euroasia semiconductor

www.euroasiasemiconductor.com

Technology leaves its mark

Emerging opportunities from pervasive growth

An Angel Business Communications publication

Entangled industry

Safe material handling

Organic growth

editor's word

Editor-in-Chief David Ridsdale
+44 (0)1923 690210 dr@angelbcl.co.uk

Director of SOLAR & IC Publishing
Jackie Cannon
+44 (0)1923 690205 jc@angelbcl.co.uk

Account Manager
Shehzad Munshi
+44 (0)1923 690215 sm@angelbcl.co.uk

Sales Executive
Martin Jennings
+44 (0)1923 690222 mj@angelbcl.co.uk

Director of Logistics
Sharon Cowley
+44 (0)1923 690200 sc@angelbcl.co.uk

Design & Production Manager
Mitchell Gaynor
+44 (0)1923 690214 mg@angelbcl.co.uk

Subscriptions Manager
Debbie Higham
+44 (0)1923 690220 dh@angelbcl.co.uk

USA Representatives:
Tom Brun, Tom Brun Media,
T: 724 539-2404, E: tbrun@brunmedia.com
Janice Jenkins, Tom Brun Media.
T: 724 929-3550, E: jjenkins@brunmedia.com
Japan Representative:
Katsuhiro Ishii, ACE MEDIA SERVICE INC.,
T: 81-3-5691-3335, E: amskatsu@dream.com
China Representative:
Parker XU, Unionbandy Limited,
T: 86-755-83753881, E: xp@unionbandy.net

Directors:
Bill Dunlop Uprichard – CEO
Stephen Whitehurst – COO
Jan Smoothy – CFO
Haroon Malik, Jackie Cannon, Scott Adams,
Sharon Cowley, Sukhi Bhadal

Published by
Angel Business Communications Ltd Hannay House,
39 Clarendon Road, Watford, Herts WD17 1JA, UK
T: +44 (0)1923 690200
F: +44 (0)1923 690201
E: euroasia@angelbcl.co.uk

Angel Business Communications Ltd
Unit 6, Bow Court, Fletchworth Gate, Burnsall Road,
Coventry CV5 6SP
T: +44 (0)2476 718 970
F: +44 (0)2476 718 971
E: info@angelbc.co.uk

EuroAsia Semiconductor is published four times a year on a controlled circulation basis. Non-qualifying individuals can subscribe at:
£105.00/€158 pa (UK & Europe), £138.00 pa (air mail), $198 pa (USA). Cover price £4.50.

Printed by: Pensord Press.
ISSN 1751-1135(Print)
ISSN 2041-1383(Online)

EuroAsia Semiconductor is a Corporate Member of SEMI

Emerging opportunities despite consolidation

The semiconductor industry has focused strongly on the progression of Moore's Law ever since Gordon Moore proposed the trajectory of innovation that the industry has pushed the boundaries of known physics to keep up with. While it is a fascinating exercise to watch the innovative leaps made in order to keep up with Mr. Moore's supposition, it is only the bleeding edge of semiconductor manufacturing that maintains Moore's pace.

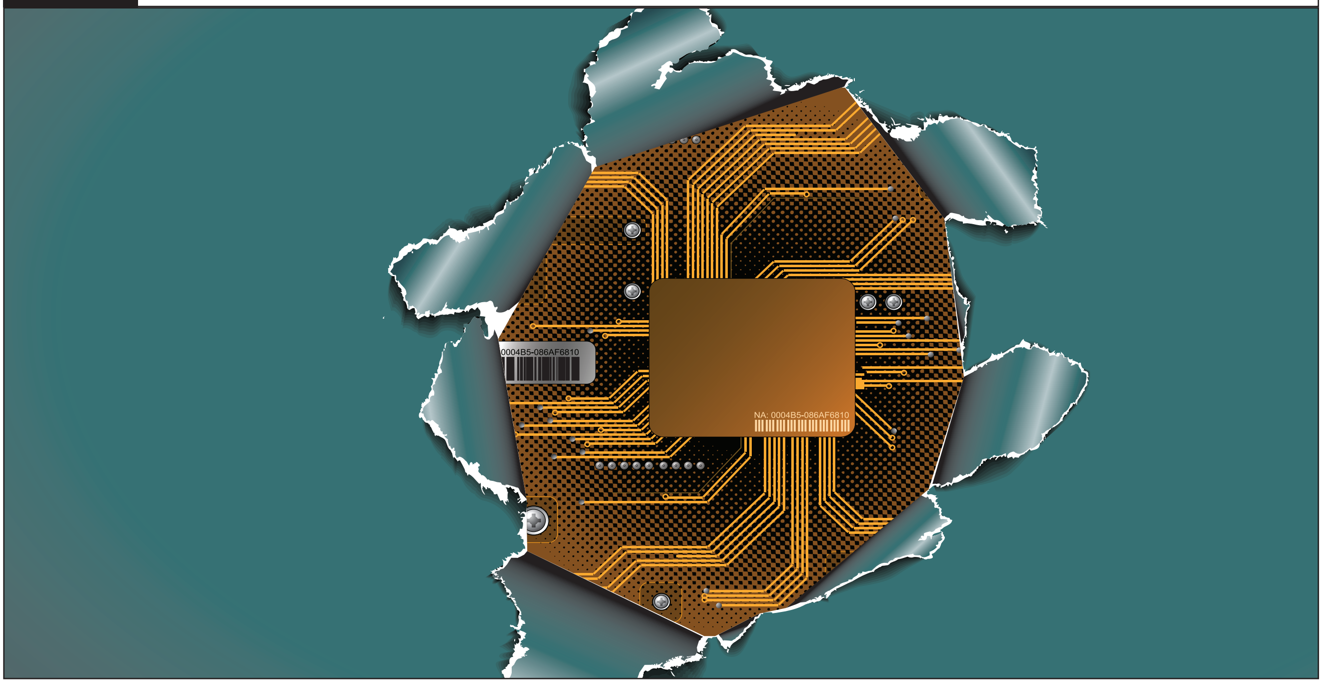
I have no doubt that similar projections could be made for other segments of the industry but the heady technology focus is at the top end. For a number of years I have thought this provided a skewed view of the overall industry and opportunities and too often analysts rely on Moore's Law progression to make predicitons for the whole industry. The result is that many fail to recognise the emerging and existing opportunities within the industry that are not direclty tied to bleeding edge Moore's Law research. Solar manufacturing is a prime example. A number of OEM companies considered solar powerhouses were, only a few years ago semicondutor laggards. There is also the fact that the largest percentage of IC devices are not made at the cutting edge and a number of companies are making a success of focusing in these areas of expertise.

MEMS and nanotechnology are finally starting to reach volume levels and application reach to ensure the financial spotlight is starting to move that way. This will spur investment and growth in both areas. Research continues in a variety of areas looking at innovative ways to embed semcondutor circuitry within more types of substrates, materials and with application potential than ever before. Sometimes it is the market growth that provides opportunity. The medical application of microelectronics is tipped to grow expotentially and innovative ideas are being generated on a daily base. Much of this new and emerging technology and processes is manufactured on machinary that was developed in the semicondcutor sector. Sometimes on tools the industry had foregone provding new leases of life throughout the value chain.

Despite the continued consolidation that will continue in the mainstream semicondutor industry the opportunities are developing faster than many realise. The generalised approach of the financial community is undergoing change as the emerging opportunities arise

David Ridsdale
Editor-in-Chief

contents



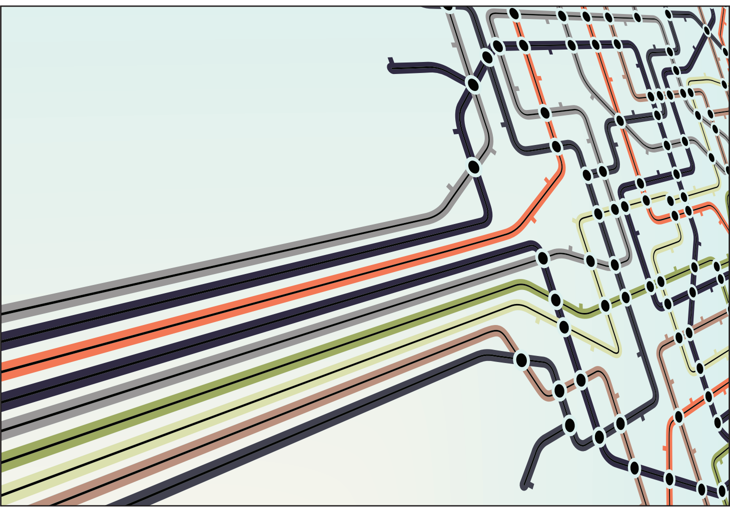
INSIDE EUROASIA

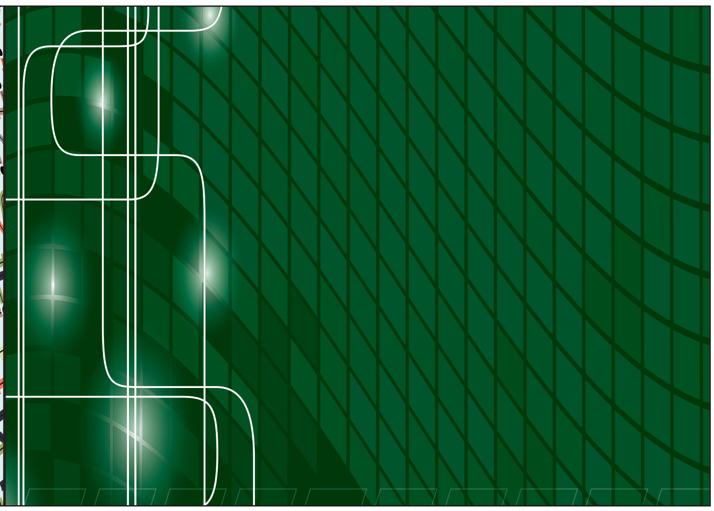
Recognising Innovation

Rewarding Motivation

IC Industry Awards 2011

Front Cover designed by Mitchell Gaynor





Industry exceeds emissions targets

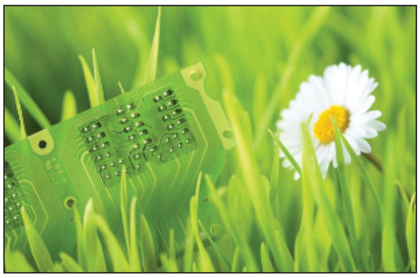
THE SEMICONDUCTOR INDUSTRY ASSOCIATION (SIA) announced that the worldwide semiconductor industry has exceeded its initial 10 percent reduction goal for perfluorocompounds (PFCs) emissions, bringing total PFCs emissions down by 32 percent over a ten-year period. Additionally, the industry has set a new ten-year goal to implement state-of-the-art practices at all new semiconductor fabrication facilities, operated by members of the WSC, which is expected to result in a 30 percent reduction in normalized emissions by 2020.

The WSC is an organization with representatives from the semiconductor industries in Chinese-Taipei, Europe, Japan, Korea, the United States and the newest member, China, joining in 2007. The WSC meets annually to address issues of global concern to the semiconductor industry and to expand international cooperation in the semiconductor sector.

