

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 Sarada, Vice President of Electronics Materials for the Linde Group, the ESG products include C_3F_8 , CF_4 , CO , F_2/N_2 mixture, HBr , $HCDS$, NF_3 , and 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.

版圖，像是在台灣技術中心引進 KLA SP3晶圓檢測系統，讓該公司在台灣的晶圓檢測能力擴展至19奈米，得以自行產出晶圓缺陷的數據，以引導新產品開發及改善產品性能。

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，製程的精細與複雜不言而喻，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平坦化、清潔、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產品包括全氟丙烷(C3F8)、四氟甲烷(CF4)、一氧化碳(CO)、氟氮混合氣體、溴化氫(HBr)、六氯乙矽烷(HCDS)、三氟化氮(NF3)、六氟化硫(SF6)等。

一般半導體製程包括：沉積、蝕刻(Etch)/清洗(Cleaning)、摻



圖6 林德集團電子材料副總裁Anshul Sarda(左)、林德電子技術及創新研發總監Carl Jackson(左二)、聯亞科技總經理周祖堯(右二)、林德電子行銷經理Francesca Brava(右)。

雜(Doping)、光刻(Lithography)等階段都需要使用電子特殊氣體，聯亞科技總經理周祖堯形容，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料的角色，SPECTRA-N氮氣產生器為半導體和面板產業提供彈性、高效能的氮氣供應；SPECTRA光刻氣體推出可靠、精確的氟氮與鹵素氣體混合物，使得深紫外線(Deep UV, DUV)光刻能夠應用於高性能、高效率製造。

聯華林德近期投入兩種SPECTRA EM新產品的生產，氟氮混合氣體及溴化氫。氟氮是一種高活性氣體，與20%的氮氣混合後會產生可用於安全壓縮、包裝和運輸的混合氣體，可用於清潔半導體製造設備。此外，也在中國投資建廠，提供電子級溴

化氫(HBr)產品，用於選擇性蝕刻劑的壓縮氣體，將其用於去除一種材料物質的同時能保留所需的材料物質不受影響，特別會應用在3D構裝製程中。

另外，晶片製程精細因此在氣體應用時也不容差錯，林德電子技術及創新研發總監Carl Jackson解釋，電子特殊氣體純度不夠會使電路產生誤差，尤其在先進製程，因此該公司也非常重視氣體的純化程度，希望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，除了訓練客戶使用安全性之外，也透過駐廠人員在嚴謹的標準化步驟下，直接操作具危險性的氣體，確保使用的安全性。