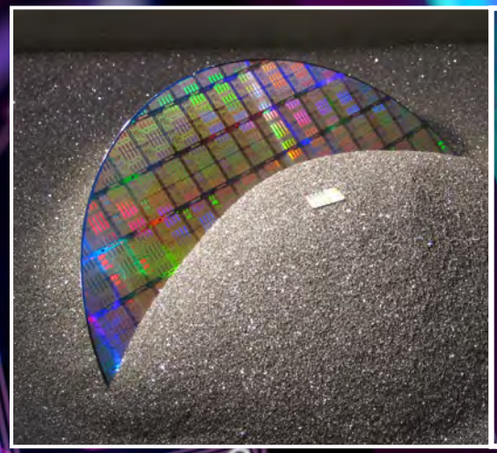

PRECISION IN PRECISION OUT

Solutions for Semiconductors and Electronics

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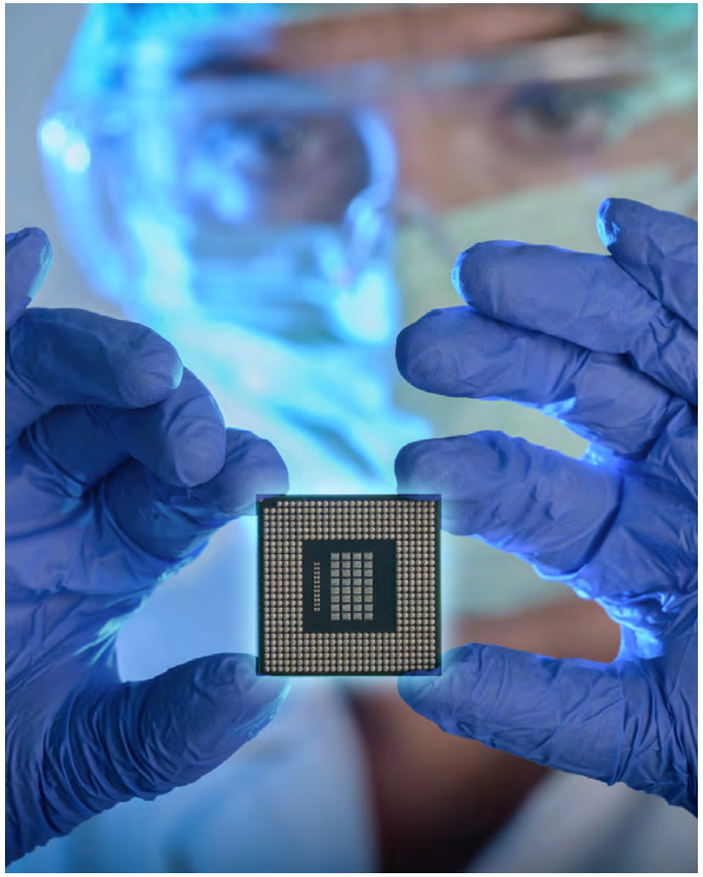
THE HEARTBEAT OF INNOVATION



Semiconductors are driving the new global economy. They're at the heart of most every innovation you can name, from telecommunications to automobiles to national security to healthcare. And semiconductors are constantly changing and morphing, becoming smaller, lighter, more powerful and reliable – and at the same time, more susceptible to interference by chemical and particulate contaminants during manufacturing processes.

These trace-level contaminants can cause product reliability issues, even product failures. So they need to be detected and abated when receiving raw materials; during research, development, and fabrication; at the QA/QC and failure testing stages; and throughout the assembly and packaging processes.

That's why our instrumentation, software, and services have become the indispensable tools of semiconductor and electronics manufacturing companies everywhere, enabling you to design ever-smaller, ever-faster components – and higher quality end products.

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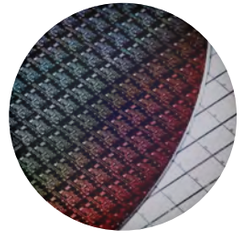
KNOW WHAT'S IN YOUR RAW MATERIALS

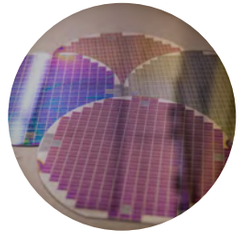
As semiconductors and microelectronics get smaller, there's greater dependence on pure raw materials to ensure successful manufacture. Semiconductor research and development managers are tasked with establishing the right set of process and selecting the right materials for the entire integrated circuitry (IC) manufacturing processes. The choices and recommendations semiconductor R&D managers make today impact the operation's ability to achieve 24/7 manufacturing operations and downstream production ROI.