"This accomplishment is the result of industry wide commitment to environmental stewardship," said Ray Stata, chairman of the board, Semiconductor Industry Association and founder & chairman of the board, Analog Devices, Inc. "Each member company within the WSC associations has made environmental protection a key tenet of long-term strategy and continues to make significant investments to ensure that our valuable natural resources are protected."

PFCs are a group of greenhouse gases (GHGs) that are essential to the semiconductor manufacturing process. To achieve critical GHG emissions reductions, WSC members developed new manufacturing techniques, optimized processes to use PFCs more efficiently and applied point-of-use abatement devices. Further, the industry has eliminated all non-essential uses of perfluorooctylsulfonate (PFOS) which are used in the photolithographic process for imprinting circuitry on silicon wafers. These accomplishments solidify the industry's commitment to implement innovative solutions and voluntarily reduce emissions even while substantially increasing production output.

"The announcement that we have surpassed our ten-year goal, along with our commitment to further reductions over the next ten years, demonstrates the



continued leadership of the U.S. and global semiconductor industry on addressing climate change," said Brian Toohey, president, Semiconductor Industry Association.

Semiconductor industry emissions comprise approximately 0.12% of the total annual GHG emissions in the United States. The U.S. semiconductor industry has nonetheless made substantial investments to reduce PFC emissions. The global efforts through the WSC complement a collaborative partnership initiated in 1996 between the SIA and the U.S. EPA. The 2010 data shows that U.S. industry surpassed its goal, reducing emissions 31 percent below 1995 levels, successfully concluding the industry's commitments under the voluntary PFC Reduction/Climate Partnership for the Semiconductor Industry.

SPTS and Australia's Griffith University to develop SiC-on-silicon technology

SPP Process Technology Systems (SPTS), a manufacturer of plasma etch and deposition, and thermal processing equipment and Griffith University in Australia have signed a joint development agreement (JDA) targeting SiC-on-silicon technology. SiC-on-silicon substrates have a variety of applications for the growing LED, MEMS and power markets.

SiC is an important substrate for growing the GaN films used to manufacture LEDs. The increased radiation hardness, mechanical strength and thermal properties of SiC also make it a suitable replacement for silicon in MEMS devices for harsh environments. In addition, SiC is used to create semiconductor devices for high power, high frequency applications where the electrical properties of SiC are significantly superior to common silicon.

Technology created by the research team at Queensland Microtechnology Facility (QMF) at the Griffith University's Queensland Micro- and Nanotechnology Centre (QMNC), has demonstrated the ability to grow crystalline SiC directly onto low cost silicon wafers. Through the JDA, SPTS will develop the thermal process and equipment expertise necessary to commercialise the technology.

Three key technologies required for SiC-on-silicon devices are SiC deposition, etch and oxidation. The QMNC has commercially orientated research into all these areas to provide focus.

"The JDA enables transfer of this SiC deposition process technology to device research and development activities, and provides a bridge to volume production through batch processing for up to 300mm diameter Si wafers. SPTS's strength in thermal processing makes them an attractive partner," said Alan Iacopi, Operations Director of QMNC. "This JDA is an important step in the commercialization of our SiC research efforts, especially with a partner with the global reach of SPTS" agreed Sima Dimitrijev, Project Leader and Deputy Director of QMNC.

Edwards opens Korean factory

EDWARDS has opened a manufacturing facility in Korea to serve its Korean and other global customers. The UK Business Secretary, Vince Cable and Edwards CEO, Matthew Taylor, officially opened the site in the presence of the Governor of Chungchungnam-do; the Mayor of Cheonan; and HE Martin Uden, the British Ambassador, among others.

Edwards has invested approximately $100 million in its advanced manufacturing site which is not only a factory but also a technical centre, allowing more local technical applications support for our customers as well as development of product derivatives and the rapid introduction of new products. The facility will be an important hub for the company's growing range of high-quality dry vacuum pumps and systems for the most demanding of processes in the semiconductor, LCD, solar, LED and flat panel display markets and it boasts the latest manufacturing equipment to assure product quality, together with lean manufacturing techniques to reduce production times and a range of sophisticated energy saving features.

The new facility, which will have a manufacturing capacity in excess of 25,000 units per year, will employ 300 staff initially, growing to 400 by 2012. Edwards expects total employee numbers in Korea to be up to 700 in 2012. The Korean factory brings Edwards' total number of manufacturing sites around the world to seven, including sites in the UK, Czech Republic, and Japan. In addition, the company has 15 service centres worldwide. Edwards has been present in Asia for more than 40 years, and in Korea for 27 years. Nearly 60 percent of the group's revenue derives from customers located in Asia.

Sung-Min Lee, President of Edwards Korea said: "We are tremendously proud to be opening our new Cheonan site. Although Edwards has been in Korea for 27 years, this is a momentous occasion for the company and cements our position as an important business partner for Korea as well as a strong part of the local community. We welcome all our new employees and look forward to recruiting the next generation of engineers who will help us remain leaders in the production of high quality vacuum pumps."

Printable solar cells

A TEAM of researchers from the University of Chicago and the U.S. Department of Energy's (DOE) Argonne National Laboratory has demonstrated a method that could produce cheaper semiconductor layers for solar cells. The inorganic nanocrystal arrays, created by spraying a new type of colloidal "ink", have excellent electron mobility and could be a step to addressing fundamental problems with current solar technology.

"With today's solar technology, if you want to get significant amounts of electricity, you'd have to build huge installations over many square miles," said team leader Dmitri Talapin, who holds a joint appointment with Argonne and the university.

Current solar cells are based on silicon, which is costly and environmentally unfriendly to manufacture, they aren't cost-effective over large areas. The challenge for scientists is to find a way to manufacture large numbers of solar cells that are both efficient and cheap. One possibility to make solar cells more economically would be to "print" them, similar to how newspapers are printed. Solar cells have several layers of different materials stacked on top of each other. The team focused on the most important layer, which captures sunlight and converts it into electricity. This layer, made of a semiconducting material, must be able to transform light into negative and positive electrical charges but also easily release them to move further along the material to generate electrical current. Most methods require high temperatures, but a cheaper approach would be to make them in solution. This, however, requires a precursor that is soluble.

The team developed that precursor using quantum dots. Small grains of semiconductors, suspended in a liquid, are "glued" together with new molecules called "molecular metal chalcogenide complexes."

The process heats the material to about 200 degrees Celsius, much lower than the temperatures required for manufacturing silicon solar cells. The result is a layer of material with semiconducting properties.

"The electron mobility for this material is an order of magnitude higher than previously reported for any solution-based method," Talapin said.

The team used intense X-rays from the DOE Office of Science's Advanced Photon Source at Argonne to watch as the semiconductor film was created.

Talapin said the success played on the partnership between the University and Argonne's Center for Nanoscale Materials. "At the university we have great students and postdocs who can do a lot of the theoretical chemistry, which requires a lot of manpower," Talapin said, "but Argonne is a fantastic place to do research that requires sophisticated instrumentation and infrastructure."

"Band-like transport, high electron mobility and high photoconductivity in all-inorganic nanocrystal arrays", in Nature Nanotechnology.

IHS iSuppli suggest DRAM was not as strong

IN what is considered a quiet time of the year for the dynamic random access memory (DRAM) market, industry revenue in the first quarter fell short of expectations due to weak pricing, according to new IHS iSuppli research. Global DRAM revenue during the first three months of the year amounted to $8.3 billion, lower than the $9.0 billion anticipated. The first-quarter total represented a 5.6 percent decline from $8.8 billion in the fourth quarter of 2010. The weak result came as the result of softer-than-expected average selling prices (ASPs), which averaged $1.61 during the quarter, compared to the expected $1.89. The DRAM ASP in the fourth quarter of 2010 was $1.97. One year ago in the first quarter of 2010, DRAM revenue was even higher at $9.4 billion, and ASPs then also occupied a loftier perch at $2.78.

"Buffeted by a weak market companies saw their revenues contract across the board in the first quarter of this year," said Mike Howard, principal analyst for DRAM and memory at IHS. "For the Top 8 DRAM companies revenue in the first quarter this year fell for every single player, although the rankings held steady."

Maintaining its lead at the top was Samsung Electronics. Although DRAM revenue for the South Korean electronics giant fell to $3.3 billion in the first quarter, down from $3.6 billion in the fourth quarter last year, Samsung still accounted for 39.3 percent of the DRAM market. That market share is down from 41.3 percent at the end of last year, and the first-quarter decline in 2011 marks the end of four consecutive quarters of market share gain for the company. But even with two points shaved off, Samsung's share still is nearly double that of its nearest competitor and leagues ahead of the rest.

If history is any indicator, Samsung is poised for a strong rebound. After Samsung's previous two sequential declines in revenue the company experienced a period of robust growth. Samsung's next move is likely to be another grab for DRAM market share. Samsung's slight loss at the top was to the benefit of the four players that saw a rise during the first quarter, even though each firm's revenue declined. The four companies that gained market share were No. 2 Hynix Semiconductor, also of South Korea, up from 21.8 percent to 23.0 percent; No. 3 Elpida Memory of Japan, up from 13.4 percent to 13.5 percent; No. 4 Micron Technology of the United States, up from 12.4 percent to 13.0 percent; and No. 8 Winbond Electronics of Taiwan, up from 1.2 percent to 1.3 percent.

Elpida and Micron in 2011 are likely to battle for the No. 3 spot. Neither is ready to challenge Hynix for second place. For Hynix, which had the smallest decline, the company's share in the first quarter was also its highest ever. Holding down the fifth, sixth and seventh spots were the Taiwanese DRAM makers Nanya Technology, Powerchip and ProMOS, respectively. Nanya and Powerchip held on to their market share unchanged, while ProMOS saw a dip of 0.1 percent, the only other company besides leader Samsung to suffer a loss of market share during the period.

