Improving thermal performance in semiconductor process chambers

Eurotherm®

Expertise in systems and solutions, services and support

Atomic layer deposition

Eurotherm by Schneider Electric™ provides a range of products, digital engineered solutions and services throughout the world. Our expertise in semiconductor applications allows us to supply solutions that help improve the quality and throughput of both wafers and chips.

Our solutions support process efficiency and Data Integrity to help create a safer and more sustainable world.

Safer

We help our customers to meet material property specifications and reduce regulatory costs.

Sustainable world

We help global foundries and fabs to meet energy targets and reduce manufacturing costs by providing scalable, high reliability, power and control solutions.

We have application expertise in:

- Temperature control:
  - Wafer processing
  - Chemical vapor deposition (CVD)/ Atomic layer deposition (ALD)
  - Equipment front-end module (EFEM)
- EtherCAT® communications:
  - Process control
  - Power control
  - Member of the EtherCAT Technology Group (ETG)

eurotherm.com/semicon

Life Is On Schneider Electric

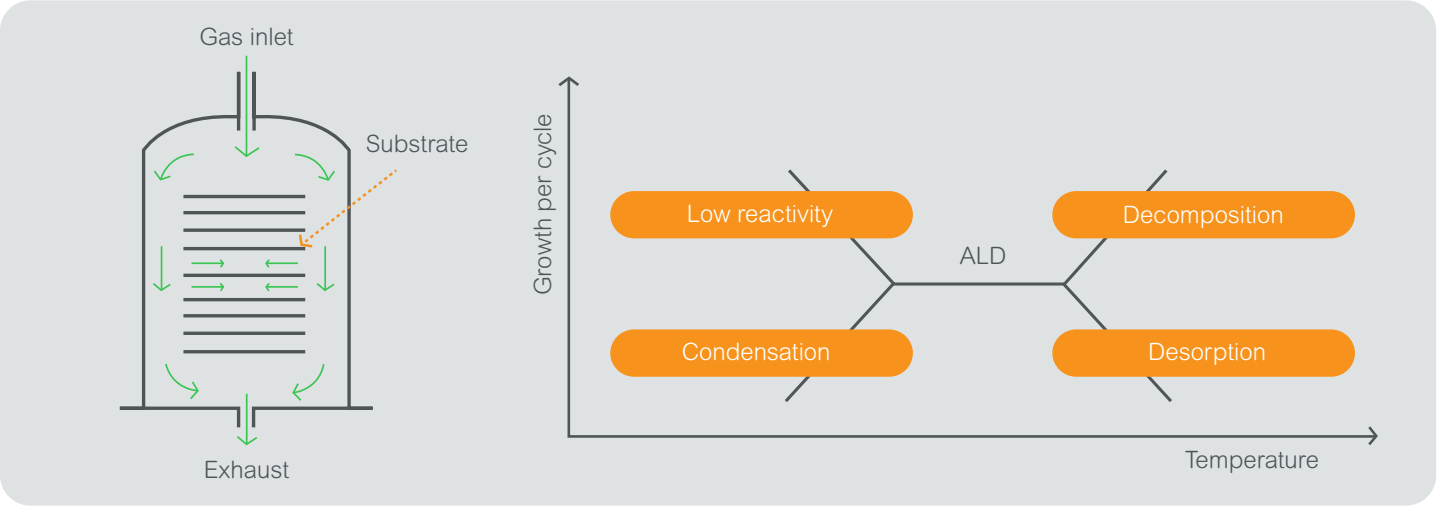
ALD solutions

Increasing demand for more powerful devices in smaller sizes (for example in computation, data storage, communication, energy storage, and sensing technologies) has resulted in the development of semiconductor manufacturing tools for more precise control of thin films. Critical film layers in today's transistors are only a few atoms thick. ALD, also known as atomic layer epitaxy (ALE), is a vapor-phase deposition technique used to grow these ultrathin films.

ALD process overview

Chemical reactions are used to grow films one atomic layer at a time. By managing the cycle stages, it is possible to achieve precise control of the quantity and composition of the layers. Uniform coverage is possible on any topology or 3D structure. These chemical reactions are thermally driven, most frequently by heating a substrate, and can be further enhanced during the gas-phase by applying plasma assistance during the deposition process.

Self-limiting uniform growth can only be achieved within an ideal temperature range. If outside this, the ALD process could be impaired by one of the detrimental effects shown in the diagram below.



Growth control

Atmospheric contamination in the chamber can lead to undesirable growth defects in the film layers, impacting the surface chemistry and ultimately reducing the performance characteristics. Controlling the environment within the chamber is critical to avoid this contamination.