CLICK THE IMAGES FOR MORE INFORMATION

Wet Processing



Particle Analysis



Elemental Contamination

Solvents

Photoresist Solutions

Sputtering Target and Metal Purities

Bulk Gases

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Wet Processing

Ultrapure water (UPW) is central to all wet-processing steps such as wafer rinsing and diluting compounds for chemical baths. Standards bodies such as SIMI and ASTM International dictate such low acceptable levels of metallic contaminants that ultrasensitive ICP-MS techniques are a must. Ultratrace contaminants in acid water mixtures like hydrochloric acid (HCI) for silicon wafer surface cleaning also follows SEMI standards for maximum concentrations of impurities that can cause device failure.

READ OUR APP NOTES TO LEARN MORE ▼

- Ultra-Trace Elemental Analysis in Sulfuric Acid - ICP-MS
- Characterization of Ultrapure Water - ICP-MS
- Analysis of SiO2 Nanoparticles - SP-ICP-MS
- Impurities in Electronic-Grade Hydrochloric Acid - ICP-MS

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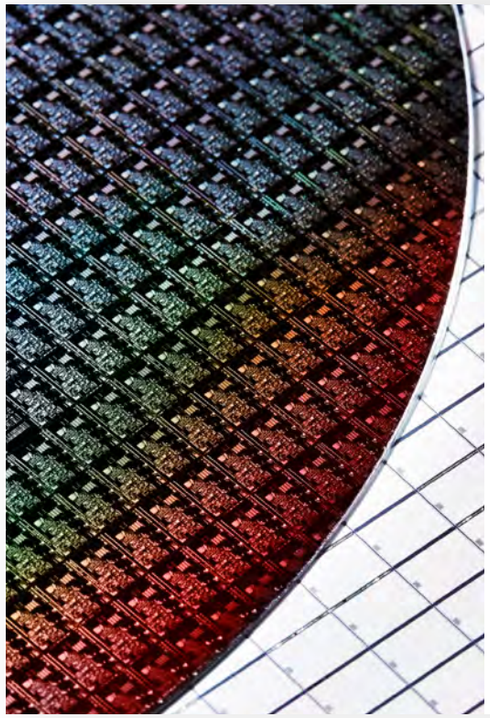

Particle Analysis

Other supersensitive techniques are required for chemical mechanical planarization (CMP) – wafer polishing to create topographically flat surfaces critical for formation of electrical interconnections. A slurry containing nanoparticles and functional chemicals removes target material, but all slurry particles must be small enough to avoid mechanical abrasion. It only takes a few large particles to cause damage, so it's critical that you be able to characterize CMP slurry mixtures and abrasive raw materials to determine their large particle count or concentration (LPC) to reduce risk and increase yield.

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Characterization of Nanoparticle Element Oxide Slurries for CMP-SP- ICP-MS

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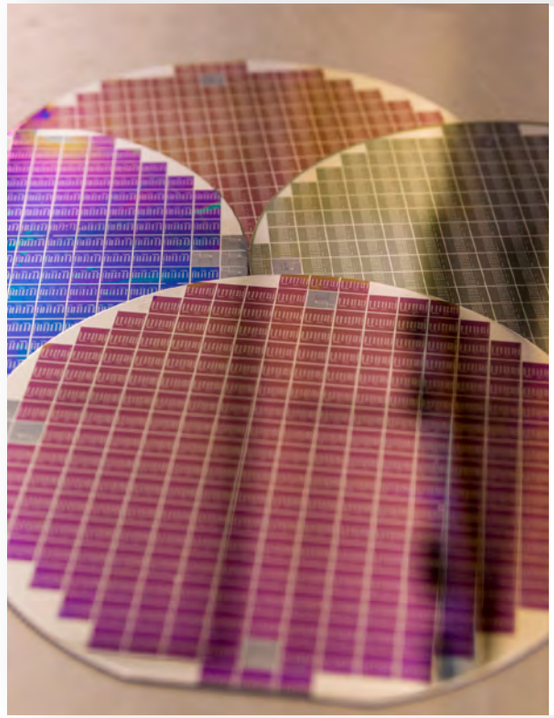

Elemental Contamination

Contaminants in semiconductor products adversely affect device performance. As chips get smaller, allowable levels of metal contamination also shrink. Single-particle ICP-MS is a key technique for analyzing nanoparticles in liquids to detect, count, and size at concentrations between 100 and 1000 particles/mL, minimizing the risk of contaminated manufacturing processes and material or product failures. In addition, IR spectroscopy can help monitor and quantify oxygen and carbon introduced during manufacturing, which can become trapped in the crystal lattice and affect final product characteristics.