Global DRAM Market Share (Ranking by Revenue in Billions of U.S. Dollars)

Rank	Company	Q1-11 Revenue	Q1-11 Market Share	Q4-10 Revenue	Q4-10 Market Share	Sequential Change in Revenue
1	Samsung	$3.26	39.3%	$3.63	41.3%	-10.2%
2	Hynix	$1.91	23.0%	$1.91	21.8%	-0.3%
3	Elpida	$1.12	13.5%	$1.18	13.4%	-5.0%
4	Micron	$1.08	13.0%	$1.09	12.4%	-0.7%
5	Nanya	$0.34	4.1%	$0.36	4.1%	-5.8%
6	Powerchip	$0.21	2.5%	$0.22	2.5%	-6.4%
7	ProMos	$0.12	1.4%	$0.13	1.5%	-9.2%
8	Winbond	$0.11	1.3%	$0.11	1.2%	-1.9%
	Others	$0.16	1.9%	$0.16	1.8%	1.3%
	Total	**$8.29**	**100.0%**	**$8.78**	**100.0%**	**-5.6%**

Source: IHS iSuppli May 2011

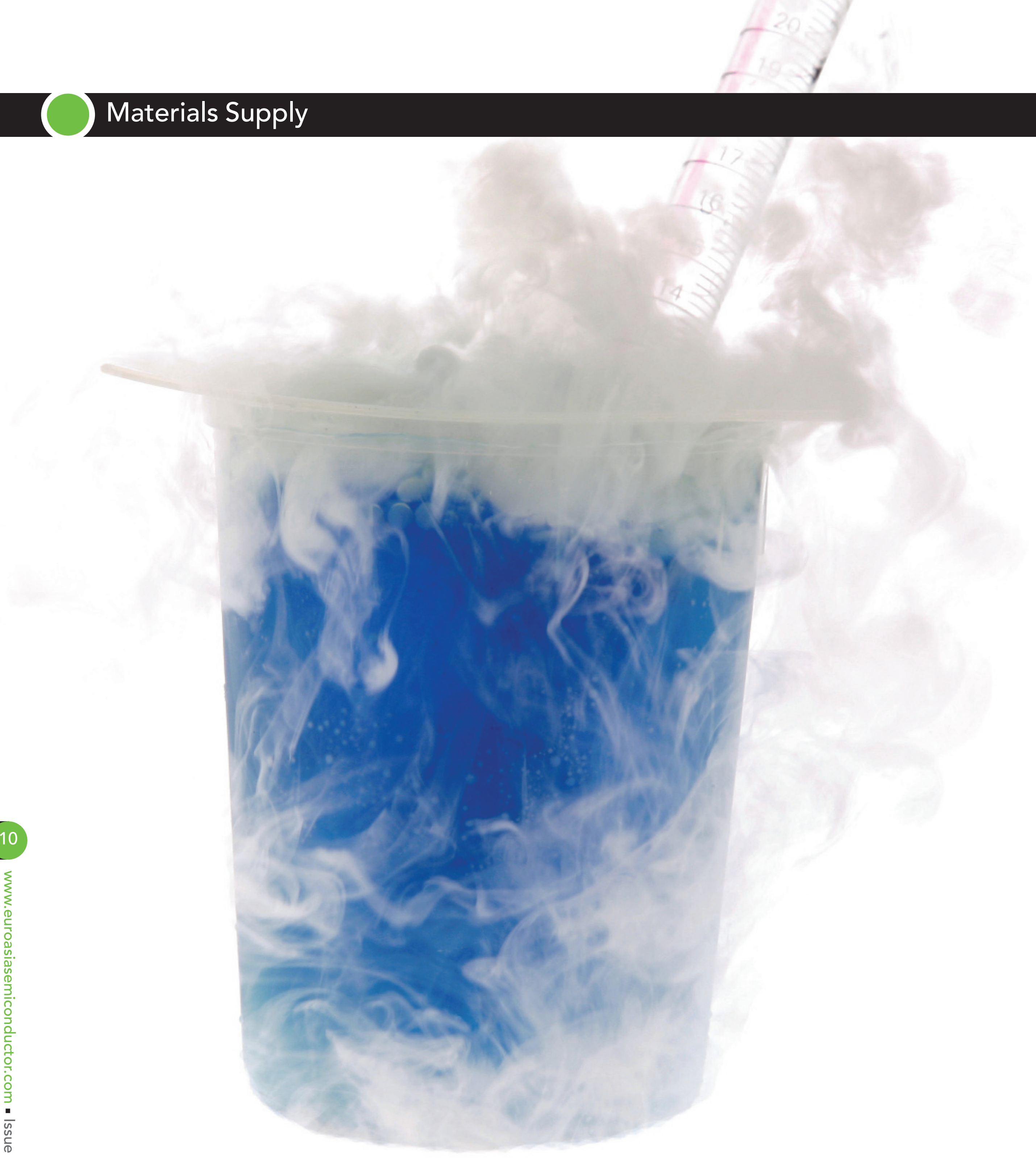
MEMS JV for EVG

EV GROUP (EVG) announced it is collaborating with the Industrial Technology Research Institute (ITRI), Taiwan's largest high-tech R&D institutions, in the development of advanced processes for next generation MEMS devices. As part of the collaboration, ITRI has purchased an EVG wafer bonding system and an automated mask alignment system.

The new systems will be installed at ITRI's Micro Systems Technology Centre for research into wafer-level anodic, eutectic and metal thermo compression bonding, which are critical steps in the production of MEMS devices. The EVG bonder will play a key role in supporting ITRI's transition to 200-mm MEMS wafer processing.

"At ITRI's Micro Systems Technology Centre, our mission is to create innovative applications and develop interdisciplinary technologies that will drive continued growth in the MEMS industry," stated Tzong-Che Ho, Centre Director of ITRI's Micro Systems Technology Centre.

According to market research firm IHS iSuppli (El Segundo, Calif.), the MEMS market is set to enjoy double-digit growth from 2012 through 2014, with market revenue rising to $10.81 billion in 2014, up from $5.97 billion in 2009. Key drivers for market growth include the use of accelerometers, gyroscopes, pressure sensors and other MEMS devices for automotive and consumer mobile communications applications. Wafer-level aligned bonding is key for MEMS due to the need to protect the miniature and fragile mechanical devices as the wafer goes through the remainder of the manufacturing process.



Secure and safe ammonia

The semiconductor manufacturing industry has continued to branch out into new opportunities including compound semiconductor, MEMS, nanotechnology and solar industries. The increase in manufacturing opportunities has seen a rise in the use of chemicals and materials. Not all of which are benign and require a pro-active plan to ensure supply and safety. Praxair Electronics recently completed a study that looked at ammonia bulk specialty gas systems and looked at the difference between liquid or vapour delivery systems.

Ammonia is a specialty gas that is widely used in production processes within the semiconductor and electronics industry. For example, ammonia is used in high brightness light emitting diode (HBLED) manufacture to grow thin films of gallium nitride (GaN) for blue and green light emitting diode (LEDs). Another use of ammonia is as a nitrogen source in the deposition of silicon nitride films for surface passivation and as an antireflective coating in crystalline solar cells. Ammonia used in the electronics industry is required to be of high purity and must contain little or no moisture (typically less than 10 ppb), since high moisture content may negatively impact the quality of deposited films, resulting in poor device performance, e.g., affecting brightness in the case of LEDs .

Growth in LED and LCD manufacturing as well as in solar cell fabrication has resulted in increased consumption of ammonia and created a need for bulk quantities of high-purity ammonia. The supply of sufficient quantities of high-purity ammonia to the manufacturers of these devices has therefore become a critical part of the production process.

There are two common ammonia delivery methods employed:

- Vapour Withdrawal (Figure 1) - Ammonia is vaporized inside a container equipped with a heating device and withdrawn from the container as vapour.
- Liquid Withdrawal (Figure 2) - Ammonia is withdrawn from the container in the liquid phase and is vaporized externally through use of a vaporizer.

Such bulk ammonia supply systems typically consist of two containers connected to a supply manifold that is sized appropriately to meet the user's flow demand. Ammonia product is supplied from the vapour or liquid phase of one of the containers until that container becomes depleted, at which time the supply of ammonia is switched to the reserve container. Regardless of the delivery method, ammonia supply systems must be carefully designed to ensure that safety, flow, and purity needs are met. Typical bulk containers used in the supply of high purity ammonia are listed in Table 1 and are selected by users based on their consumption rates. To meet the diverse and challenging demands of our ammonia customers, Praxair Electronics has conducted studies on the safety and performance of bulk ammonia supply systems that feature liquid or vapour withdrawal. The knowledge the company has gained from these studies has been used to develop a complete portfolio of ultra high purity (UHP) flow bulk gas delivery systems for ammonia and other specialty gases which are optimized in terms of delivery purity and safety.

Performance metrics

The performance of Praxair's bulk specialty gas system (BSGS) offerings has been evaluated using a state-of-the-art pilot plant located at the company's Technology Centre located in Tonawanda, New York. Equipment used in the construction of the plant was chosen to replicate systems used by Praxair's customers, thus ensuring that data generated at the pilot plant during evaluation of our bulk supply systems, provide a direct measure of their performance at customer locations.

Table 2 shows typical design flows for vapour delivery of ammonia from bulk ammonia systems offered by Praxair. Note that the "sustainable flow" listed in the table is the flow at which the container can be run continuously without reduction in container pressure and subsequent reduction in flow. The systems are

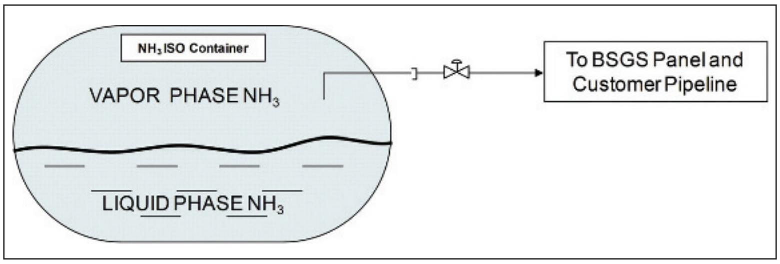


Figure 1: NH3 Supply by Vapour Withdrawal

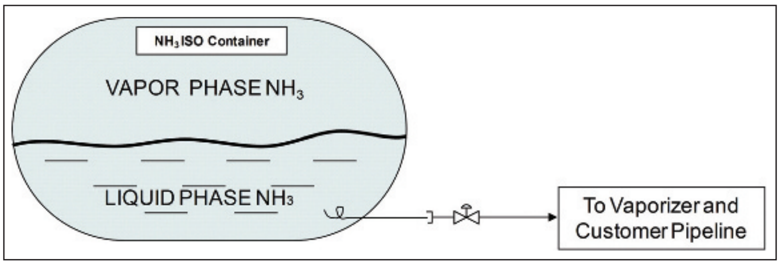


Figure 2: NH3 Supply by Liquid Withdrawal

Table 1 Bulk Containers with Typical Capacities	
Container	**Liquid Ammonia Capacity (lbs)**
Tonner	510
Drum	1000
ISO container	23000

also capable of delivering higher flows for limited periods of time.

Praxair's proprietary heating design for vapour withdrawal from bulk containers also ensures high energy efficiency. For example, typical energy efficiencies for indoor installations are greater than 60 slpm per kW, or greater than 90 percent of the energy consumption used to vaporize ammonia. Liquid withdrawal systems can be designed to deliver similar flow rates by appropriately sizing the external vaporizers.

Liquid and vapour withdrawal systems differ in terms of the purity of the delivered ammonia. In vapour withdrawal systems, heavy contaminants including moisture concentrate in the liquid heel and the downstream process

Figure 3: Ammonia Pilot Plant at Praxair's Technology Centre

(e.g., point-of-use purifiers) sees a reduced amount of impurities in the delivered vapour. In liquid withdrawal systems, heavy contaminants including moisture are vaporized entirely by an external vaporizer and are all delivered to downstream process. For example, the content of key impurities such as moisture before any point-of-use purifier can be two orders of magnitude higher in liquid withdrawal systems than in vapour withdrawal systems. In addition to the intrinsic purity benefit due to vapour withdrawal, Praxair's proprietary heating design further optimize the moisture performance so that the moisture level stays relatively constant throughout the use of the vessel.

The first instance

Most ammonia bulk delivery systems are equipped with safety features to minimize the possibility of ammonia release to the environment. However, ammonia can still be released due to accidents or operating errors and it is therefore important to understand the potential impact of an ammonia release and to have corresponding engineering controls and response plans to minimize the impact of such a release on safety and the environment. Table 3 shows the number of accidents involving the release of ammonia between 2000 and 2006 in the United States, according to Occupational Safety and Health Administration (OSHA) findings.

