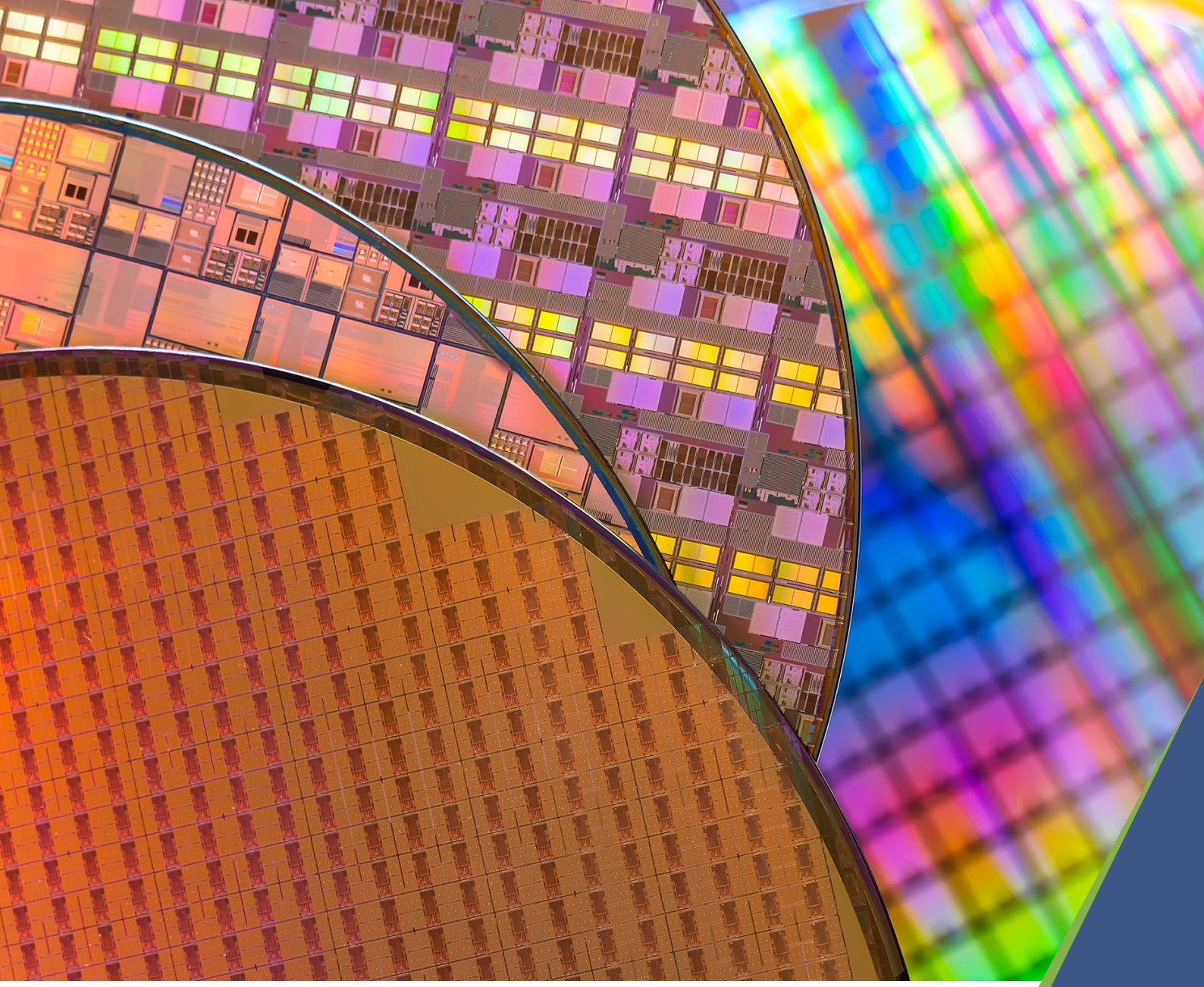


SEMICONDUCTOR MANUFACTURING SOLUTIONS

Supporting Advanced Fabs from Wafer to Package

AIR • WATER • ENERGY • EMISSIONS • COMPLIANCE

CECO Environmental delivers integrated Greenhouse gas abatement, ultra-pure water treatment, and hazardous emissions management solutions purpose-built for semiconductor fabrication facilities. Our technologies safeguard product yield, protect personnel, and ensure full regulatory compliance across every stage of chip manufacturing.

CECO ENVIRONMENTAL

www.cecoenviro.com
info@OneCeco.com

Coverage Across the Semiconductor Value Chain

Raw Material Preparation & Wafer Manufacturing	Wafer Cleaning, Oxidation & Surface Treatment	Photolithography & Patterning
Etching & Doping (Ion Implantation)	Thin Film Deposition (CVD, PVD & ALD)	Chemical Mechanical Planarization (CMP)
Metallization & Interconnect Formation	Wafer Testing, Assembly & Packaging	Final Packaging

01 Raw Material Preparation & Wafer Manufacturing

KEY CHALLENGES

- **Ultra-Pure Water (UPW):** Water at 18.2 MΩ·cm resistivity is required at every rinse and clean step. A single ionic contaminant at parts-per-trillion concentration can cause circuit failure at sub-nanometer feature sizes.
- **Chemical Storage:** Aggressive process acids, including hydrofluoric acid (HF) and sulfuric acid (H_2SO_4), require leak-proof primary containment, secondary bunding systems, and strict chemical segregation protocols.
- **Air Contamination Control:** Fabrication cleanrooms must maintain ISO standard. A single airborne particle can render an entire wafer batch defective, representing significant yield loss.