READ OUR APP NOTE TO LEARN MORE ▼

Analysis of Iron Nanoparticles in Organic Solvents - SP-ICP-MS

Semi-Automated FT-IR Measurements of Elemental Impurities in Silicon Wafers

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Solvents

Commonly used organic solvents such as isopropyl alcohol (IPA), propylene glycol methyl ether (PGME), propylene glycol methyl ether acetate (PGMEA), and N-methylpyrrolidone (NMP) are used as silicon wafer cleaners or thinners of photoresist and are analyzed for trace metal contamination.

The standard for electronic-grade IPA specifies contamination limits of less than 100 ppt, requiring ICP-MS for quality control of inorganic contamination. GC analysis allows you to compare and identify samples with the least amount of organic impurities for the crucial end-of-fabrication drying process. When measuring ultratrace contaminants, even minute levels of impurities can cause device failure. The NexION® 5000 system enables analysis at SEMI standards without the need to pretreat the sample, preventing additional contamination entry points.

READ OUR APP NOTE TO LEARN MORE ▶ Impurities in Organic Solvents - ICP-MS

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Photoresist Solutions

Meeting SEMI guidelines for analysis of liquid chemicals usually requires high-performance, multielement techniques such as ICP-MS. But labs often need to test for single elements only – for example, alkaline elements such as sodium, calcium, and aluminum or transition elements such as iron and copper. Graphite furnace atomic absorption spectrometry (GFAAS) techniques meet these challenges, while helping to increase productivity for quality control by achieving ultratrace determination in organic photoresists and highly concentrated corrosive acids.

READ OUR APP NOTE TO LEARN MORE ▼

Elements at Ultratrace Levels in Ultrapure Acids and Photoresist Stripper Solutions - GFAAS

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Sputtering Target and Metal Purities

Sputtering target materials rely on extremely pure copper, manganese, aluminum, and titanium to create the metal wiring used in semiconductor devices. The industry relies on these raw materials having extremely high purity levels, in the range of 99.999%. The analytical techniques employed for accurately testing the purity of these metals must easily handle high-matrix samples, while being easy to operate. ICP-OES is an excellent option for sputtering target testing.

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Impurities in Aluminum Following London Metal Exchange - ICP-OES

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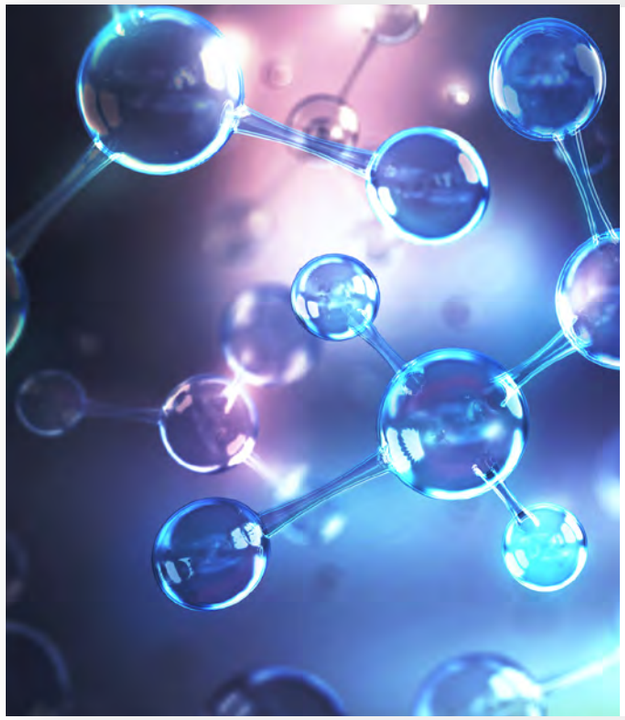

Bulk Gases

Gases are the second most utilized component in semiconductor fabrication and display manufacturing. Nitrogen, hydrogen, argon, helium, oxygen, carbon dioxide, and more must be tested for purity. Technologies such as preconfigured GC analyzers built to meet ASTM standards enable the extremely low-impurities detection limits sought after in the industry.