A likely release scenario that would have a safety and environmental impact would be an ammonia release due to a main delivery line break. In the case of a liquid withdrawal system this release would be in the form of a liquid; while for a vapour withdrawal system the release would be in the form of a vapour. In this section, the impact of both unmitigated liquid and vapour ammonia releases from a typical ISO container-based system is studied by dispersion modelling. Using the well-recognized DNV Process Hazard Analysis Software Tool (PHAST) software (Version 6.54), with the following assumptions, which represent a typical release scenario, the unmitigated dispersion of ammonia following a release is simulated.

- Line break with pipe diameter 0.742 inch (18.85 mm) for vapour release.
- Line break with 0.742 inch (18.85 mm) or 0.5 inch (12.7 mm) for liquid release.
- Horizontal discharge, 1 meter above ground.
- Initial container pressure 150 psig.

- No berm/dike to contain liquid release.
- Wind speed 1.5 meter/second.

The PHAST software predicts the concentration of released substances as a function of location and time from the point of release. In this study, the potential impact of an ammonia release is measured by the size of the impact zone within which the ammonia concentration reaches or exceeds several established concentration thresholds.

For both the liquid and vapour release scenarios, the simulation results are shown in terms of two-dimensional cloud development from piping of diameter 0.742 inch or 0.5 inch (Figures 5 through 8). The x axis shows the distance downwind from the point of release, and the y axis shows the vertical elevation from the point of release. The areas enclosed in the concentration contours represent the areas in which the concentration of ammonia in the atmosphere is larger than the corresponding concentrations shown on the legend.

Vapour Release

Figures 5 and 6 show the simulation results for a vapour release scenario as described previously. In this case, the release rate decreases before stabilizing at a much lower value than the rate immediately after the onset of the release. As a result, the ammonia cloud expands during the first few minutes after the release, and then shrinks as the release rate decreases.

Liquid Release

Figure 7 shows the simulation results for a liquid release scenario as described above. In this case, the release rate remains constant and for any location downwind of the release, the ammonia concentration first increases and as ammonia continues to accumulate; its dissipation rate towards further downwind locations also increases. After some time, the concentration at

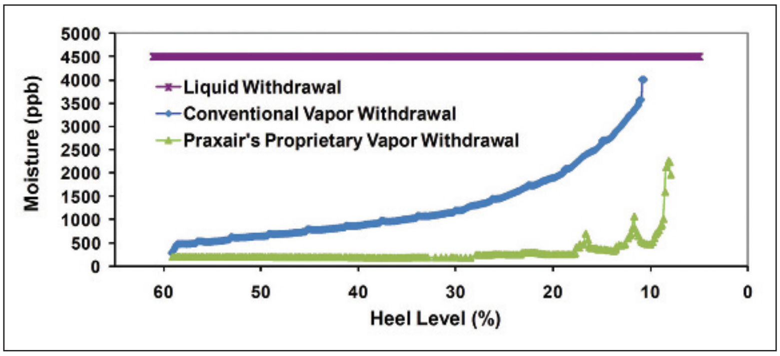


Figure 4: Moisture Performance Comparison throughout Use of One Vessel

any particular location downwind reaches a steady state, i.e., the ammonia cloud becomes fully developed. At steady state, the concentrations of interest reaches their maximum downwind distances respectively. Such steady states usually are reached in a fairly short time. For example, 300 ppm (IDLH) steady state maximum distance is reached at around 15 minutes for liquid release. It is recognized that by design choice the main process line for a liquid withdrawal-based system may have a smaller diameter than that for a vapour withdrawal-based system for equivalent flows. Figure 8 shows the simulation results for a liquid release scenario where the pipe diameter is reduced to 0.5 inch.

From Figures 5 through 8, the maximum downwind distance for a given concentration can be extracted, which is an important measurement of the potential impact of an ammonia release. The maximum downwind distance at ground level for 300 ppm (IDLH) and 5000 ppm (LC50) is summarized in Table 4 for vapour and liquid release, respectively. The potential affected areas with NH3 concentration at or exceeding 300 ppm (IDLH) corresponding to a vapour release (0.742 inch line) and a liquid release (0.5 inch line) are compared in Figure 9.

There are two reasons for the order-of-

Table 2
Design Flow Rates for Typical Praxair Bulk Ammonia Packages

Source Configuration	Sustainable Flow (slpm)
1x1 Tonner	550
1x1 Drum	610
ISO Container	2000

magnitude difference in the downwind distance for the concentrations of interest shown in Table 4 for liquid and vapour release scenarios. These are:

- Ammonia released from a liquid withdrawal system has a much larger release rate. Vapour and liquid ammonia releases differ in that during a vapour release, ammonia is first vaporized inside the container before leaking. In this case the heat of vaporization is provided only by the ambient air. As a result, ammonia liquid in the tank is cooled; the tank pressure decreases and the release rate decreases over time before stabilizing at a rate much lower than the initial rate. During a liquid release, there is no such cooling effect provided by the vaporization of the liquid and as a result, the container is maintained at its initial pressure, thus maintaining the release rate at the initial flow rate until the container is emptied. This difference is illustrated in Figure 10, in which the x axis is the time after release (x=0 for the start of the release) and the y axis is the ammonia release rate in lb/hr.

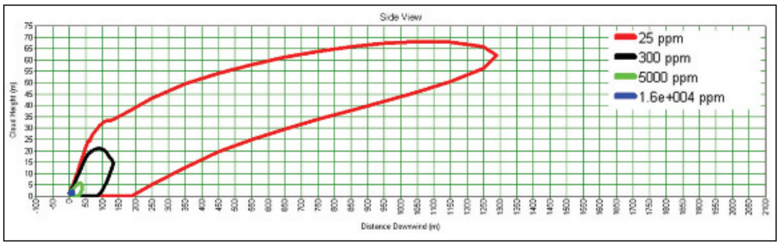


Figure 5: Ammonia Concentration Contours at 11.3 Minutes after the Start of a Vapour Release (Pipe Diameter 0.742 inch)

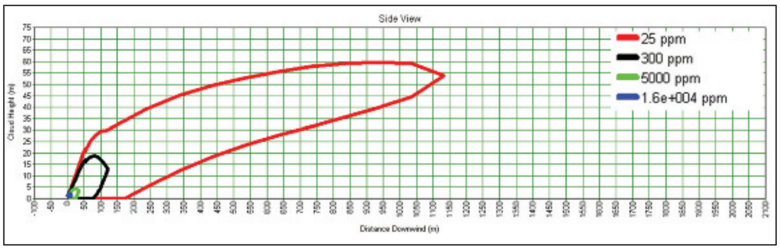


Figure 6: Ammonia Concentration Contours at 62.0 Minutes after the Start of a Vapour Release (Pipe Diameter 0.742 inch)

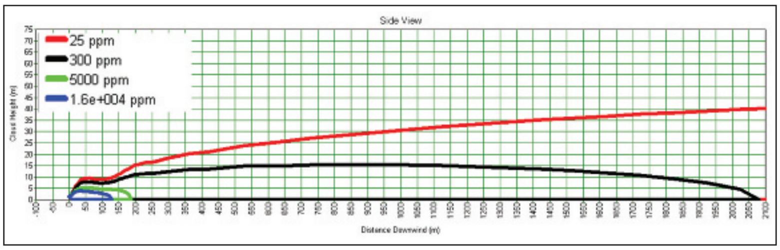


Figure 7: Concentration Contours Fully Developed Cloud for Liquid Release (Pipe Diameter 0.742 inch)

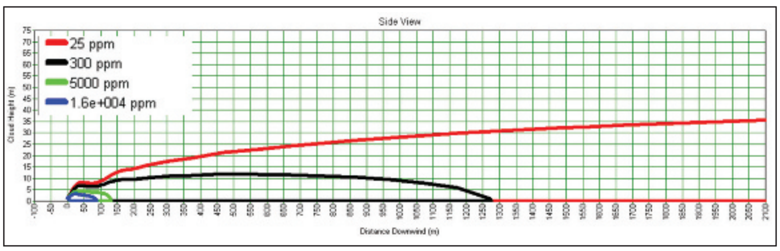


Figure 8: Concentration Contours Fully Developed Cloud for Liquid Release (Pipe Diameter 0.5 inch)

In addition to the difference caused by the "cooling effect", Figure 10 also illustrates the larger mass flow from a liquid release compared to a vapour release from broken process lines of similar size. Therefore, a drastic difference in the potential safety impact is expected, as shown in the simulation results of vapour and liquid releases.

- Liquid ammonia tends to form a dense aerosol, which can travel along the ground instead of immediately rising in the air. The direct result from this effect is that the overall ammonia concentration on the ground would be higher than that in the case of vapour withdrawal. In addition, in a liquid release the ammonia concentration at the point of release, which is close to the operating site, might reach the flammable range (16 to 25 percent). Without proper mitigation, this would present a very serious threat to the

Table 3
OSHA Investigation Findings:
Accidents Involving the Release of Ammonia (2000-2006)

Calendar Year	Number of Accidents	Number of Fatalities
2006	6	1
2005	3	0
2004	6	2
2003	6	2
2002	5	2
2001	9	3
2000	8	3

Table 4
Maximum Downwind Distance for 300 and 5000 ppm

Release Scenario	Maximum Downwind Distance where 300 ppm (IDLH) Concentration Exists	Maximum Downwind Distance where 5000 ppm (LC50) Concentration Exists
Vapor Release (0.742 inch line)	90 m	35 m
Liquid Release (0.742 inch line)	2080 m	190 m
Liquid Release (0.5 inch line)	1280 m	135 m

operators and the emergency responding personnel.

Conclusions

The performance and safety of liquid and vapour withdrawal type bulk ammonia delivery systems are compared. A key learning is that when ammonia is released from the supply system, dispersion modelling shows that a release from a liquid withdrawal system presents a more severe risk to personnel over a larger area than a release from a vapour withdrawal system, due to the following reasons:

- The release flow rate is larger in the case of liquid withdrawal.
- Liquid ammonia forms dense aerosol, which can travel along the ground instead of immediately rising in the air.

In view of the above finding, liquid withdrawal systems would require:
- More extensive engineering controls.
- Emergency response measures.
- Additional cost associated with the maintenance of the additional equipment.

In terms of system performance, both vapour and liquid withdrawal type systems can be designed to deliver comparable flow rates with similar power efficiency. However, the moisture in the delivered product is two orders of magnitude higher in the case of liquid withdrawal type systems for ammonia of the same starting grade. Since most users rely on point-of-use purifiers to ensure sub-ppb levels of moisture and oxygen concentration in the ammonia vapour at tool inlet, the life of those purifiers before having to be regenerated or replaced would be shorter for liquid withdrawal type systems. While this may not affect the overall operating cost of such purifiers substantially if they can be regenerated on site, adequate purifier sizing and appropriate regeneration schemes must be ensured.

