

Technology overview

The **FlexAL** product family

- **FlexALRPT** offering both remote plasma and thermal ALD in a single system to provide a wide choice of precursors and processes
- **FlexALRPX** offering the widest range of precursor options within both remote plasma and thermal ALD, having the maximum number of precursor delivery modules and deposition temperatures up to 700 °C

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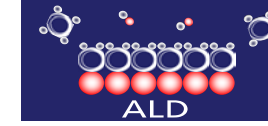
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Technology overview

Atomic layer deposition

FlexAL™

Systems for remote plasma and thermal ALD

ALD and its benefits

- Atomic layer deposition (ALD) is a self-limiting process giving precise thickness control
- ALD is a truly "nano" technology – ultra-thin films of a few nanometres can be deposited
- ALD typically uses two or more liquid halide or organometallic precursors in vapour form, allowing a wide variety of materials to be grown; alternate precursor pulses chemisorb on the exposed surface
- Conformal coating can be achieved even in high aspect ratio structures
- Pin-hole and particle free deposition is achieved
- Mainstream semiconductor applications are being driven by the need to reduce gate and dielectric layer thicknesses for the next-generation production "nodes"
- A wide variety of materials is possible, for example:
 - Oxides, e.g. HfO₂, Al₂O₃, Ta₂O₅, TiO₂, La₂O₃, SiO₂
 - Nitrides, e.g. TiN, TaN, AlN, GaN, Si₃N₄
 - Metals, e.g. Ru, Cu, W, Mo

Example applications of ALD

- High- κ gate oxides, e.g. HfO₂ and nanolaminates, e.g. HfO₂-Al₂O₃
- Storage capacitor dielectrics, e.g. HfO₂ and nanolaminates
- High aspect ratio diffusion barriers for Cu interconnects, e.g. TiN
- Pinhole-free passivation layers for OLEDs and polymers, e.g. Al₂O₃
- Highly conformal coatings for microfluidic and MEMS applications
- Coating of nanoporous structures
- Fuel cells, e.g. single metal coating for catalyst layers

Benefits of plasma ALD

- Remote plasma enables low temperature ALD processes while maintaining low damage
- Effective metal chemistry through use of hydrogen plasma rather than complex thermal precursors
- Eliminates the need for water as a precursor, reducing purge times between ALD cycles
- Higher quality films through improved removal of impurities, leading to lower resistivity, higher density, etc.
- Ability to control and vary stoichiometry
- Higher deposition rates than thermal ALD
- Plasma surface treatment is possible
- Plasma cleaning of chamber is possible, removing or reducing the need for physical and/or chemical cleaning

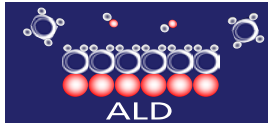
Why remote plasma?

Plasma ALD operates as either a direct plasma, in close contact to the wafer/substrate, or as a remote plasma; in remote plasma ALD:

- Lower plasma damage is obtained
- More radical species are created
- Higher plasma density
- Isolation of the plasma source prevents deposition of conductive and insulating coatings and coating in thermal ALD mode
- Remote plasma ALD allows for greater process flexibility; for example, inductively coupled plasma (ICP) sources are extremely effective at dissociating hydrogen for use in metal ALD

Oxford Instruments' **FlexAL** product family offers a new range of flexibility and capability in the engineering of nanoscale structures and devices by combining remote plasma ALD processes with thermal ALD.





The ALD process – TiN example