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Trace Gas Analyzer - GC

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CONTROL PROCESSES TO SPUR INNOVATION

With increasing demand for personal electronics – smartphones, tablets, wearables, and Internet of Things (IoT) devices among them – tech companies are looking to rapidly refresh existing product lines and quickly develop new ones. That means embracing the right processes, employing pure chemicals and materials, and standardizing on the use of cutting-edge, reliable instruments, data analytics, and other technologies.

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Impurities Monitoring and Control

Process Control and QA/QC for Materials

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Impurities Monitoring and Control

During fabrication, researchers develop and employ ultraclean processes, contamination control, and online monitoring solutions for trace metals and organics, while also planning for back-end device fabrication. The choices and recommendations R&D managers deploy impact your operation's ability to achieve 24/7 manufacturing operations and optimize downstream production ROI.

Although online ICP-MS is not new to semiconductor fabrication, uptake of fully automated systems minimizes contamination from environmental and human factors, while minimizing fabrication operators' risk of chemical exposure.

READ OUR APP NOTE TO LEARN MORE ▼

Analysis of Ultratrace Metallic Impurities in Semiconductor FAB - Online ICP-MS

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Process Control and QA/QC for Materials

Measuring the band gap of materials is important in the semiconductor field, as well as in other industries such as nanomaterials and solar energy. For semiconductors, band gap is a major factor in electrical conductivity, and methods for measuring band gap energy are critical to their manufacture.

The term band gap refers to the energy difference between the top of the valence band to the bottom of the conduction band – electrons can jump from one band to another. A specific minimum amount of energy is required for an electron to jump from a valence band to a conduction band. Using a LAMBDA® 1050 UV/Vis/NIR spectrometer along with 150-mm integrating sphere, band gap energy values for various powder nanomaterials can be calculated.

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Measuring Band Gap Energy -- UV/Vis/NIR

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PACKAGING MAKES THE PRODUCT

When testing for assembly, housing, and packaging components, semiconductor and electronics manufacturers need easy-to-use, high-sensitivity, robust solutions to perform QA/QC on substrate, resins, and other materials and maintain sub-ppt impurity levels. Thermal analysis techniques are essential to supply a broad range of materials characterization solutions for quality control of substrate and conductor materials, solders, and plastic components in end-product phases.

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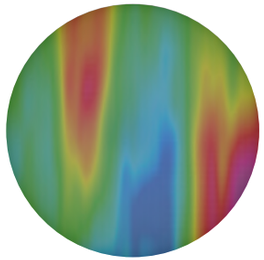
Thermoset Curing

Curing Optical Adhesives

Characterizing Epoxies



Thermal Expansion

Unexpected Contamination

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Thermoset Curing

Proper curing of thermosets is key to semiconductor packaging design, process optimization, and end-use performance. Accurate characterization can be achieved with solutions such as differential scanning calorimetry (DSC) and software tools such as StepScan™ to enhance data interpretation by separating results into more detailed thermodynamic (reversible) and kinetic (irreversible) analyses.

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Characterization of Thermosets - StepScan DSC

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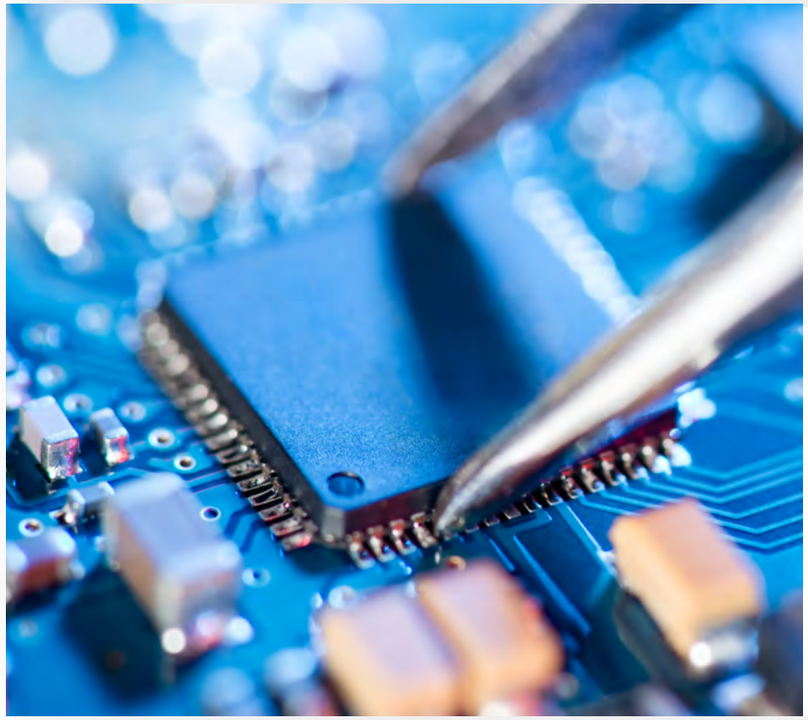