-

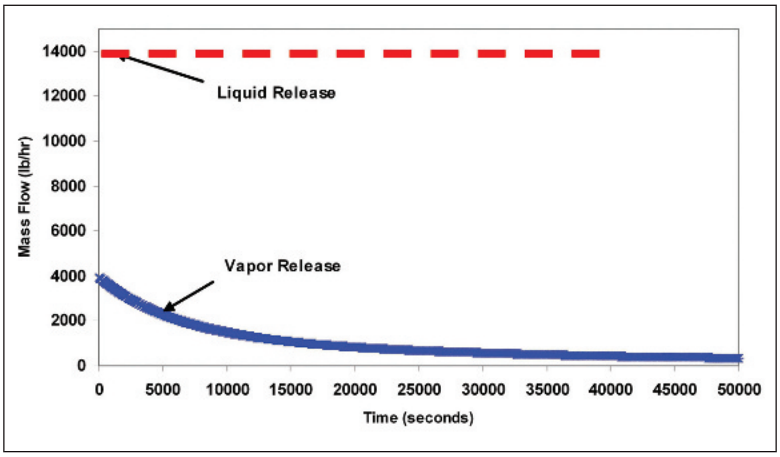


Figure10: Comparison of release rate of vapour and liquid ammonia release

Figure 9: Potential Affected Areas with NH3 Concentration At or Exceeding IDLH

Authors
Heng Zhu (Development Associate I, Electronics R&D, Praxair)
Christos Sarigiannidis (Development Associate I, Electronics R&D, Praxair), Martin Timm (Process Safety Manager, Corporate Safety, Praxair), Lloyd Brown (Senior R&D Manager, Electronics R&D, Praxair)

UK industry annual get together

JEMI UK was formed over a decade ago after a group of UK companies involved in semiconductor manufacturing decided that their needs were no longer being met by the incumbent international industry bodies. The conference the group began is now in its 13th year and this year moves to the birthplace of computing and the home of Alan Turing at the University of Surrey. This year the focus is on Innovative Manufacturing Processes.

With the importance of manufacturing as a powerhouse to the economy resurfacing on the UK Governments' agenda it is appropriate that the theme of this years' annual S2K conference event should be Innovative Manufacturing Processes in Micro and Nano electronics applications so as to look at the opportunities still available to UK based companies.

The use of manufacturing techniques, once confined to the production of semiconductors has become pervasive in many areas of new technology including medicine, electronics, energy to name but a few. The manufacture of devices and features at the nano and micro scale is assisting in areas such as energy scavenging for mobile phone technology and integrated plastic electronics in clothing. It is in this context

The event will include an industry forecast overview form Malcolm Penn of Future Horizons to set the background for the development of the sector providing a useful insight into the applications which will drive future technological developments

that the S2K event will take place at the University of Surrey in Guildford, UK bringing together up to 200 top decision makers from throughout Europe across the now, horizontal platform of micro and nano manufacturing.

The event will include an industry forecast overview form Malcolm Penn of Future Horizons to set the background for the development of the sector providing a useful insight into the applications which will drive future technological developments. Bernie Capraro, Head of EU Nanotechnology Research at Intel will describe how Intel Ireland has leveraged Europe's strengths beyond manufacturing in initiatives such as nanotechnology research, IT innovation, independent living and 450mm equipment development, as Intel looks forward to the next 20 years of further success in Europe. Other speakers include Seagate, QUB, IMEC and University of Edinburgh.

Home town boy: A statue of local hero Alan Turing on the university grounds

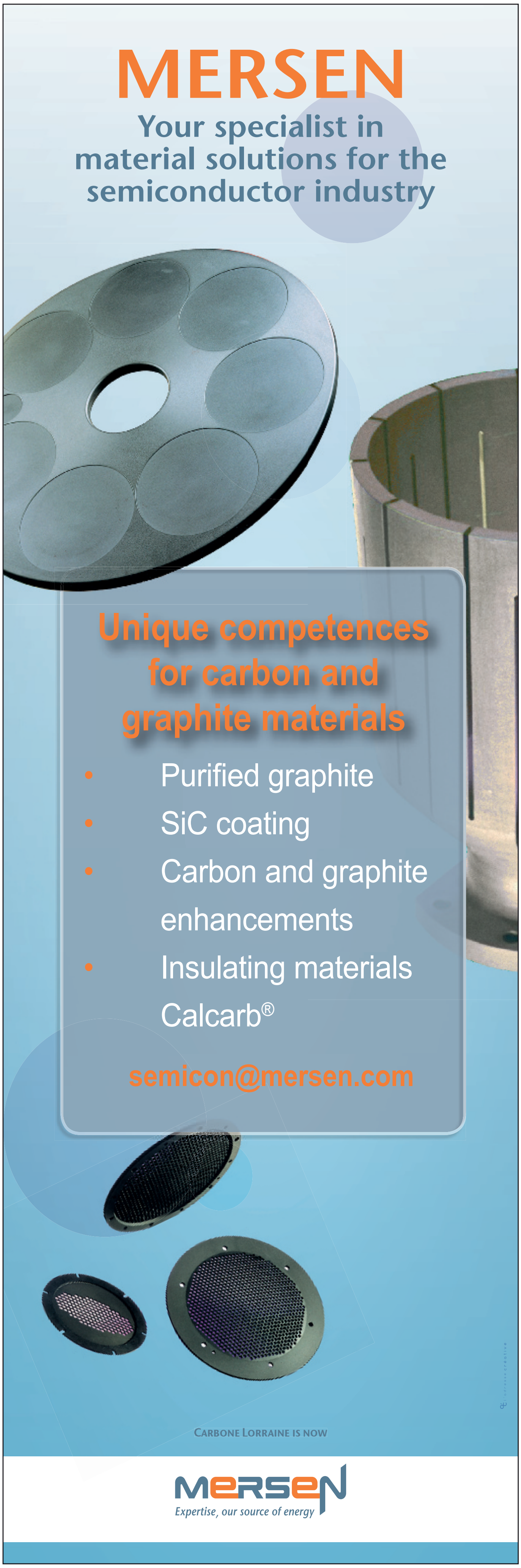
Mike Smyth, Chairman of S2K commented "The theme of the event is aligned with the announcements made by Government in their recent Growth Review, which targets the expansion of Britain's manufacturing sector and positioning the UK as Europe's leading exporter of high value goods. We are very fortunate to have secured Bernie Caparo of Intel as Chairman for the 2011 S2K event. Intel is one of the leading and certainly the most recognised Global Semiconductor Manufacturers. Combined with a strong speaker line up and program of workshops, this event is essential for anyone interested in high tech growth areas"

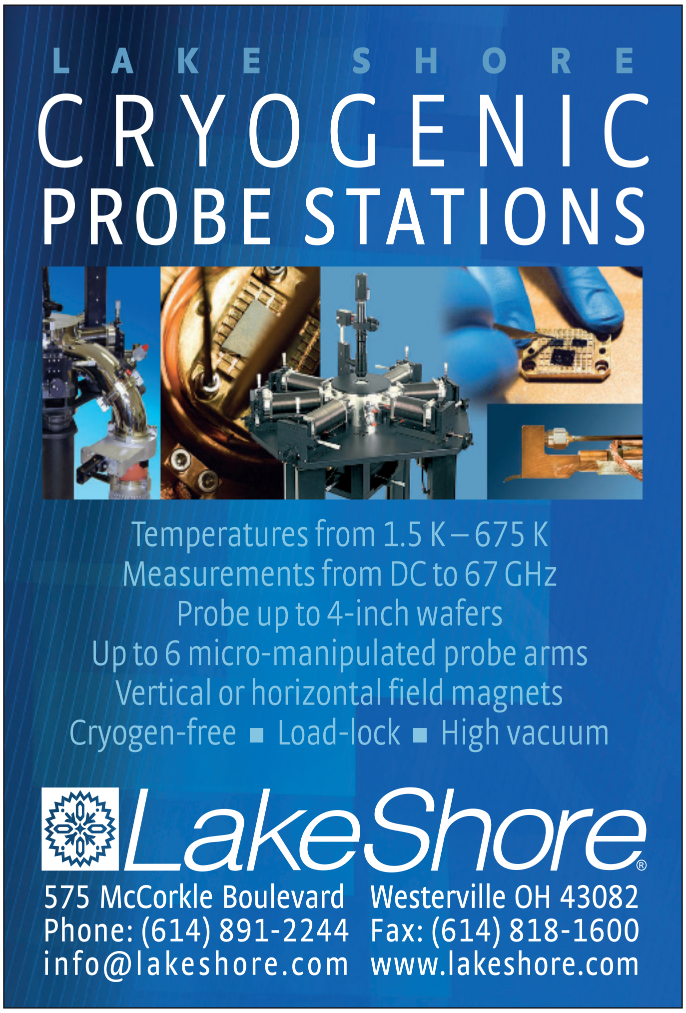
This year's S2K/ I2 AMP event which will take place on the 21st /22nd June and will build on the format developed over the past 2 years of combining associated events with the main conference and which has resulted in a very successful and well attended event will a great level of engagement.

This year's event also incorporates a poster session supported by around 6 Universities which will be judged and a total of £500 awarded to students presenting the best papers publishing research in the area of nano and micro manufacturing methods. The addition of this feature has been designed to bring together academia and industry to promote collaboration in areas where innovation can be used to support industry technology roadmaps.

JEMI UK Ltd and the Nanotechnology KTN who are supporting the event expect that up to 200 top level micro, nano and semiconductor professionals will attend the event and spend two days networking and learning.

For more information on how to register for S2K or exhibit at the event, visit www.semiconductor2k.com


MERSEN
Your specialist in
material solutions for the
semiconductor industry
Unique competences
for carbon and
graphite materials
• Purified graphite
• SiC coating
• Carbon and graphite
enhancements
• Insulating materials
Calcarb®
semicon@mersen.com
CARBONE LORRAINE IS NOW
MERSEN
Expertise, our source of energy


LAKE SHORE
CRYOGENIC
PROBE STATIONS
Temperatures from 1.5 K – 675 K
Measurements from DC to 67 GHz
Probe up to 4-inch wafers
Up to 6 micro-manipulated probe arms
Vertical or horizontal field magnets
Cryogen-free ■ Load-lock ■ High vacuum
LakeShore®
575 McCorkle Boulevard
Westerville OH 43082
Phone: (614) 891-2244
Fax: (614) 818-1600
info@lakeshore.com
www.lakeshore.com


RABOUTET S.A.
Manufacturer of Molybdenum.
Components for MBE.
Specialized Cleaning
& Degassing available.
RABOUTET S.A.
250 Av Louis Armand
Z.I Des Grand Prés
F-74300 Cluses France
Tél : 33 (0)4 50 98 15 18
Fax : 33 (0)4 50 98 92 57
E-mail : info@raboutet.fr
http://www.raboutet.fr

Embedded collaboration

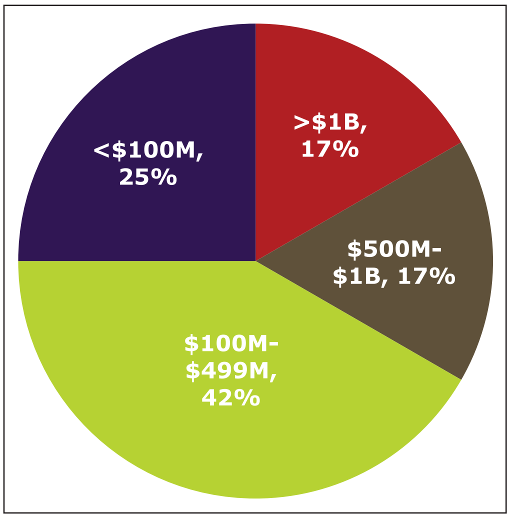
The Global Semiconductor Association recently commissioned a report entitled, "Collaborative Innovation in the Global Semiconductor Industry". **Rahul Kapoor, a management professor at The Wharton School of the University of Pennsylvania,** conducted the research and discovered an entangled industry ecosystem along the value chain.

