electronics e-learning center

FEOL Dielectric Materials (Silicon Oxide and Silicon Nitride)

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As the semiconductor industry moves toward smaller process nodes, the fabrication of transistors for both logic and memory devices continue to grow even more complex as the device dimensions keep shrinking and the performance requirements increasing.

Silicon nitride and silicon oxide dielectric films continue to be employed for sidewall spacers, but the film requirements are undergoing significant changes. Not only are the films used as mask materials for controlling ion implantation profiles, they are also being employed to create very high tensile or compressive stress to improve the device performance by increasing the carrier mobility. For Flash and DRAM memory manufacturing, silicon nitride and oxide are finding new applications such as sacrificial films to assist in patterning, protection layer for other films, etching stops, and diffusion barriers. These applications cannot all be addressed by just one composition of nitride or oxide. Therefore, there have been emerging needs for nitride and oxide-based films with certain properties including tunable wet and dry etching rates, variable dielectric constants, and/or with stress that is either compressive or tensile.

To address these requirements, Air Products and Chemicals is introducing the AP-LTN and AP-LTO series of chemical precursors for use in depositing modified silicon nitride and oxide films by Atomic Layer Deposition (ALD), Plasma Enhanced Atomic Layer Deposition (PEALD), Low Pressure Chemical Vapor Deposition (LPCVD), and Plasma Enhanced Chemical Vapor Deposition (PECVD). The different chemicals in this product line are designed to be compatible with these different types of deposition processes. These precursors can also be tailored to meet the film requirements for different IC fabrication process.

Air Products' AP-LTN 500 series has offerings that can tune the dielectric constant of nitride films to values less than 6.0, and/or etch rates at or below the rate typically measured for dense silicon nitride films. This series also offers chemicals that can be used to deposit dense nitride films at temperatures significantly lower than conventional precursors. Other products in this LTN series are specially targeted for ALD-based applications to deposit high quality, low etch rate nitride films at low temperatures.

Air Product's AP-LTO 500 series has offerings that can tune the etch rate at or significantly below the rate typically measured for dense silicon oxide films. This series also offers precursors that are targeted for ALD-based applications to deposit films with low etch rate at low temperatures.

Deposition of low hydrogen containing silicon nitride and oxide films is being addressed with our Air Products' LTN-510 and LTO-510 precursors. These products enable the deposition of low hydrogen content dielectric films by either thermal or plasma enhanced processes. In addition to applications in integrated circuit manufacturing, Air Products sees potential for this product to be utilized for lower temperature PE-CVD based processes for depositing silicon nitride at temperatures well below 400°C for use in the fabrication of displays.

For sidewall spacer and other applications, there are increasing needs to lower the dielectric constant without compromising the wet etching rate. These requirements are being addressed with our Air Products' LTN 530 and LTO 530 product line. Depending on the process need, this product can be formulated to deliver the required performance properties.

At Air Products we are leveraging our expertise in molecule design, synthesis, computational modeling, applications support, and chemical packaging and delivery to develop a new line of products for depositing films that can be customized to help you achieve another degree of process control. If you have any questions or interests, please feel free to contact me at 610-481-3991. Thank you for your time and we are looking forward to working with you.