Curing Optical Adhesives

In semiconductor and chip manufacturing processes, optical adhesives are used, where some solvents are considered undesirable due to their potential to introduce contaminants. Photo-DSC is a critical tool for monitoring the fast, energetic reactions of optical adhesives. With accurate temperature control and wide dynamic range, our photo-DSC solution captures the complete curing behavior of optical adhesives.

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Curing Optical Adhesives - DSC

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Characterizing Epoxies

Thermogravimetric analysis is the traditional method for studying epoxies in packaging and assembly, but further studies are needed to reach a more comprehensive understanding of curing systems. Material thermal stability and out-gassing characteristics are critical in sensitive electronic packages. Hyphenated methods such as thermogravimetric analysis mass spectrometry (TG-MS) or thermogravimetric analysis gas chromatography mass spectrometry (TG-GC/MS) go farther in confirming materials that remain in the epoxy and can cause component failure.

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Study of Epoxy Materials - DSC, DMA, TG-GC/MS

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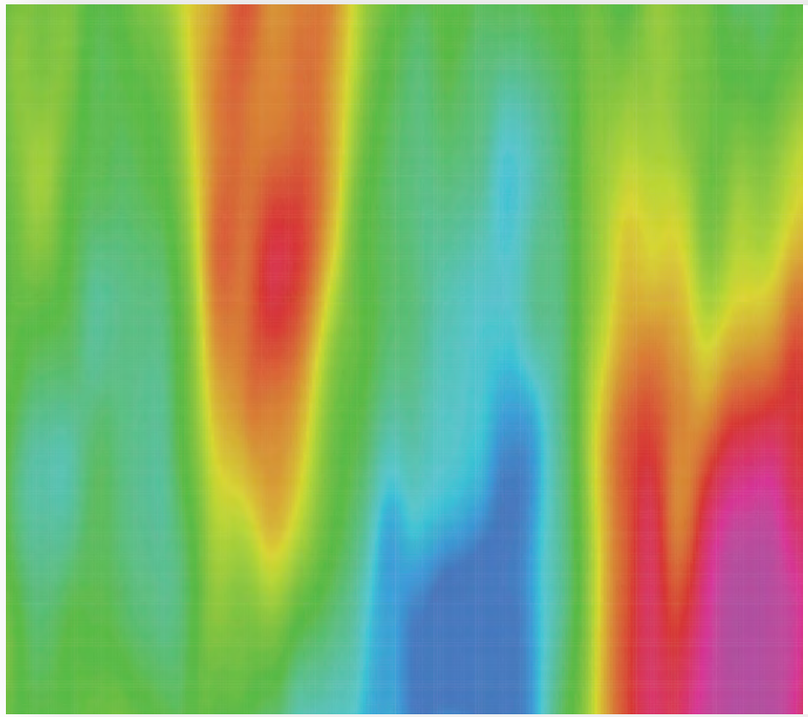

Thermal Expansion

Thermal expansion is a major source of failures in electronic circuits. Manufacturers employ thermal conductors to dissipate heat while utilizing low-expansivity materials to match the expansion properties of silicon chips and ceramic insulators. Thermomechanical analysis (TMA) is the standard test method for analyzing glass transition temperature, determining laminated material failure at elevated temperatures, and performing quality control and failure analysis.

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Standard Test Methods in the Electronics Industry - TMA

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Unexpected Contamination

Foreign objects can appear in the final product as unexpected contaminants, affecting product quality or even causing product failure. It's vitally important to determine what the contamination is and where it originated. Infrared spectroscopy is a primary analytical technique for the detection and measurement of microcontaminants for quality control and failure analysis.