Semiconductor companies are embedded in a business ecosystem comprised of suppliers, customers and complementors (i.e., providers of complementary products). Each of these players exert an important influence on the ability of the semiconductor company to create value from its own products and technologies. Many companies acknowledging this interdependence are pursuing collaborative innovation models in which value is created not only within the company, but also at the collaborative interface between the company and its diverse set of partners. However, the success of such collaborative innovation models is often constrained by the technological and organizational challenges that companies face due to increasing complexity, greater competition and the quickening pace of change.

The 2010 Wharton-GSA Semiconductor Ecosystem Survey, part of a two-year research effort, was implemented to provide a systematic analysis of the nature of challenges and opportunities faced by fabless semiconductor companies within their ecosystem. There are several specific objectives that we hoped this survey would be able to address for the global semiconductor industry community. First, the findings provide a first of its kind inside-the-box view of the patterns of collaboration between semiconductor companies and key partners in their ecosystem. These partners include foundry and assembly and test (A/T) suppliers, original equipment manufacturing (OEM) customers, and providers of complementary products

This would allow semiconductor companies to benchmark their collaborative innovation models and take steps to maximize the value that they can derive from their ecosystem. Secondly, a company's success in developing and commercializing new innovations is shaped not only through collaboration with external partners, but also through collaboration between internal functional groups which link the company's internal activities with those of its upstream and downstream partners. The findings from the survey provide a comprehensive account of the patterns of cross-functional interaction that exist between the marketing, engineering and supply chain management functions within a semiconductor company.

Distribution of Public Fabless Companies by 2009 Annual Revenue (% of Companies)



Finally, the reported results provide some key indicators of semiconductor companies' technology strategies and outcomes such as the different sources of intellectual property (IP), the extent of IP Reuse, the nature of competitive differentiation and the drivers of time-to-market.

The reported results are based on detailed responses received from senior engineering, marketing and supply chain executives from 37 publicly-listed and 25 private fabless semiconductor companies, with the publicly-listed companies representing 45% of total 2009 public fabless semiconductor industry sales. The revenue distribution of publicly-listed companies is shown above.

Findings: Product Development

- **Differentiation:** Of the total number of engineers employed by a fabless semiconductor company, on average, 23% employed are software engineers and 20% are system design engineers (46% are IC design engineers and 12% are IC manufacturing and test engineers). The results suggest that software and system design are both becoming an important driver of differentiation and opportunity for semiconductor companies competing on the global stage.

- **IP Reuse:** On average, a fabless semiconductor company reuses about 63% of design IP in the revision of an existing product design and about 44% in a new product design.

- **Source of IP:** Silicon foundries are becoming an important source of design IP for fabless companies in addition to third-party IP firms. On average, 18% of design IP blocks are from the foundry's portfolio/library, followed by 16% for third-party licensing firms.

- **Time-to-market:** The average time-to-market, defined as the period from design start to mass production, is about 14 months for a revision of an existing product design. It increases to about 19 months for a new product design. A shift to a new manufacturing process increases the time-to-market by about three months.

Supplier Relationships

- The extent of collaboration between fabless semiconductor companies and their manufacturing suppliers was evaluated in three different ways: (1) the extent to which a supplier shares different types of information with the fabless company, (2) the extent to which a supplier is involved in the fabless company's value-creating activities and (3) the extent to which both the fabless company and the supplier customise their shared activities towards each other.

- Foundry and A/T suppliers extensively share information on existing production, future technology development and capacity expansion. However, these suppliers are generally tight-lipped with respect to cost information.

- Both foundry and A/T suppliers are very involved in fabless companies' cost reduction and technology roadmapping activities. Their involvement is much lower for new product development and customer-based activities.

- Fabless companies, on average, seem to customize their products and operations more with respect to foundries than with respect to A/T suppliers. On the other hand, A/T suppliers seem to tailor their manufacturing processes and operations more extensively to the fabless company's requirements than do silicon foundries.

There are large differences among semiconductor companies in the extent to which they collaborate with foundry and A/T suppliers. Firms that have high collaboration with foundry suppliers on any one of the dimensions (information sharing/supplier involvement/customization) also have high collaboration with A/T suppliers.

Fabless semiconductor companies generally perceive their foundry and assembly suppliers' performance to be good or very good with respect to suppliers' technical competence, process quality, responsiveness to problems and inquiries, and capacity allocation. However, they seem less satisfied by the suppliers' price competitiveness, and this effect is stronger for foundries than for A/T suppliers.

Customer Relationships

Customers of semiconductor companies extensively share information on volume projections and product development status, but information sharing is much lower for customers' product costs and overall business strategies.

Following a trend that is similar to supplier relationships, semiconductor companies seem, on average, to be most involved in their customers' cost reduction and long-term technology roadmapping activities and less involved in short-term activities underlying product development.

In general, customers tend to tailor their product designs and roadmaps to fabless companies' ICs and roadmaps. At the same time, fabless companies tend to customize their research and development (R&D) activities and product portfolio to their customers. However, on average, neither the fabless companies nor their customers seem to significantly tailor their manufacturing operations to each other.

While large differences in the nature of collaborative relationships exist between semiconductor companies and their customers, these collaborative relationships tend to be strongly reciprocal. For example, customer relationships that are characterized by a high degree of semiconductor company involvement in customers' activities are also characterized by a high degree of information sharing by customers. Similarly, high customization by

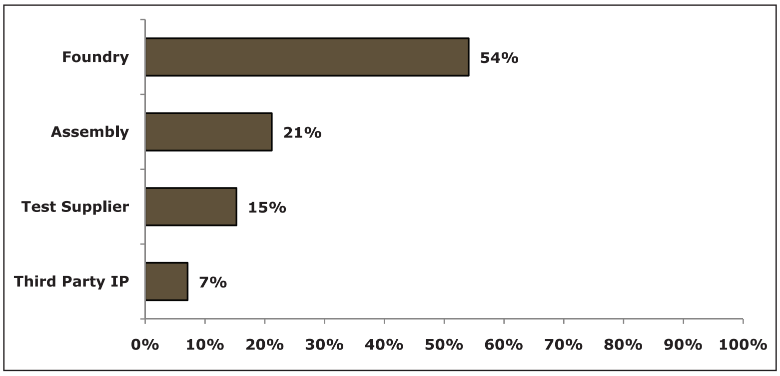


Figure 5. Fabless Company IC Product Cost

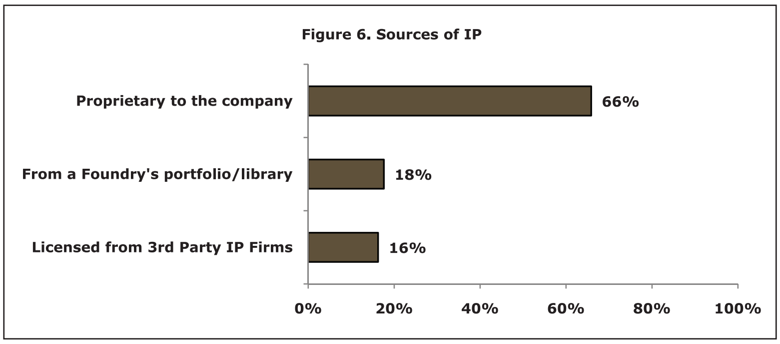
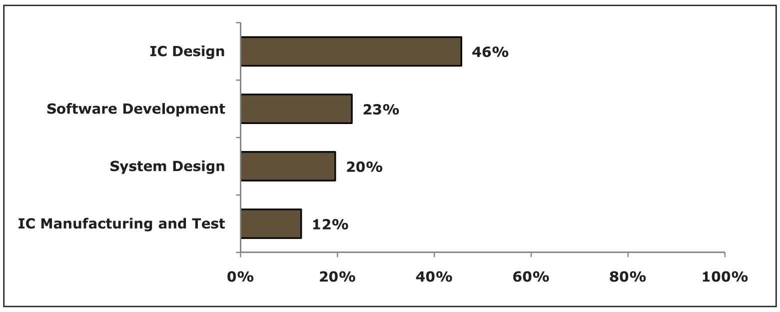


Figure 6. Sources of IP



Breakdown of Engineers Employed

fabless companies for customers is typically associated with high customization by customers for fabless companies.

Complementor Relationships

A vast majority of semiconductor companies identified other semiconductor companies (application-specific IC/application-specific standard product (ASIC/ASSP), microprocessor, graphics IC, etc.) as their complementors. Complementors also included companies

developing application software, programming software and operating systems.

- Semiconductor companies vary significantly with respect to the department that has the primary responsibility for coordinating activities with complementors: 39% (marketing department), 37% (engineering department), 17% (separate dedicated department or executive) and 7% (no specific department).

- Semiconductor companies extensively share information on specific market applications and technology roadmaps with their complementors. They also interact through joint product development and customizing products to complementors. Companies report less interaction through standard setting and licensing, and least through making investments in their complementors.

- The greatest benefits from working with complementors include improvement in the performance of products followed by increasing sales to existing customers.

- There exists a high variance in the nature of collaborative relationships between semiconductor companies and their complementors. However, more collaborative relationships are associated with greater value creation by semiconductor companies. In addition, fabless companies that have strong collaborative relationships with their customers also tend to have strong collaborative relationships with their complementors.

Internal Cross-functional Relationships

- The majority of companies indicated the use of a dedicated "program"/"new product" management group to coordinate marketing, engineering and supply chain management activities. Some companies also indicated the use of temporary or permanent cross-functional teams.

- The primary responsibility of the program manager seems to be a liaison between the different functions and organizational levels, with much less influence over critical decisions or the allocation of resources for the project.

- On average, the marketing and engineering departments seem to enjoy a high degree of collaboration, followed by engineering and supply chain which is followed by marketing and supply chain.

- There seems to be a high level of joint action between all three departments for activities related to existing customer support, new product ramp-up and cost reduction. Activities related to new customer engagement, competitor benchmarking and technology roadmapping are carried out mainly through collaboration between engineering and marketing. Activities related to supplier selection and supplier performance evaluation are carried out mainly through collaboration between engineering and supply chain departments.

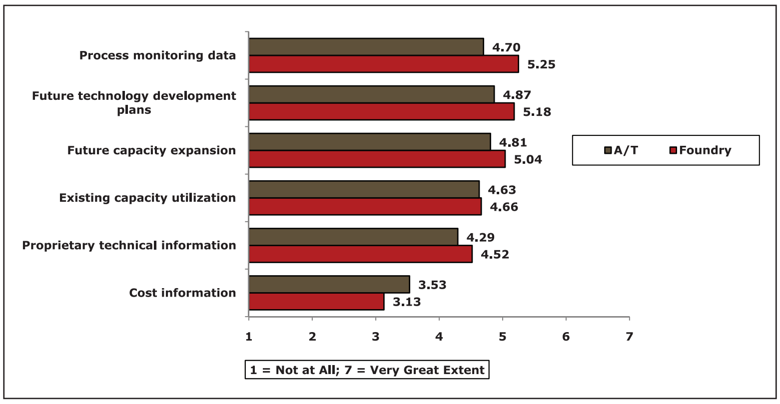
- Not only do companies vary in the extent to which the different functions collaborate, but perhaps, more interestingly, there seems to be a high degree of reciprocity in collaboration. The extent to which the marketing department collaborates with the engineering department on marketing activities/information is positively correlated with the extent to which the engineering department collaborates with the marketing department on engineering activities/information. This correlation is especially strong in the relationship between the supply chain and marketing departments.

