ASTON™

In-situ Metrology for Semiconductor Manufacturing

- ✔ Fast sampling, high sensitivity
- ✔ Resistant to corrosive gases
- ✔ Real-time actionable results

Advancing semiconductor process control with digital molecular profiling

In-situ Process Control for Advanced Semiconductor Applications

ASTON Impact and ASTON Plasma are ultra-compact mass spectrometers for quantitative gas analysis required in advanced semiconductor processes, such as deposition and etch.

Molecular Measurements

Fast, sensitive to parts per billion. Detects residual gas/condensate contamination.

Maximize Yield

Delivers chemically specific actionable insights to maximize throughput and yield.

Improve Safety

Monitor for explosive gases. Check emissions and abatement efficacy.

The ASTON Platform solves key *in-situ* metrology issues

- **Maximize throughput:** endpoint detection instead of time-based processes
- **Maximize yield:** measure process gases/by-products during deposition and etch steps at parts per billion sensitivity

Applications

Market Entry

Advanced Processing
- Atomic Layer Deposition (ALD)
- Chemical Vapor Deposition (CVD)
- Atomic Layer Etch (ALE)

Chamber Management
- Clean end-point detection
- Fingerprinting and matching

Sub-fab Safety, Sustainability and Savings Optimization
- Process safety monitoring
- Dry pump protection
- Abatement management

Expansion Applications

Deposition
- CVD
- Tungsten
- TEOS

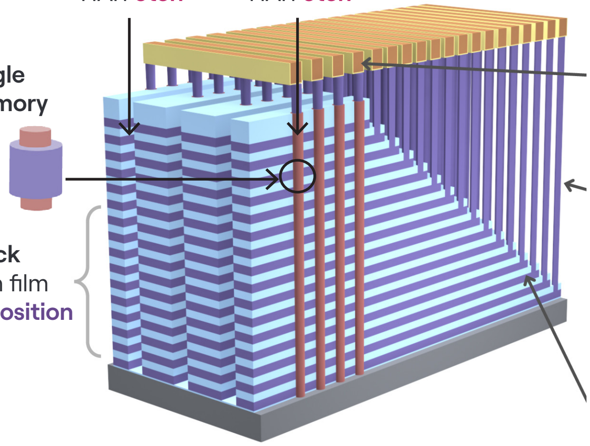
Etch
- Di-electric, conductive, metal
- High Aspect Ratio <1% Open Area detection

EUV/Lithography
- SnH_4 etch
- Photo mask etch

Autonomous Process Control
- Model-driven, real-time process monitoring and control

Deposition and Etch Processes Define 3D NAND Memory Array

3D NAND offers higher bit density by stacking memory cells



ASTON™

ASTON Advantages in advanced processes

- High-speed sampling with ppb sensitivity
- Highly suitable for high aspect ratio 3D structures
- Resistant to corrosive gases
- Rugged and compact
- Easy to integrate into tool platforms

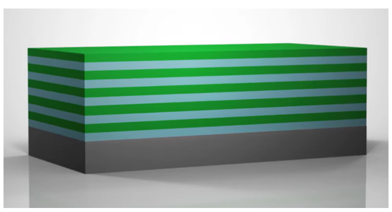
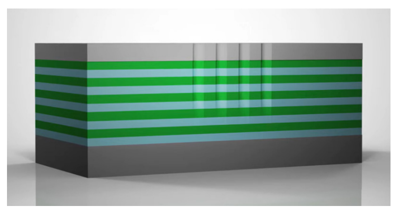
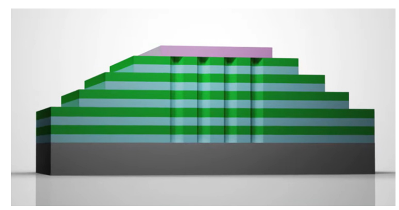
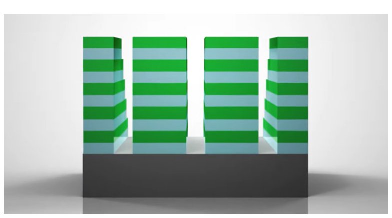
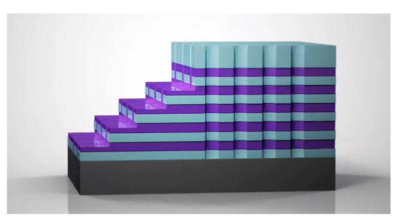
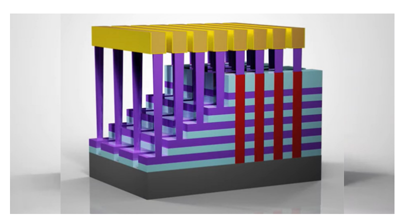
Deposition

- Real-time process gas monitoring to drive automated tool adjustments for in-process control
- End-point detection between deposition steps
- Enables stoichiometric engineering of layers

Etch

- Process gas and by-products measured in ppb
- Enables endpointed chamber cleans

3D NAND process overview

			
Process Steps	**ON stack deposition**: Alternating oxide (blue) and nitride (green) thin film deposition (>200 pairs per stack)	**Channel etch:** Hard mask deposited, openings formed, high aspect ratio (HAR) channels etched through all layers. (>1 trillion holes per wafer)	**Staircase etch:** Contact pads to the wordlines are created using controlled etches that produce the staircase structure.
ASTON Advantage	Uniform thickness is critical for electrical performance. ASTON enables thickness control, layer definition and stoichiometric engineering.	High aspect ratio channel holes must be complete and uniform top to bottom with no bowing or twisting. ASTON enables in-chamber measurement of etch reactants.	Etched profile control precision (angstroms). Etch depth capability (microns). ASTON enables etch engineering by measuring chemicals dynamically.
			
Process Steps	**Slits etch:** Hard mask layer deposited, hard openings patterned, slits etched to separate the columns of channel holes. This creates an array of memory cells.	Wordlines deposition: In some 3D NAND schemes, nitride layers are removed, then tungsten wordlines are created with an inside-out atomic layer deposition process (purple).	Cross-section of final 3D NAND structure on wafer.
ASTON Advantage	ASTON enables uniformity and precision of etch by continuous measurement of reactants.	Complete removal of nitride layer and fill with tungsten. ASTON enables molecular-level control.	

Source: Lam Research: 3D NAND - Key Process Steps (2016) url: https://www.youtube.com/watch?v=hglK1cf3meM