Electronics gases – The clarity and confidence driving consumption

By Rob Cockerill, published in gasworld magazine | 1 February 2018

Rewind 3 to 4 years, and much of the conjecture in the electronics business surrounded the next wave of expected technologies and wafer fabrication processes, from 450mm wafers to 14 nanometer (14nm) node transistors to lithographic patterning.

This created a collective feeling of uncertainty at the transition to these new technologies and a fear of being either the early adopter – and potentially the bearer of many pitfalls that this might bring – or slow on the uptake and quick to lose ground in this fast-paced business.

Coming out SEMICON West 2017, however, was a newfound vibe of clarity and confidence, for the electronics industry is in a moment of relative certainty – with less confusion about ‘the next big thing’ and more conviction in the technological roadmap it aims to pursue. That roadmap is one of continuous innovation: less doubt, more confidence.

This translates into seemingly less upheaval and apprehension in the marketplace – from the major OEMs right through to materials suppliers such as those in the gases industry. Following the event, Head of Market Development at Linde Electronics, Dr. Paul Stockman, told gasworld, “I think what we see now, from an industry point of view, is that it’s less about discrete innovation, with questions such as, what is the next node? With the advent of 3D structures and with the complexity at the leading-edge of logic and foundry, I think what we see is that the industry is proceeding at more of a continuous innovation.”

For electronics materials suppliers like Linde, this translates to increasing demand for consistency and quality in bulk, specialty and rare gases delivery. “For us, this is relevant in terms of the technology with these 3D structures; it’s much more about deposition and etch from a specialty gas perspective,” Dr. Stockman added.
The gases industry has certainly appeared to witness a surge in demand for specialty and ultra high purity (UHP) gases, with China in particular at the forefront of growing electronics gases demand. China has become one of the largest countries to consume semiconductor devices in the world, in fact around half of all new semiconductor fab investments in the next few years will be in China, according to global trade association Semiconductor Equipment and Materials International (SEMI). gasworld Business Intelligence also identified that total sales of gas to China’s electronics sector amounted to around $880m in 2015 – and growing.

In the last 12 months alone, there have been various plant start-ups or project announcements in China, including:

- **March 2017** – The Linde Group revealed a multi-million-euro investment in new onsite gas production facilities in the eastern and central provinces of China. Through Linde LienHwa and Linde's Engineering Division, it aimed to design, construct and commission multiple gaseous nitrogen plants with a combined capacity of over 110,000 Nm³ per hour, plus several other bulk gas supply systems by the end of 2017.

- **April 2017** – Air Products commissioned a new plant in Chongqing City, western China, to support the country's burgeoning electronics manufacturing industry. The site supplies China’s highest-generation, most efficient thin-film transistor liquid crystal display (TFT-LCD) fab, owned and operated by Chongqing HKC Optoelectronics Technology Co. Ltd, with high-quality bulk gases, including high-purity nitrogen, oxygen, hydrogen, argon and helium.

- **June 2017** – Taiyo Nippon Sanso Corporation (TNSC) is expanding its electronics gas manufacturing capacity in Asia, after breaking ground on a new plant in Yangzhou, China in June. The electronics gas plant is being built at the Yangzhou Chemical Industry Park (YCIP) in Jiangsu province, China, to support increasing demand for electronics gases in Asia and will commence operations in 2019. The investment is part of a new ‘Total Electronics’ function the company has established in Shanghai, to “prepare for increasing electronics gas demand and rapidly changing technology trend of global semiconductor manufacturers and market.”

Rare gases are also in vogue. "One of the messages we had going into the show was about rare gases," said Dr. Stockman. "These are becoming increasingly important in semiconductor manufacturing, all the way from the traditional laser gases that have been used for the past 30 years, as well as new applications in laser anneal for both semiconductor and for display, to etch assistance for some of the 3D structure processing."