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Detection and Identification of Contaminations in Manufacturing - IR

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KEEPING IT CLEAN, INDOORS AND OUT

While traditional monitoring of the clean room atmosphere has focused on the measurement of small particles, laboratories are tightening their requirement to include volatile organic compounds (VOCs) and airborne molecular contaminants (AMCs) in sensitive manufacturing environments. Thermal desorption gas chromatography (TD-GC) is an indispensable tool, combining sample handling and instrumentation to provide an easy-to-use, proven system for measuring organic airborne contaminants.

Read Our Outdoor Air Monitoring Compendium to Learn More ▶

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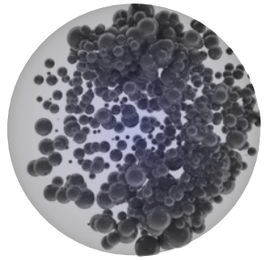

Volatile Organic Compounds (VOCs)

Hazardous Air Pollutants (HAPs)

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Volatile Organic Compounds (VOCs)

Semiconductor manufacturing uses and generates chemicals and gases that could result in occupational and environmental exposures. Exposure media can include indoor air, outdoor air emissions, and solid waste streams. Potential exposure chemicals typically include volatile and semi-volatile organic compounds (VOCs and SVOCs), metals, and airborne molecular contaminants (AMCs). These are challenging measurements due to the highly competitive and constantly changing nature of the industry.

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Analysis of VOC Emissions - ATD-GCMS

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Hazardous Air Pollutants (HAPs)

Like many other industries, semiconductor and electronics manufacturers generate hazardous air pollutants (HAPs). High volumes of VOCs are emitted with waste gases produced during cleaning, etching, and photolithography. To analyze compounds to control VOC emissions, gas chromatography mass spectrometry (GC/MS) is the go-to method, allowing manufacturers to meet and often exceed the most stringent regulatory limits.

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Better Air Quality for a Cleaner Environment

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BETTER TESTING FOR ANCILLARY PRODUCTS

The global semiconductor industry, based mostly in the United States, China, Taiwan, South Korea, and the European Union, is the driving force behind many secondary high-tech electronics applications. Here we've highlighted just a few of the many analytical techniques related to primary semiconductor and electronics manufacture.

Read Our Outdoor Air Monitoring Compendium to Learn More ▶

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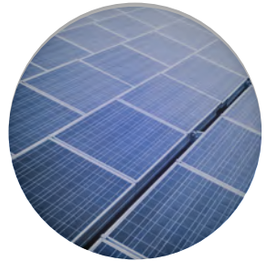
Lithium Ion Battery Testing



Materials Testing (Solar Industry)

Electronic Display

View how our technologies fit into all aspects of impurity analysis ▶

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Lithium Ion Battery Testing

Innovative analytical solutions are required to test individual battery components, including electrode materials, separators, and electrolytes, during development and quality control and to improve battery characteristics and safety.

READ OUR APP NOTE TO LEARN MORE ▼

Li-Ion Battery Testing

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BETTER TESTING FOR ANCILLARY PRODUCTS

The global semiconductor industry, based mostly in the United States, China, Taiwan, South Korea, and the European Union, is the driving force behind many secondary high-tech electronics applications. Here we've highlighted just a few of the many analytical techniques related to primary semiconductor and electronics manufacture.

Read Our Outdoor Air Monitoring Compendium to Learn More ▶

Materials Testing (Solar Industry)

The solar industry requires measurement of surface reflectance on diverse materials such as metal and semiconductor coatings and antireflective surfaces on windows. Transmission, reflectance, and absorbance testing are of interest to the industry and are where spectroscopy analysis techniques shine.

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Curing of EVA for Solar Panel Application - DSC

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Electronic Display

Enhanced specular reflectors (ESRs) are ultrareflective mirror-like optical enhancement films for efficient brightness in LCD applications. ESRs are researched and tested for performance characteristics with UV/Vis/NIR for displays in laptops and device screens, and for architectural, automotive, and solar lighting.

Rare earth elements (REEs) are also used in the assembly of semiconductors and electronics such as displays and are tested for impurities.

