

## ElectronicsIQ.

Information Quarterly from Linde Electronics.

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## Solar success.

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### Spring 2012

#### Welcome to ElectronicsIQ, your update from Linde Electronics.

Electronics manufacturers worldwide are creating unprecedented demand for specialist gases and solutions. 2011 has been a particularly exciting year for Linde in Asia, with leading TFT-LCD manufacturers choosing Linde's gas technology solutions, highlighting the company's continuing expansion across the continent.

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## Green future for manufacturing.

Very large volumes of ultra-high purity gases play a critical part in the manufacture of TFT-LCD screens. They are used to create the microscopic thin-film transistors required to control each of the thousands of pixels that make up the visible image. According to IHS iSuppli, global large panel area capacity is set to increase by 78 percent in the next four years, reaching 283 million square metres by 2015. Due to the rapid growth of this market, it is essential that the manufacturing processes used are as environmentally sustainable as possible.

To illustrate, when building the thin-film transistors on the back-plane of a display, silicon films using a chemical vapour deposition (CVD) process must be etched to create the required patterns. That CVD process also deposits quantities of silicon on the inside of the process chamber, which must be cleaned to maintain production efficiency. Both these etching and cleaning processes use fluorine based gases. As the process chambers need to accommodate glass substrates with an area of more than five square metres, the amount of gas required is very large. Moreover, the gases used have very high global warming potential (GWP) – sulphur hexafluoride (SF<sub>6</sub>) used for etching, has a GWP 23,900 times that of CO<sub>2</sub>, while nitrogen trifluoride (NF<sub>3</sub>) used for cleaning, has a GWP of 17,200. So, with a typical Gen8 facility requiring upwards of 300 tonnes of such gases per year, the environmental impact is very significant.

**Due to the rapid growth of the TFT-LCD market, it is essential that the manufacturing processes used are as environmentally sustainable as possible.**



To minimise process emissions, many manufacturers are looking into materials with lower GWP. One strong contender is fluorine gas (F<sub>2</sub>). It is the simplest molecule containing fluorine atoms and has the lowest bond energy. High purity fluorine gas is the highest performance cleaning gas available, improving productivity on CVD tools, reducing energy consumption and environmental impact with zero GWP. Because of these advantages for both the environment and the displays manufacturers' cost of operations, Linde encourages more companies to switch their NF<sub>3</sub> and SF<sub>6</sub> supply volumes with F<sub>2</sub>. This will deliver more tangible benefits than is achievable with any other programme, helping to safeguard a greener future for display manufacturing.

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## Helping microelectronics manufacturers slash CO<sub>2</sub> emissions

Research sectors and manufacturers of photovoltaic, semiconductor and TFT-LCD devices are adopting fluorine (F<sub>2</sub>) as a more environmentally friendly, efficient and secure alternative to the greenhouse gas nitrogen trifluoride (NF<sub>3</sub>) for the cleaning of Chemical Vapour Deposition chambers. To meet the increasing demand for F<sub>2</sub>, the Linde Gases Division has opened a new manufacturing facility in Inju City, South Korea to produce next generation on-site F<sub>2</sub> systems equipment. The state-of-the-art 3,700 square-metre site features the latest equipment assembly and chemical processing facilities. The new EUR 2.5 million plant aims to reduce microelectronics manufacturers' CO<sub>2</sub> emissions by more than 3 million tonnes by facilitating F<sub>2</sub> adoption. The new facility will support the continuous growth of Linde's Asian customer base and enable the company to better serve its global customers with the quality, innovation and value that they have come to expect from Linde on-site F<sub>2</sub> technology. Located adjacent to the Linde Fluorine Centre of Excellence in the Yellow Sea Free Economic Zone, 60km south of Seoul in South Korea, the new site also houses a dedicated Linde electronic special gases facility.



## Solar success



Capitalising on the return of growth to the photovoltaic (PV) industry in 2010-2011, Linde has secured over 25 new contract agreements and renewals with leading thin-film and crystalline silicon manufacturers worldwide. These include strategically important agreements such as Schueco and Bosch in Germany, GCL and Renesolar in China, as well as business expansion with Suntech, Trina and Motech.