CECO SOLUTIONS

- Demineralization Package
- Reverse Osmosis (RO) Water Treatment System
- Ultrafiltration (UF) Systems
- Ceramic Membrane Filtration
- Softening Package
- Special Media Filtration

VALUE DELIVERED

Produces ultrapure water (UPW) required for silicon crystal growth, wafer slicing, and chemical cleaning, while providing safe and compliant storage infrastructure for process acids and solvents.

02 Wafer Cleaning, Oxidation & Surface Treatment

KEY CHALLENGES

- **Acid Fumes (HF, HCl, H_2SO_4, HNO_3):** Hydrofluoric acid (HF), hydrochloric acid (HCl), Sulfuric acid (H_2SO_4), and Nitric acid (HNO_3) fumes generated at wet bench stations demand sealed enclosures with dedicated point-of-use exhaust scrubbing systems.
- **Mist & Particulate Contamination:** Aerosol mist and fine particulates from chemical bath processing require point-of-use filtration and laminar airflow enclosures to prevent wafer surface re-contamination.
- **Wastewater Treatment:** Mixed acid and alkaline effluents from RCA clean, piranha solution, and HF dip processes must be neutralized, separated, and treated to meet environmental discharge standards

CECO SOLUTIONS

- High-Capacity Electroplating Filter Systems
- Candle Filters / Brink Mist Eliminators
- Packed Bed Gas Scrubbers
- Ionizing Wet Scrubbers
- High-Efficiency Dry Scrubbers
- Industrial Wastewater Treatment Package
- Multimedia Filters
- Activated Carbon Media Filters

VALUE DELIVERED

Captures acid mist, solvent vapors, and airborne particulates at the point of generation while treating complex wastewater streams to meet semiconductor fabrication environmental discharge standards.

03 Photolithography & Patterning

KEY CHALLENGES

- **Solvent Vapors (VOCs):** Volatile organic compound (VOC) emissions from photoresist spin-coating and resist stripping require sealed process tracks with dedicated exhaust systems and activated carbon filtration.
- **Airborne Molecular Contamination (AMC):** Trace-level airborne molecular contaminants including acids, bases, and organics degrade photoresist chemistry at parts-per-trillion concentrations, requiring chemical filtration integrated into HVAC systems.
- **Cleanroom Air Quality:** Lithography scanner environments must maintain ISO standard with sub-nanometer particle control to protect extreme ultraviolet (EUV) and deep ultraviolet (DUV) optical systems and maximize exposure tool uptime.

CECO SOLUTIONS

- Carbon Adsorption Systems (CAS)
- Activated Carbon Media Filters
- HEPA Air Filtration Systems
- FRP / Carbon Fiber Centrifugal Exhaust Fans
- Ducts, Hoods and Exhaust Stacks
- Vibration Dampeners

VALUE DELIVERED

Maintains ISO cleanroom integrity, protects lithography scanner yield, and safely captures and removes photoresist solvent emissions in compliance with applicable air quality regulations.

04 Etching & Doping (Ion Implantation)

KEY CHALLENGES

- **Toxic Process Gases:** Etching and ion implantation utilize highly toxic gases including chlorine (Cl_2), hydrogen bromide (HBr), arsine (AsH_3), and phosphine (PH_3), requiring fully sealed delivery systems with continuous leak detection.
- **Corrosive Exhaust:** Plasma etch chambers generate corrosive exhaust streams that must be neutralized through dedicated scrubbing systems before atmospheric release, protecting personnel and downstream equipment.
- **Hazardous By-Products:** Arsenic compounds, fluorinated residues, and other toxic by-products require strict waste segregation, specialist disposal contractors, and rigorous personnel protection protocols.

CECO SOLUTIONS

- Carbon Adsorption Systems (CAS)
- Activated Carbon Media Filters
- HEPA Air Filtration Systems
- Ducts, Hoods and Exhaust Stacks
- Vibration Dampeners
- FRP / Carbon Fiber Centrifugal Exhaust Fans
- Post-Scrubbers, Electrically Heated RTO (ERTO)

VALUE DELIVERED

Safely neutralizes and abates etch gases, dopant exhausts, and corrosive acid streams, protecting fab personnel and surrounding communities while maintaining stringent emissions compliance.