"For Linde, we have the largest portfolio of our own sources of rare gases being made in our air
Electronics gases – The clarity and confidence driving consumption

separation units, as well as a portfolio from third party sources. This is definitely a message that we put out before the show and we continued to follow up with both in terms of defining who are and how we invest in customers, as well as for specific customer interactions.”

Linde has over 35 captive air separation units (ASUs) with rare gas production and in 2016 announced that it was increasing neon capacity by 40 million litres at a newly installed neon production facility in La Porte, Texas. The company has also been adding rare gas processing capacity at its Medford, Oregon plant and completing a xenon expansion project at its Alpha, New Jersey plant to meet the high-volume commercial adoption of xenon for etch applications in new 3D semiconductor structures.

Key trends

On the technology front, the fruition of the Internet of Things (IoT) has created a lot of stability and optimism in the semiconductor industry – even for legacy 200mm wafer fabs.

“Right now we're in the midst of one of the strongest cycles in recent years in terms of dollar value, but also important for a materials supplier like Linde in terms of the number of chips, the complexity of those chips, and the amount of silicon area that's under manufacture,” he said.
"A theme that we saw mature this year was the whole buzz around IoT. A few years back there was quite a lot of hype around how many billions or even hundreds of billions of things there were that were going to be connected. A few years on from that initial wave of hype and I think we have actually seen the reality develop underneath that. For us and for our customers it's quite encouraging, it becomes much more concrete about how things are going to work."

He elaborated, “What we see are at least two distinct markets that are going to come out of this. On the Things side, all of the smart devices, this was the hype part [of recent years] and this is becoming much more concrete; these things are getting manufactured, we see it in our own everyday lives with the number of things you are connecting to, and how your home or business network is increasing at a very fast pace."

“These things need to be quite small, quite cheap, and what it means for our customer portfolio is that the capacity to manufacture at older technology nodes in logic and foundry are being very well supported by these. In fact, there's even an uptick in 200mm [wafer] manufacturing."

This is an interesting point where both the industry and the gases it requires are concerned; 300mm wafers came in at the beginning of the 21st century and within a decade or less, most manufacturing in terms of silicon area was at the 300mm level. Legacy 200mm fabs were therefore in danger of becoming a thing of the past, but the realisation of IoT is breathing new life into these trusted sites. “There's a huge number of 200mm fabs out there that are 15, 20 or more years old – and they have found a new lease of life with this IoT application wave,” affirmed Dr. Stockman. “And these Things are extending not only to devices in our houses but to businesses, cities and even smart vehicles. All of this is loading up these legacy fabs.”

“At the same time, the cloud is getting very well supported and accelerating this growth. Most of these things aren't so smart themselves, but they're sending data and having it processed and then returned to them over high-speed networks and the data is being stored and processed in cloud computing centres. So this is driving not only the expansion of the types of server logic and memory chips that are required for the cloud, but it's also pushing the innovation on those chips to make them faster and safer."

“If you follow the loading of 200mm fabs, it was never like they were on some sort of death spiral, but they have levelled off. Now there's an uptick in the loading and, in fact, SEMI was reporting that market for used 200mm equipment is actually becoming quite active and main equipment manufacturers are actually building quite a bit of new 200mm equipment just to meet the demand.”
All of which is challenging companies like Linde to improve the quality and consistency of materials that they’re delivering to customers.

**Clarity**

Another trend to emerge from last year’s SEMICON West event was the increased certainty in extreme ultraviolet lithography (EUV) on the technology roadmaps of the major manufacturers for new leading-edge fabs.

On the future technology roadmap for some time now, but a source of much hesitation in recent years, the confidence in EUV is another trend helping to bring about clarity and assurance in the business. “Overall, the observation would be that things are very positive,” Dr. Stockman concluded.

“We’re in the midst of a cycle that economically is quite positive, and the strongest we’ve had in recent years, and from a technology point of view I think that things are quite clear for our customers in a way that they haven’t been for quite a while. Not to say that people were stymied, but things have become much more settled in terms of the technology roadmap.”