This increase in new business has seen Linde's global PV customer capacity treble to 17.4GW. The majority of this growth has been fuelled by customers in Greater China, establishing new production capacity of nearly 13.5GW.

Linde is well positioned to take advantage of the renewed investment into amorphous silicon in 2012 and expects to supply its award-winning fluorine generation technology to additional customers worldwide. The company is also moving to offer its fluorine expertise for the production of crystalline silicon, which is still expected to dominate the market in 2012, maintaining more than 70 percent market share.

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## My Life at Linde

### Welcome to the 'My Life at Linde' hot seat Mathilda, let's start by hearing a little bit about your role at Linde...

I am a Manager for Global Total Gas and Chemical Management which involves me providing best practice advice to customers on our onsite services and working closely alongside them to ensure their installations run smoothly. I also work on operations, helping with expansion into new, emerging markets. It's a fascinating role which challenges me and perfectly suits my enthusiasm for helping customers to solve their problems.

### So what does your schedule look like on an average day?

My typical day in the office starts with responding to a wide range of customer enquiries and convening meetings to ensure that all projects are running as effectively as possible. I'm often on the road, carrying out site reviews, training and helping to set up new sites. It's a very intensive customer-facing role but equally very varied and satisfying.



### Tell us about your proudest achievement during your time at Linde?

The highlight for me has been winning Linde's first onsite services contract in Singapore with a major semiconductor customer. The icing on the cake was getting praise from the customer for demonstrating the best operating practices and values! Another interesting project was working on the TGCM, Chemlab and ESG's new start-up in East Malaysia in 2006 – learning about the customer's culture was a fabulous experience.

### What excites you about working at Linde?

I've been at Linde for five years and met some great people, both locally and worldwide. I'd have to say that the best part of my job is travelling around the world meeting international customers and other Linde team members. People are at the heart of everything that Linde does and the company promotes interaction among colleagues to share ideas and new innovations.

### Quick-fire questions

#### 1. Describe your role in three words

Exciting, multicultural, dynamic

#### 2. Describe your colleagues in three words

Warm, 'winning spirit', collaborative

#### 3. Tell us an interesting fact that we might not know about Linde

There's a legacy Linde fridge at a supermarket in Singapore!



## Linde heads TFT-LCD boom in China with landmark gas facility



TFT-LCD manufacturing processes are calling for more technologically advanced, cost effective and environmentally sustainable solutions. Growing local demand has made China a preferred manufacturing location for flat panel displays and the country's government has recently launched historic projects to boost the growth of its TFT-LCD industry. As a significant contributor to these investment projects, Linde LienHwa has opened a major ultra-high purity gas plant at BOE's latest 8.5 generation TFT-LCD manufacturing facility in the Beijing Development Authority. This is one of China's largest nitrogen generator installations and the on-stream supply at BOE's facility further reinforces Linde's leading position in bulk gases supply to the booming electronics market in Asia.

## Linde and UCLB drive forward nanotube commercialisation

To facilitate the commercialisation of single-wall nanotubes (SWNT) in applications such as touch screen displays and photovoltaics, a team of scientists from University College London and Imperial College has developed an innovative process to separate and purify SWNTs. Unlike existing systems that produce very low yields and can result in damage to the nanotubes, this ground-breaking process is high-yielding, cost-effective and, crucially, commercially scalable. Linde has licensed this technology with to bring to market high-value carbon nanotube materials that will offer superior performance and value in different applications.



## Linde builds the largest nitrogen generator of its type in China



TFT-LCD fabs require a reliable supply of high quality raw materials. To meet the demands of the fast-growing Chinese TFT-LCD market, Linde has invested RMB 200 million (EUR 22 million) to build an on-site gases supply facility at the new Gen8.5 TFT-LCD fab of China Star Optoelectronics Technology (CSOT) in Shenzhen. Linde will construct the largest on-site nitrogen generator of its type in China for the site, which is designed to produce 100,000 LCD panels per month and 17 million LCD TV modules per year. Linde and CSOT will also engage in a joint study examining the role of gases in facilitating the industrial and technological development of the region.

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