All chamber temperatures are monitored outside the chamber. Temperature control is generally provided via precise control of the energy input.

Temperature control of the ALD process is key to prevent the following detrimental effects:

- Low reactivity within the chamber due to low process temperature
- Condensation of precursors impacting effective purging
- Decomposition of precursors adding an undesirable component
- Desorption of the film or precursor

Growth control becomes even more important on large substrates (large wafers etc.) to achieve uniformity of the film.

Process stages

An ALD reactor heats the samples to the desired deposition temperature. Pulses of precursors and co-reactants are injected into the reactor chamber. An inert gas is typically used to purge the reactor between the steps. Filling and purging of the reactor chamber should be efficiently controlled to achieve reasonable cycle times.

The timing of individual cycle steps needs to be accurately controlled.

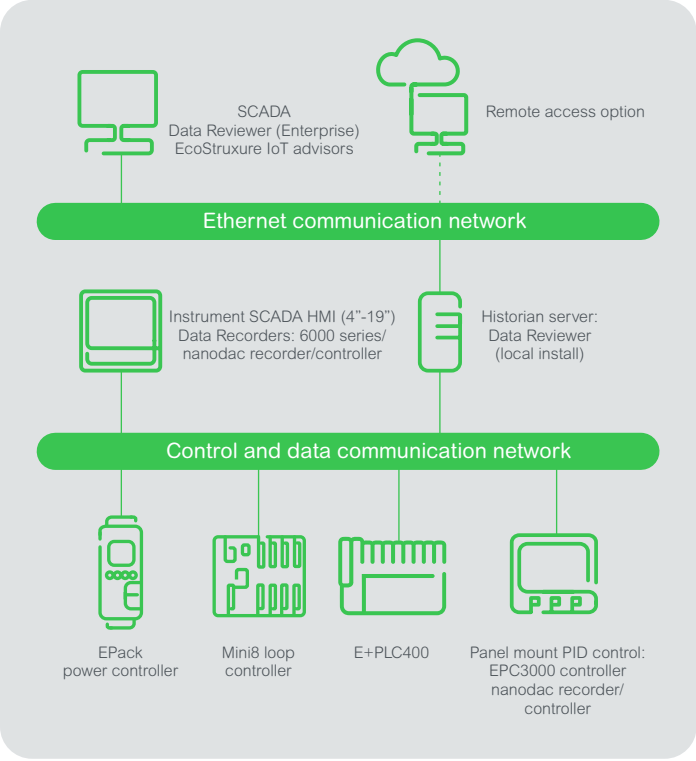
A typical cycle consists of four steps:

- Precursor dosing
- Purge/pump
- Co-reactant
- Purge/pump

Expertise supporting precise atomic layer deposition

Eurotherm solutions:

- Precision multiloop temperature control available with DeviceNet or EtherCAT communications - Mini8™ loop controller
- OEM Security option for guarding valuable IP
- Process hi-limit - EPC3000 programmable controller
- Power control - EPack™ compact SCR power controller range
- Power monitoring - EcoStruxure™ Power Monitoring Expert
- Integrated PLC/data management - E+PLC400
- Batch/recipe management
- Digital data management
- Local HMIs to full SCADA solutions
- Reporting
- Environmental condition monitoring
- Remote condition monitoring
- Calibration, compliance, asset management

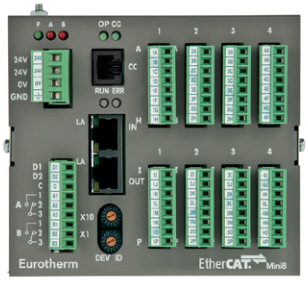


Specific industry requirements

The EtherCAT Technology Group ETG (www.ethercat.org) was created to keep EtherCAT technology open for all users. SEMI™ (formerly Semiconductor Equipment and Materials International) has accepted EtherCAT as a communication standard (E54.20) for the semiconductor industry.

Highlight: Eurotherm EtherCAT enabled products

Mini8 loop controller



- Thermal stability
- EtherCAT connectivity
- Precision control
- Compact size

EPack compact SCR power controller

- True power control
- Advanced load diagnostics
- EtherCAT connectivity
- Configurable via front panel and remotely via iTools

Industry 4.0 ready technology

EcoStruxure is Schneider Electric's open IoT-enabled system architecture aiding the digital transformation to Industry 4.0 technology. Eurotherm connected instruments and software fit into this cybersecurity-in-mind designed architecture.

EcoStruxure™
Innovation At Every Level

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