wave collides at the interface between YIG and platinum, and transfers its spin to an electron in the platinum. This influences the motion of the electron, resulting in an electric current that the researchers can measure. The researchers already studied the combination of platinum and YIG in previous research.

From this research it was found that when spin is transferred from platinum to YIG, this also implies the transfer of heat across the interface. This enables the heating or cooling of the platinum-YIG interface, depending on the relative orientation of the electron spins in the platinum and the magnetisation in the YIG.

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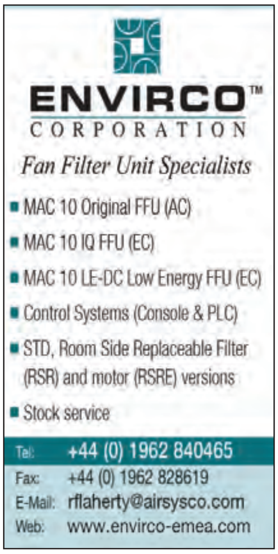

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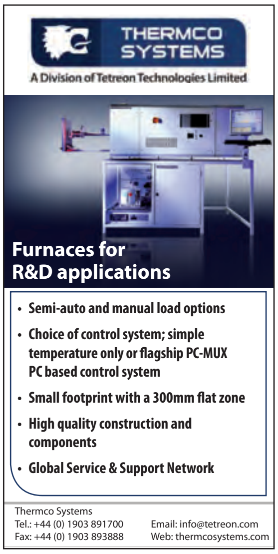

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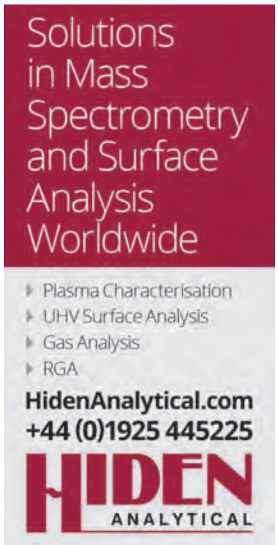

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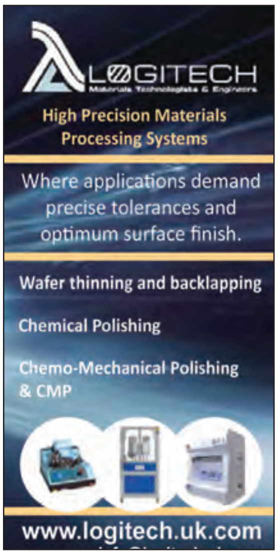

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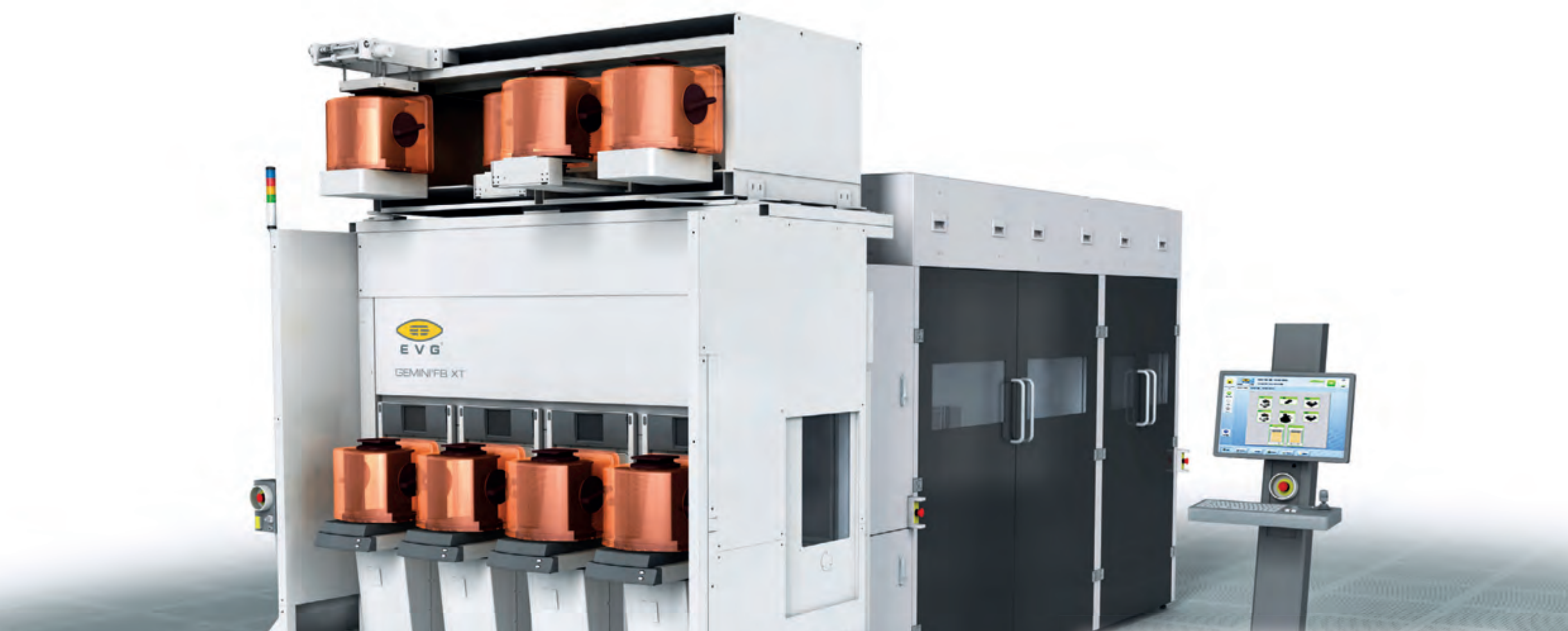

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