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# Linde ERDC shines a light on new material development

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Linde Electronics, a member of The Linde Group, is one of the major global manufacturers of bulk and electronic specialty gases used during the manufacturing of semiconductors, displays, solar panels, LEDs and other electronics products.

Facing the severe challenges of advanced semiconductor process technology nodes in sub-micron grade of silicon chips manufacturing, the company established Linde Electronics research and development center (Linde ERDC) in 2016 to enhance its local capabilities and product portfolio to meet growing demands from industries. Linde ERDC, located at Taichung Harbor Related Industrial Park in Taiwan, is a two-floor building design with advanced gases analytic laboratories and a product development centre. This ERDC has been operating to provide analytic services of high-purity electronic gases in Asia Pacific regions and is also focusing on the development of new materials, packages and services. It has supported the launch of several joint development projects to test and make new materials in-house with the closed collaboration with customers and third-party suppliers for the purposes of reduced cost, process and development time.

During a recent interview, Linde Electronics' head of Electronics Technology and Innovation, Carl Jackson, pointed out that the global leading-edge pure-play semiconductor foundries have been in a tight race to lead process technology development and are migrating from 10 to 5 to even 3 nanometers in the coming years. It is becoming more critical for them to improve their electronic performance by integrating other materials when processes push the limits of silicon physics, especially considering the joint development of ultra-purity materials. Meeting this challenge is a key driving force for Linde ERDC working in tight cooperation close to customers.

Jackson observed that in the early 1990s period, some materials being supplied were in the of 99% purity range. Today, industries are requesting products of 7N grade, which means 99.99999% purity, with the possibility to move to even tighter product purity specifications in the next few years. For those ultra-high purity materials, it is very important for the customers such as for Taiwan first tier semiconductor and electronics manufacturers to request proper measurement of the materials when various chemical treatments purifies them through processes. This is why Linde ERDC plays an important role in advanced process development fields.

Another obvious benefit of Linde ERDC has been largely used by local customers: testing speed of the labs. Most Asia clients prefer to send the sample to a local analysis laboratory in order to obtain results faster. This is one of the the reasons why Linde Electronics continues to invest in local capabilities in Asia Pacific.

Linde Electronics' non-stop efforts to pursue material development excellence achieves the strengthening of corporate core competence successfully. These strategies also leverage the synergy to maximize customers' value and win the market. Taiwan semiconductor manufacturing service providers own the superior manufacturing capability and readily react instantly toward the rapidly changing market. Therefore, Linde ERDC partners with Taiwanese companies to form a competitive edge and to be successful in the market. Here is the Q&A with Carl Jackson.

**Q:** Linde ERDC was opened at the end of 2016. What has happened since then?

**A:** Well, the first thing to say is that overall Linde Electronics had a very positive year in 2017. We are continuing to invest significantly in this region both in our on-site business, but also in our electronics special gases capabilities, so the set-up of this facility looks to be well-timed to support this growth and is fully aligned with our "Local Partner,

Global Expertise" strategy.

From the ERDC perspective, we have been very busy with one of our main activities here, which is the "fingerprinting" of materials. This means essentially processing materials through all our analysis systems to enable us to see a complete profile of the material quality, often looking much deeper than the standard specification. With this information, we are better positioned, for example, to ensure that our sub-suppliers' raw material meets our demanding operational requirements or that we are able to quickly support our customers should they need to fix or improve a particular process.

Another focus area that we continue to ramp is the development of new products, in collaboration with our customers. For a material supplier like Linde Electronics, the definition of a new product has a broad scope. We can be talking about a new molecule not conventionally used in IC manufacturing that is needed to enable a new process application. It could be an existing material that is required at a higher purity, it could be a new method or equipment to deliver materials to the customer process, or it could be a combination. We are working on examples of all of these new products here in Taiwan.

**Q:** How is having a local R&D team helping to bring value to customers in this region?

**A:** Our investment in this facility has been very well received by our customers, who have been very quick to see the additional service and support these physical capabilities can provide. However, enabling us to get the most value out of these capabilities is our local team, which is centered here and stretches out into China and Korea.

Clearly we have put a lot of emphasis on being close to our customers, which is essential when trying to coordinate the type of complex development projects that we manage. Sometimes technology does help and we can work effectively as a virtual team; however, for most projects, we need to be here, we need to be local to really understand what the customer needs and when, and we need to deliver on our commitments.

Working with our regional businesses has also benefited from our new capabilities here enabling the Improvement of supply chain reliability for certain existing products. We are working on several initiatives to help our regional business localize the production of electronic specialty gases or other value-added activities so that our customers have ready access to local supply of products rather than having to rely on the traditional long supply chains.

**Q:** Following the success here in Taiwan, do you plan to add more R&D centers in other countries in Asia?

**A:** Linde has a significant and long-established R&D presence already in China, for example, serving our related industry sectors such as Metals and Glass, Food and Additive Manufacturing. From an electronics perspective, we are well positioned in Taiwan to serve all customers in the east Asia region. It is possible in the future that we could expand our advanced analytical capabilities, however, for product development, you need a certain critical mass of highly specialized personnel, who operate most effectively when co-located so we will continue to build our development team here.

**Q:** What main challenges do you see looking forward?

**A:** Our customers' speed and scope of technological innovation is relentless. Keeping pace with this and ensuring we are working in the areas that bring most value will remain a challenge as no material supplier can effectively operate in all areas. As I mentioned earlier, we have been seeing more and more non-traditional materials on the customers' development planning roadmaps, which can present an analytical challenge for us. Also, these materials may be supplied as liquids or solids, so the delivery from the source to the tool also needs a significant amount of focus to bring to high-volume manufacturing readiness.

That said, we have a lot of experience successfully serving this market and are further encouraged by our experience during our first full year of operation here in Taiwan. We feel very well positioned to be able to work with our customers to solve these challenges in a way that also supports our continued growth and investment in this region.



Head of Linde T&I E, Carl Jackson



Inner view of Linde ERDC



Linde ERDC

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