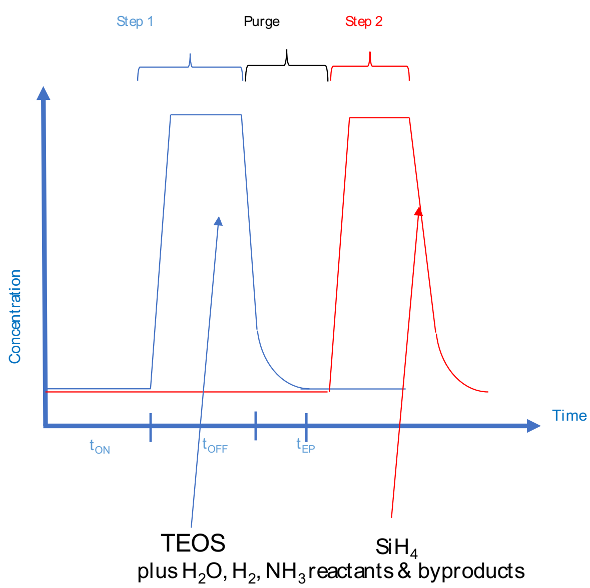
ATONARP ASTON™

Atomic Level Deposition (ALD)
Application Brief

Introduction

A wide range of materials can be deposited using atomic level deposition (ALD), including oxides, nitrides, and metals. ALD processes are widely used, as they provide ultra-thin monolayers of material that can be built up into a controlled thickness thin-film, which are by nature conformal and pinhole free. ALD use is growing extensively within advanced semiconductor manufacturing applications, such as memories (3D-NAND and emerging stacked 3D-DRAM) and advanced logic process transistors (gate-all-around). These processes are characterized by the need for precisely controlled thin-film layers which are only a few tens of molecules thick, measured in angstroms (1Å=1x10^{-10}m).

The Problem



Legacy in-situ metrology solutions that are typically used for deposition process management such as optical emission spectroscopy (OES) fundamentally work with emitted plasma light sources. However, ALD processes often have no plasma, or a weak remote plasma source, effectively leaving OES metrology in the dark. A high-speed, chemically-specific, quantified metrology solution is needed that can work with harsh process gases (e.g. hydrochloric acid, a common byproduct of ALD deposition processes), and with condensate particles, which can form on chamber surfaces during processing.

The cycle of precursor gas injection, gas purge, reactant gas injection, and by-product gas removal happens rapidly – typically just a few seconds per cycle – so the in-situ metrology solution has to be capable of rapid real-time chemical quantification to ensure crisp transitions form one processing stage to another.

Without in-situ metrology in place, these process step transitions are typically for a fixed-duration, which leads to processing inefficiency as sufficient margin between steps must be left to ensure precursor and reactant gases to not inadvertently mix in the chamber.

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Additionally, simple issues such as verification that precursor or reactant gas at appropriate concentration is actually being delivered to the chamber when needed is only possible with in-situ metrology, Running no plasma and weak plasma ALD processes without metrology runs the risk of significant line yield loss or process excursions.

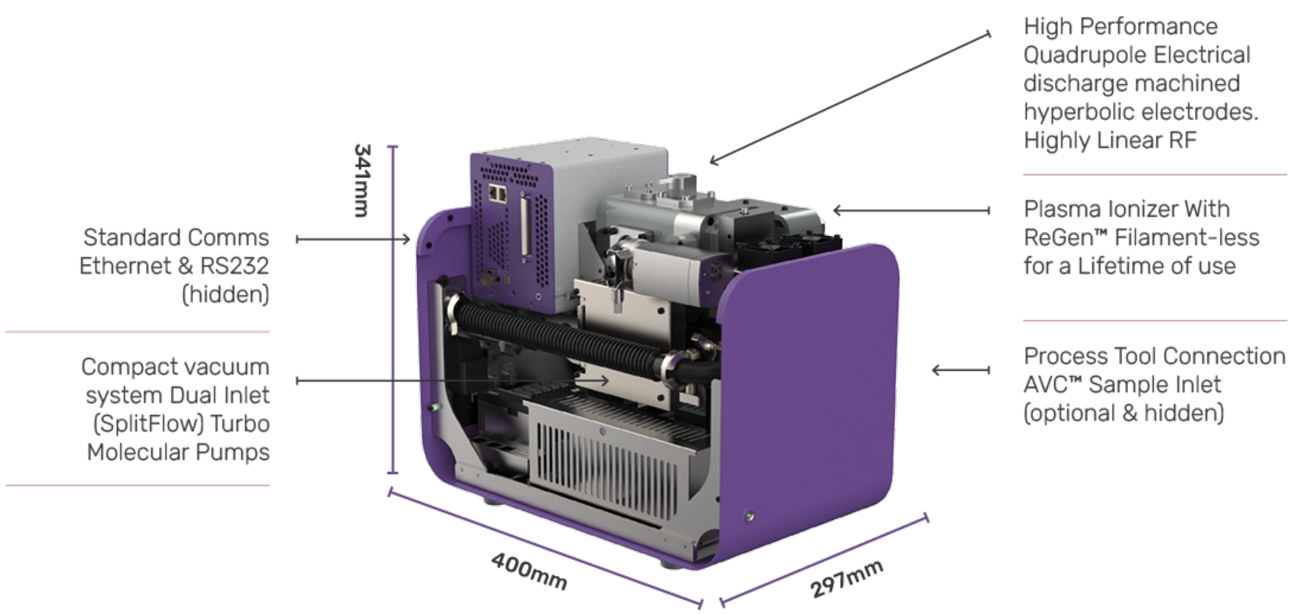
Aston as a Solution

Using Atonarp's Aston in-situ mass spectrometer allows for rapid, chemically-specific, quantitative gas analysis. Scores of samples per second can be taken at PPM level sensitivity levels, without the need for plasma. During chamber fingerprinting and commissioning post-clean, Aston can analyze down to the parts per billion levels.

The integrated plasma and electron ionization sources support a wide process pressure range and plasma ionization allows for harsh gases at higher pressures to be analyzed without the typical problems of filament corrosion seen in residual gas analyzers. The plasma ionization source can also be used to self-clean Aston with process clean gases during routine maintenance cycles.

Summary

Aston from Atonarp is a targeted in-situ ALD metrology solution that allows for the powerful benefits of ALD processing to observed, measured, and controlled – enabling efficient ALD solutions for advanced memory and logic processes.



Atonarp is advancing medical diagnostics, life sciences research, and industrial process control through next-generation digital molecular profiling. In-situ molecular profiling in advanced manufacturing means higher throughput, improved efficiency, and reduced waste. Real-time, quantitative diagnostic tests can improve outcomes and patient satisfaction at lower cost.