Conclusions

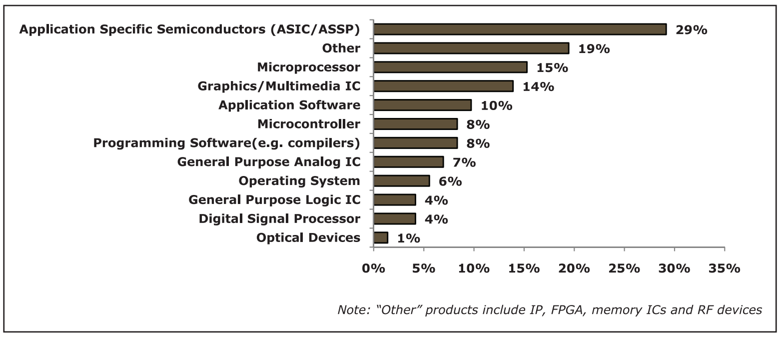
The findings shed light on a broad array of challenges and opportunities that semiconductor companies face within their ecosystem. The results from the survey confirmed that companies are subjected to high technological complexity, short product life cycles and hard-to-change cost structures. In assessing the nature and the implications of these challenges, the survey uncovered the different drivers of time-to-market, companies' IP strategies and the nature of competitive differentiation.

The results reaffirmed that the ecosystem provides a rich set of opportunities for semiconductor companies to create value. However, while many companies have established extensive collaborative relationships with suppliers, customers and complementors, there are many others that seem to be working at an arms-length and perhaps not able to reap the full benefits from their ecosystem.

The survey findings also showed the important role played by complementors in enhancing the semiconductor company's competitive position. Complementors are often other semiconductor companies that develop complementary ICs used in the customer's application. However, managing relationships with complementors seems organizationally more complex than managing relationships with suppliers or customers. While there are well-defined departments for managing relationships with suppliers and customers, the relationship with complementors seems to be managed in very different ways, both within and across companies. Hence, in addition to suppliers and customers, semiconductor companies pursuing collaborative innovation models need to explicitly consider different types of complementors and develop organizational structures to effectively manage these new types of relationships. Finally, the survey indicates that companies need to manage both external dependencies with suppliers, customers and complementors, as well as internal dependencies between supply chain management, marketing and engineering functions so as to ensure that they are able to maximize value from all collaborative linkages. The results caution executives that it may only take one ineffective collaborative link to undermine the total value created by the firm within the ecosystem.



Extent of Information Sharing between Suppliers and Fabless Companies



Complementary Products Identified by Fabless Semiconductor Companies

While there are well-defined departments for managing relationships with suppliers and customers, the relationship with complementors seems to be managed in very different ways, both within and across companies

Organic circuit

Researchers recently revealed they had a record speed circuits where a silicon sten was used to boost an organic t transistor's speed. **Institut für Mikroelekt Stuttgart** discuss their recent try

attained
cil mask
thin-film
tronik in
t results.

Researchers from the Institute for Microelectronics Stuttgart (IMS CHIPS) and the Max Planck Institute (MPI) for Solid State Research in Stuttgart, Germany, recently presented the outcome of their joint effort that led to a record performance organic electronic circuit demonstration stimulating industry interest.

The group used silicon stencil mask technology and presented a current steering mode 6-bit digital-to analogue convertor (DAC) in organic thin-film transistor (OTFT) technology, which is 1000 times faster and 30 times smaller than the currently fastest 6-bit DAC in organics. OTFT by stencil mask technology.

The two institutes have joined in an effort to demonstrate the smallest and fastest OTFT ever built in a manufacturable fabrication process.

The group was led by Dr. Hagen Klauk at MPI, who is an international leader in research and development of organic thinfilm transistor (OTFT) technology with a particular focus on low-voltage (<5 V) operation.

This is the voltage range at which microelectronic chips operate. In contrast, most international competitors design OTFTs for high-voltage operation (>50 V), where OTFTs switch comparably faster.

Besides supply voltage, the transistor speed is to a large extend determined by the length of the transistor's channel that can be controlled by the gate contact. A shorter channel leads to a faster transistor. Until recently Klauk's group used evaporation of materials through a plastic shadow mask, which is patterned by means of laser cutting. The minimum channel length feasible with this patterning technique is 20 µm.

IMS CHIPS, headed by Prof. Joachim Burghartz, is an international expert in nanopatterning. The team of Dr. Florian Letzkus at IMS CHIPS can fabricate silicon membrane stencil masks with feature sizes down to 100 nm, depending on the thickness of the membrane.

A set of stencil masks with transistor channel lengths down to less than 1 µm were fabricated, allowing the MPI group to demonstrate transistors with a more than 20-fold shorter channel than before. Those transistors switched more than 100 times faster than the OTFTs built by using the plastic shadow masks.

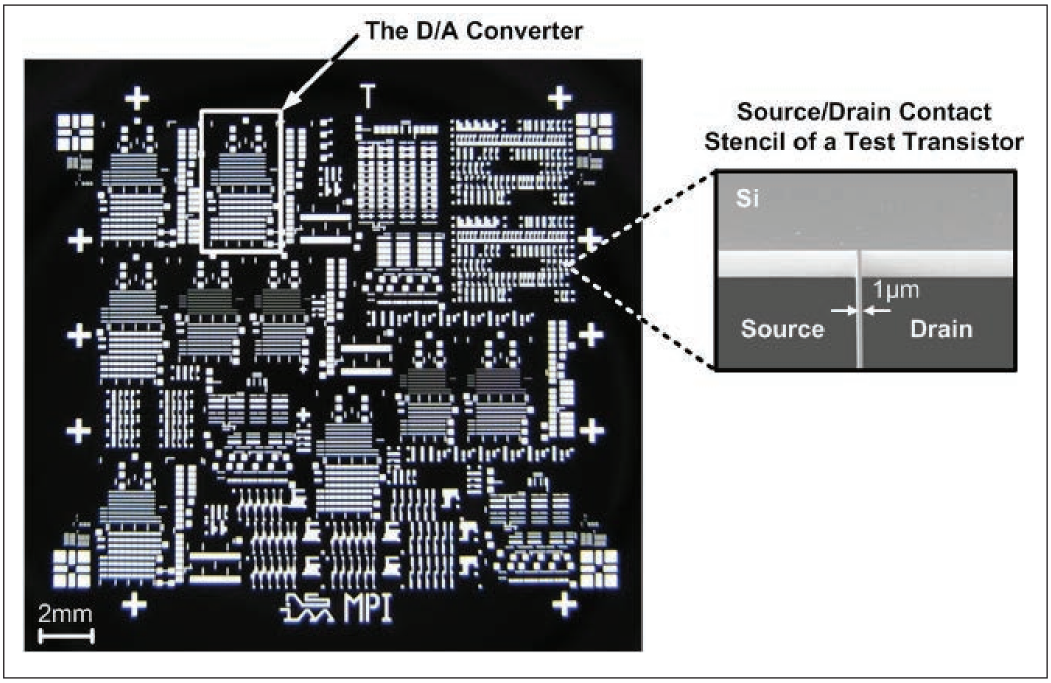


Fig. 1: Overall view of the stencil mask

The OTFT is viewed as the basic device technology considered for future flexible electronic products. This includes flexible displays (so-called electronic paper), diagnostic tapes for medical monitoring and life sciences, radio-frequency identification (RF-ID) tags as a smart replacement for the barcode, smart ticketing and smart signage

An additional breakthrough resulted from the mechanical quality of the silicon stencil masks, providing excellent stiffness and stability. As a result, the characteristics of transistors across the mask area were very similar, thus allowing for the design of circuits comparably to microelectronic chips. In contrast, the plastic shadow masks tend to some wrinkling and do not attach entirely planar to the substrate. This causes a rather large spread of device characteristics, which severely limit's the choice of circuit topologies that can be realized.

Circuit designers can therefore benefit from both the considerably higher transistor speed and the freedom to apply any circuit topology known from microelectronic circuit design. This led to the successful 6-bit DAC demonstration at ISSCC 2011, which is a 1000 times faster and 30 times smaller circuit than state-of-the-art.

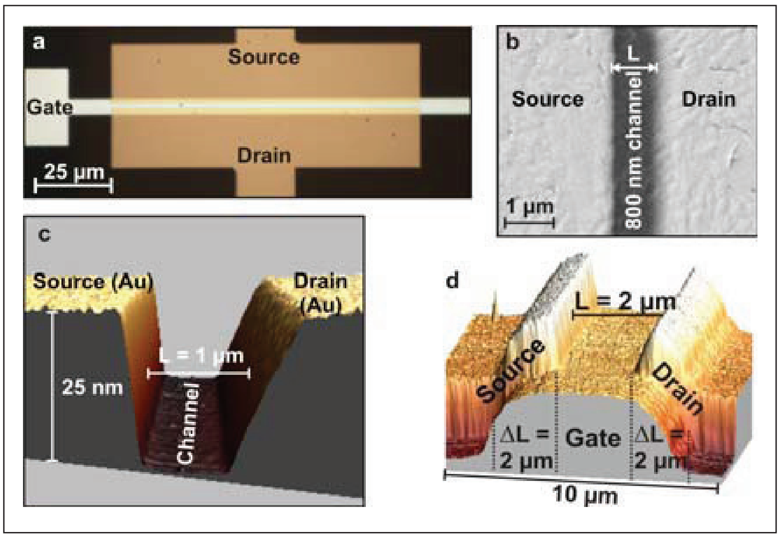


Fig. 2: Top view test transistor (a); REM photograph transistor channel (b); section view of transistor channel (c); section view of test transistor (d)

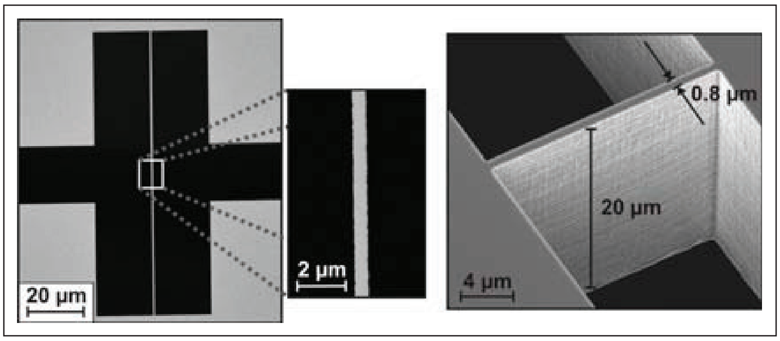


Fig. 3: Microscopic details of the transistor structure on the stencil mask

OTFT applications

The OTFT is viewed as the basic device technology considered for future flexible electronic products. This includes flexible displays (so-called electronic paper), diagnostic tapes for medical monitoring and life sciences, radio-frequency identification (RF-ID) tags as a smart replacement for the barcode, smart ticketing and smart signage. The fabrication technology is quite different from microelectronics manufacturing. Flexible electronics will be fabricated by using high-throughput roll-to-roll printing technologies that will be derived from paper printing processes. There is even the vision to fabricate a sheet of electronic paper by using an inkjet printer similar to that on an office desk.