05 Thin Film Deposition (CVD, PVD & ALD)

KEY CHALLENGES

- **VOC Emissions from Precursor Gases:** Volatile organic compound (VOC) emissions from chemical vapor deposition (CVD) precursors such as silane, tetraethyl orthosilicate (TEOS), and metal-organic compounds require point-of-use abatement and catalytic oxidation.
- **Flammable Process Exhaust:** Silane (SiH_4) and hydrogen (H_2) exhausts from deposition chambers present significant flammability hazards, requiring explosion-proof extraction, continuous gas monitoring, and emergency isolation valves.
- **Particulate Carryover:** Solid by-products from deposition reactions can migrate from process chambers onto wafer surfaces, requiring in-situ chamber cleaning protocols and inline particle monitoring between production runs.

CECO SOLUTIONS

- Regenerative Thermal Oxidizers (RTO)
- Combustion Systems & Burner Technologies
- Fuel Gas Conditioning Skids
- Candle Filters / Mist Eliminators
- Ionizing Wet Scrubber
- Electric Thermal Oxidizers (ERTO/ETO)
- Concentrator + RTO Systems (RCTO)
- Centralized Catalytic Treatment

VALUE DELIVERED

Provides high-efficiency destruction of high-volume VOC streams from deposition processes, with energy-efficient thermal oxidation technology reducing both emissions output and operating cost.

06 Chemical Mechanical Planarization (CMP)

KEY CHALLENGES

- **Slurry Waste Management:** Spent CMP slurry contains abrasive nanoparticles (silica, ceria) and heavy metals requiring specialized collection and chemical treatment prior to compliant disposal.
- **Fine Particle Re-Contamination:** Residual abrasive particles from spent slurry risk wafer surface re-contamination, necessitating post-CMP brush-scrubbing and high-purity ultrapure water rinse steps.
- **Wastewater Reuse:** CMP processes consume substantial water volumes. Closed-loop recycling, slurry reclaim systems, and ultrafiltration recover and reuse process water, reducing operating cost and environmental footprint.

CECO SOLUTIONS

- Ultrafiltration (UF) Systems
- Ceramic Membrane Filtration
- Multimedia Filters
- Special Media Filtration
- Sewage Treatment Package
- Industrial Wastewater Treatment Package

VALUE DELIVERED

Delivers efficient CMP wastewater treatment and closed-loop water reuse, significantly reducing the fab's water consumption footprint and wastewater disposal costs while maintaining discharge compliance.

07 Metallization & Interconnect Formation

KEY CHALLENGES

- **Metal Fumes & Vapor Emissions:** Physical vapor deposition (PVD) sputtering and CVD precursors including tungsten hexafluoride (WF_6) and copper-organic compounds generate metal-laden fumes requiring high-efficiency exhaust filtration and point-of-use abatement.
- **Solvent Emissions (VOCs):** Photoresist stripping and low-k dielectric cleaning operations produce significant volatile organic compound (VOC) loads, managed through carbon adsorption and thermal oxidation treatment systems.
- **Hazardous Liquid Waste:** Spent process liquids containing copper, tungsten, and fluoride compounds require segregated collection, chemical precipitation, and certified disposal to meet environmental discharge regulations.

CECO SOLUTIONS

- High-Capacity Electroplating Filter Systems
- Candle Filters/Brink Mist Eliminators
- Packed Bed Gas Scrubbers
- Carbon Adsorption Systems (CAS)
- FRP Chemical Storage Tanks
- Industrial Wastewater Treatment Package

VALUE DELIVERED

Controls metal-laden exhaust streams and treats spent process chemicals, ensuring full regulatory compliance and protecting worker safety across copper electroplating and tungsten deposition operations.

08 Wafer Testing, Assembly & Packaging

KEY CHALLENGES

- **Cleanroom Air Quality:** Assembly-stage particulate contamination during wire bonding and flip-chip attachment causes open circuits and yield loss, requiring sustained ISO cleanroom air quality through the full packaging line.
- **Odor Control:** Epoxy molding compounds, die-attach adhesives, and flux residues generate process odors requiring dedicated exhaust scrubbing with activated carbon filtration across encapsulation and assembly areas.
- **Thermal Exhaust Management:** Burn-in ovens and thermal cycling chambers used in reliability qualification generate significant heat loads, demanding precision HVAC design, heat recovery systems, and controlled exhaust management.

CECO SOLUTIONS

- HEPA Air Filtration Systems
- Activated Carbon Media Filters
- Ducts, Hoods and Exhaust Stacks
- Vibration Dampeners
- FRP/Carbon Fiber Centrifugal Exhaust Fans
- Bag Filters, Packed Bed Scrubbers

VALUE DELIVERED

Maintains stable, contamination-free environments through final test and packaging, minimizing yield loss from airborne particulates while managing thermal loads from high-temperature qualification equipment.

CECO Environmental
Your End-to-End Semiconductor Compliance Partner

From ultra-pure water generation and acid mist capture to VOC destruction and wastewater treatment, CECO delivers proven, integrated solutions at every stage of the fabrication process. Our engineering teams work directly with fab operators to design, supply, and support systems that protect yield, protect people, and meet the world's most demanding environmental standards.

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