ESGs Contribute to Advanced Semiconductor Manufacturing Processes

Semiconductor manufacturing processes are increasingly advanced and the next technology nodes at 5nm or 3nm are at atomic levels. The sophistication and complexity of manufacturing processes are beyond imagination. Devils are in details especially with the integration of new technologies such as 3D additive manufacturing and heterogeneous integration SiP. Electronic Special Gases, ESGs, serve to smoothen, clean and separate different layers in the processes. Optimistic about the development of semiconductor industry in Taiwan, Linde LienHwa (LLH) has invested significantly in the R&D and production of ESGs.

Expert in electronic gases and chemical technologies, LLH launched its highest quality brand of electronic materials: SPECTRA® EM at SEMICON Taiwan, highlighting on the purity, packaging and analytical technologies. According to Anshul Sarda, Vice President of Electronics Materials for the Linde Group, the ESG products include \( \text{C}_3\text{F}_8 \), \( \text{CF}_4 \), \( \text{CO} \), \( \text{F}_2/\text{N}_2 \) mixture, \( \text{HBr} \), HCDS, \( \text{NF}_3 \), and \( \text{SF}_6 \).

In general, semiconductor manufacturing processes include: etching, cleaning, doping and lithography. ESGs are required at every step. Jason Chow, Head of Linde’s local venture, Linde LienHwa Industrial Gases Co, made an analogy between semiconductor manufacturing processes and cooking. ESGs are spices in this analogy. SPECTRA-N nitrogen generator provides flexible and high-efficiency nitrogen supply to the semiconductor and display industries. SPECTRA lithography gases have pioneered reliable, precision blends of neon-halogen mixtures, which have enabled DUV (deep UV) lithographic patterning for high performance and efficiency manufacturing.

Linde LienHwa has recently commissioned production of two of the newest SPECTRA EM products, fluorine mixtures and hydrogen bromide (HBr). Fluorine is a highly reactive gas and it is combined into a 20% blend with nitrogen to yield a mixture that is safe for compression, packaging and transport. The fluorine mixtures are used to clean semiconductor manufacturing equipment. In addition, LLH has invested in China to create a new source of electronics-grade hydrogen bromide (HBr). HBr is a compressed gas that is used as a selective etchant, allowing semiconductor manufacturers to remove one material while leaving a second material untouched. This process has become increasingly important as leading-edge chip manufacturers
produce 3D structures to make transistors smaller, faster and use less power.

The sophisticated semiconductor manufacturing processes tolerate no mistakes, so Carl Jackson, Head of Electronics for Linde’s Technology and Innovation Group, elaborated that impurity of ESGs can result in circuit malfunction, especially in advanced processes. That is why LLH attaches great importance to the purity of gases to offer the highest-purity ESGs to semiconductor fabs. In the future, LLH will continue its investment in Taiwan to provide high-quality, reliable, and consistent ESGs, and strengthen security management by training their clients on product safety and by requesting its staff stationed in the fabs to follow strict and standardized procedures to handle more dangerous types of gases.
電子特殊氣體成就先進半導體製程

半導體製程越來越複雜，未來的3.5奈米已經進入原子等級的尺度，製程的細膩與複雜不言而喻，在此，再加上許多新興技術如3D堆疊、異質整合系統級封裝（SiP）等，製程中有更多細節必須兼顧，電子特殊氣體（Electronic Special Gases，ESGs）將在半導體製程中協助晶片製作，將不同的成分依照層次、間隔、不同Layer等，聯華林德看好台灣半導體產業發展，積極投資研發與生產活動。

專長電子氣體與化學品技術的聯華林德，在Semicon Taiwan推出SPECTRA EM系列的電子材料，強調純度、包裝和分析技術，該公司電子材料副總裁Anshul Sarda（圖6）表示，其ESGs產品包括濃氫氟化（CF8）、四氟甲烷（CF4）、一氧化碳（CO）、氟氫氮氣（WF6）、六氟乙硼烷（BCF6）、三氟化砷（AsF3）、六氟硫化物（SF6）等。

一般半導體製程包括：沉積（Deposition）、光刻（Lithography）等階段都需要使用電子特殊氣體，聯盟科技總經理黃維哲形容，若將半導體製造過程以做菜來形容，特殊氣體扮演的就是調味的角色，SPECTRA-N氮氣產生器為半導體和面板產業提供潔淨、高效能的氮氣供應，SPECTRA-PM氮氣產生器，以先進製造技術和深度外延（Deep UV, DUV）光刻能夠應用於高階、高精度製造。

聯華林德近期投入兩種SPECTRA EM新產品的生產，氫氟碳氣體及全氟化氫，氫氟碳化合物是一種高活性氣體，與20%的氫氣混合後會產生用於安全設備，作為裝載與運輸的混合氣體。可用於清潔半導體製造設備，此外，也在中國投資建廠，提供電子級高純化氫（HBr）產品，用於選擇性鍍金進修的綠化氣體，將其用於去除材料的同時能保留所需材料的不變形，特別會應用在3D包裝製程中。

另外，晶片製程精細，因此在氣體應用上也有所不同，聯華林德電子技術及創新研發總監Carl Jackson指出，電子特殊氣體純度不夠會使電路產生問題，尤其在先進製程，因此該公司也非常重視氣體的純化程度，積極提供半導體廠純度最高的電子特殊氣體，未來，聯華林德也將持續投資台灣，提供品質、可靠度、一致性兼具的電子特殊氣體，並加強安全管控，除了顧到客戶使用安全性之外，也透過駐廠人員在嚴格的標準化管理下，直接操作具危險性的氣體，確保使用的安全性。