While flexible electronics has potential to take a considerable part of the low-cost electronics market it will not be able to compete with microelectronics in terms of performance and integration density. Therefore hybrid solutions combining large-area organic electronics with thin flexible silicon chips may emerge in the future. For that reason there is a strong need for organic electronic transistor technology that operates at the same supply voltage as microelectronic chips.

Equipment

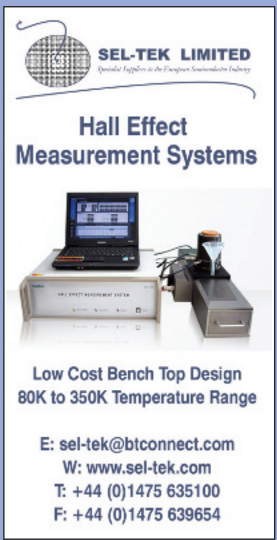
Automation & Wafer Handling

Connection Solutions

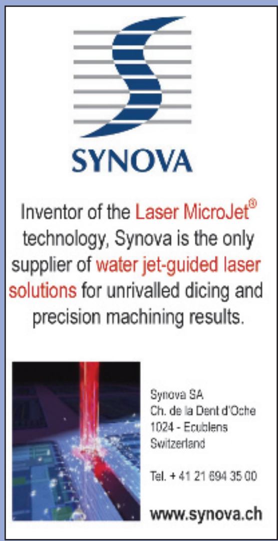
Furnaces

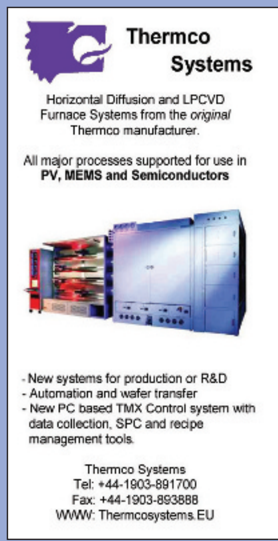
Furnaces

Chemical Pumps



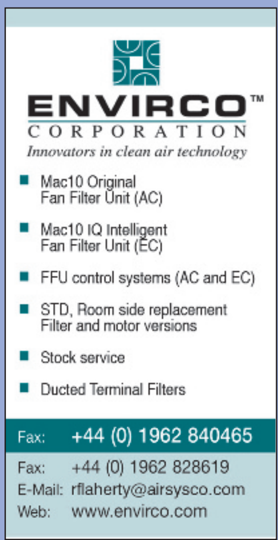
Dicing & Cutting





Cleanrooms

Fan Filter Units



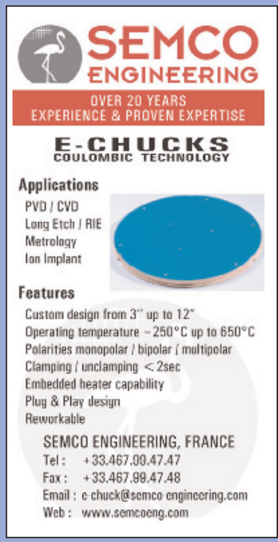
Furnaces Spares

Equipment

Gas Handling & MFC

Megasonic Cleaning Systems

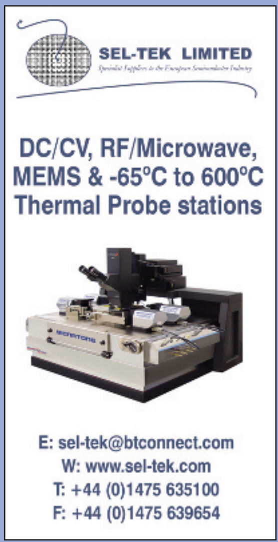
RF-/DC-/MF-Power Supplies



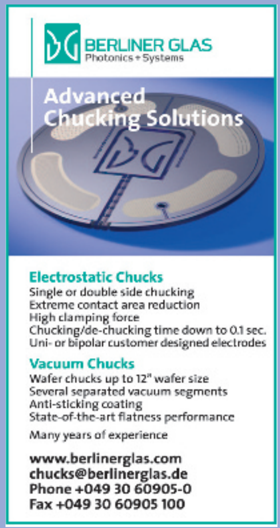
Service & Repair

Gas (High Purity) Process Control

Metrology Systems



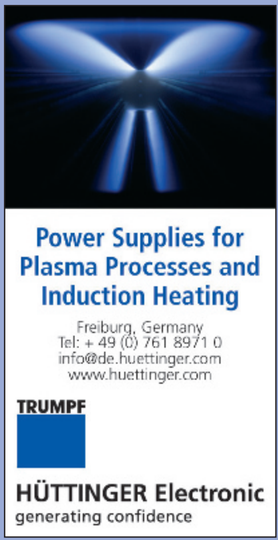
Semiconductor Equipment

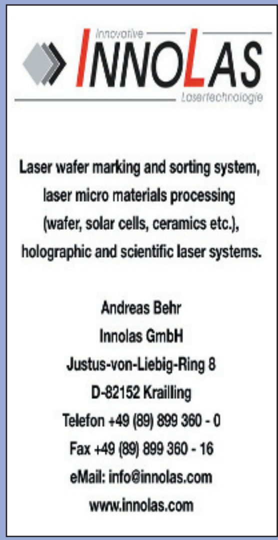


Solder Rework

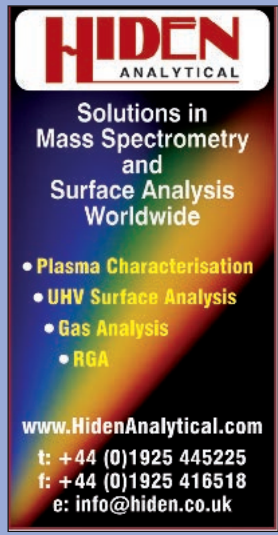
Glove Boxes

RF-/DC-/MF-Power Supplies





Vacuum Equipment



Equipment

Vacuum Equipment

Innovative Solutions
for Semiconductor, Solar and Thin-Film Technologies
EBARA

Vacuum & Gas Abatement
- Dry vacuum pumps
- Turbomolecular pumps
- Gas abatement systems
- System engineering

Wafer Processing Systems
- CMP
- Electroplating
- Bevel polishing
- Ozonizers

EBARA
Precision Machinery Europe GmbH
Tel.: +49 6181 1876-0
info_pm@ebara-pm.eu
www.ebara-pm.eu

Valves / Gas Control

ROTAREX

UHP/HP GAS HANDLING COMPONETS & EQUIPMENT

SELFA. Valves & Regulators: UHP
GAZEL. Face Seal, Weld & Micro Fittings: UHP
MTA. Cylinder Connections & Gaskets: UHP/HP
SMT. Regulators & Change Over Panels: Lab/Med
SAGANA. Fittings & Valves: Instrumentation

G2000A/M. Gas Cabinets, Manual & Automatic Deep Purge Blocks, VMBs, POU, Special Systems Controllers. Automatic Change Over, Cylinder Scale Platform & Readouts. Monitors (inputs)

Coventry CV7 8JE
T. +44(0)2476622675
F. +44(0)2476331944
E. davidhixonselfa@aol.com
W. www.rotarex.com

Wet Benches

TSE
leading in technologies

TSE-Systeme GmbH
Hardstraße 9
78256 Steisslingen - Germany
Tel.: +49 (0) 7738 / 939 959
Fax: +49 (0) 7738 / 939 960
info@tse-systeme.com
www.tse-systeme.com

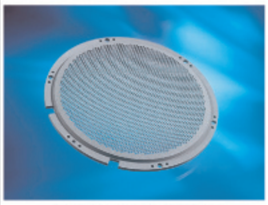
Carbon Based Materials

CARBONE LORRAINE

Your specialist in materials solutions for the semiconductor Industry

Unique competences for carbon and graphite materials

- Purified graphite
- SiC coating
- Carbon & graphite enhancements
- Insulating materials



Carbone Lorraine Composants
Tel.: +33 (0)1 41 85 45 14
Fax: +33 (0)1 41 85 43 53
semicon@carbonelorraine.com

Vacuum Equipment

oerlikon
leybold vacuum

Vacuum Technology
- Systems
- Solutions
- Services

Oerlikon
Leybold Vacuum GmbH
Bonner Strasse 498
D-50968 Cologne

T +49 (0) 221-347-0
F +49 (0) 221-347-1250
info.vacuum@oerlikon.com
www.oerlikon.com

Wet Benches

arias
wet benches & more

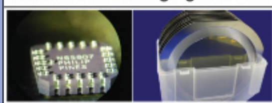
arias gmbh
- wet process equipment
- laminar flow units
- chemical supply systems
- acid and caustic cabinets

www.arias.de
Phone: +49 (0) 2304 971 12-0

Wafer Level Packaging

PAC TECH
PACKAGING TECHNOLOGIES

Wafer Level Packaging Services



- Electroless NiAu & NiPdAu UBM
- Solder Jetting for Micro Ball Placement
- Wafer Level Solder Balling
- Wafer Level Solder Rework/Reballing
- BGA & CSP Rework/Reballing
- Wafer Level Redistribution
- Wafer Thinning & Wafer Dicing
- Wafer Backside (Laser) Marking
- Automatic Optical Inspection AOI
- X-Ray Inspection
- Tape & Reel Service

Pac Tech Packaging Technologies GmbH
Tel: +49 (0)3321-4495-100
Email: sales@pactech.de
www.pactech.de

Metals

GoodFellow

For Metals & Materials for Research & Industry

Pure Metals, Alloys, Polymers, Ceramics, Composites and Compounds

Goodfellow Cambridge Limited
Huntingdon, UK
Tel: +44 1480 424 800
Fax: +44 1480 424 900
E-mail: info@goodfellow.com
www.goodfellow.com

Vacuum Equipment

PFEIFFER VACUUM

Pfeiffer Vacuum
Headquarters/Germany
Phone: +49 (0) 6441 802-0
Fax: +49 (0) 6441 802-202
info@pfeiffer-vacuum.de
www.pfeiffer-vacuum.net

Wet Benches

PAC TECH
PACKAGING TECHNOLOGIES

Electroless Plating Line

PacLine 300 A50

- Electroless NiAu & NiPdAu UBM
- Maximum Flexibility: 6", 8", 12"
- UPH: 600.000 wafer/year (6" & 8"), 450.000 wafer/year (12")
- In-line Bath Control & Replenishment
- GUI according SEMI standard
- SECS GEM Interface
- Installed at leading OEM production sites
- Compliant with Semi S2 & FM 4910

Pac Tech Packaging Technologies GmbH
Tel: +49 (0)3321-4495-100
Email: sales@pactech.de
www.pactech.de

To promote your Products and Services cost effectively to all our buyers and specifiers, take advantage of the new Sources of Supply section.

A Sources of Supply entry is effective, and an easy way of promoting your products and services for the full year.

Additionally your entry will be seen at major exhibitions and events throughout the year.

For further information, please contact: Shehzad Munshi
T: +44 (0)1923 690 215 E: sm@angelbcl.co.uk

Entries in Sources of Supply @ £1,500 per heading per year.