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Enhanced Specular Reflector (ESR) Films - UV/Vis/NIR

Determination of Trace Rare Earth Impurities in Europium Oxide - ICP-MS

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Semiconductor Manufacturing Analytical Techniques

DESIGN
Design verification

R&D
Physical and elemental analysis

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- ICP-MS
- FT-IR
- TD-GC-MS
- VPD-ICP-MS
- LC

CHEMICAL SUPPLY
Chemical testing and quality control

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- ICP-MS
- ICP-OES
- Online - ICP-MS
- Online – ICP-OES
- GF-AAS

DEVICE FABRICATION
Yield enhancement process control

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- ICP-MS
- Online TD-GC-MS
- Online TD-GC-FID
- Online – ICP-MS
- Online – ICP-OES
- VPD-ICP-MS
- LC

FINAL TEST
Functional analysis

PerkinElmer Technologies
- DSC
- TGA
- FT-IR
- SP-ICP-MS

ASSEMBLY AND PACKAGING
Functional analysis

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- DSC
- TGA
- DMA
- TMA
- FT-IR
- AAS
- ICP-OES

Analytical Techniques and Acronyms

Inductively coupled plasma mass spectrometry	ICP-MS
Fourier-transform infrared microscopy	FT-IR
Thermal desorption gas chromatography	TD-GC-MS
Thermal desorption gas chromatography flame ionization detection	TD-GC-FID
Inductively coupled plasma - optical emission spectrometry	ICP-OES
Liquid chromatography	LC
Differential scanning calorimetry	DSC
Thermal gravimetric analysis	TGA
Single particle ICP-MS	SP-ICP-MS
Vapor pressure decomposition ICP-MS	VPD-ICP-MS
Atomic absorption spectrometry	AAS
Graphite furnace atomic absorption spectroscopy	GF-AAS

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INNOVATIONS FOR PRECISION SEMICONDUCTOR AND ELECTRONICS TESTING

The semiconductor and electronics industries require the utmost precision in gas, chemicals, and materials testing to keep contaminants out of your manufacturing processes. Simply put, quality testing solutions are the keys to quality devices. Here are some of the solutions that make our everyday electronic devices and technologies possible.

Inorganic Analysis

NexION 5000 ICP-MS

The NexION 5000 is a four-quadrupole instrument innovatively designed to exceed demanding challenges, taking ICP-MS performance beyond everyday triple-quad technology to deliver exceptionally low BECs – under one part per trillion, even in hot plasma; unmatched matrix tolerance for accuracy in all matrices; and outstanding detection limits.

Avio® 550 Max ICP-OES

A compact, fully simultaneous ICP-OES instrument, ideal for labs with high throughput requirements. It uses a vertical plasma and is engineered to handle even the most difficult, high-matrix samples without dilution, delivering productivity, performance, and fast ROI.

PinAAcle™ 900T AA

With the flexibility to switch between flame and furnace in seconds, its high-throughput optical system, combined with a solid-state detector, provides the highest quality efficiency and signal-to-noise performance of any AA system on the market.

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Organic Analysis

Clarus® GC

The powerful Clarus® 590 and 690 GC instruments deliver superior sensitivity and industry-leading sample handling technology with headspace, thermal desorption, liquid autosampling, and SPME options.

TurboMatrix ATD-GC/MS

We invented the automated thermal desorption (TD) technology used globally for indoor and outdoor air monitoring. And our thermal instruments are ideal for a wide range of additional GC applications, including analysis of outgassing from all manner of materials.

TG-GC/MS

Although TG-MS allows real-time monitoring, it can be confusing due to overlapping events and higher mass ions obscuring those of lower mass. By adding GC to the system, these events can be cleanly separated and very low levels of impurities detected.

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Thermal and Elemental Analysis

TGA 8000™

Our thermogravimetric analyzer gives you complete control over your sample environment and delivers high throughput and reliability, even unattended. Advanced hyphenation technology works beautifully with GC/MS and other systems for better understanding of evolved gases.

DSC 8500

The DSC 8500 is a double-furnace DSC, featuring our second-generation HyperDSC technology. Now you can gain unlimited insight into the structure, properties, and performance of your materials.

DMA 8000

This flexible, cost effective system's innovative design, high functionality, and flexible operation make it ideal for advanced research and routine quality testing in the analysis of composite materials.

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Accelerate the drawing and publishing of chemical and biological compounds.

SIGNALS™ NOTEBOOK
A cloud-native electronic lab notebook that captures, reuses, and shares experimental data.

E-NOTEBOOK™
Document your analyses and leverage the knowledge gained from previous experiments.

LEAD DISCOVERY
Discover actionable insights by seamlessly integrating chemical and biological molecules with activity results.

TIBCO SPOTFIRE®
Quickly analyze disparate data from multiple sources and create a complete picture of what's happening in real time.

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COMPLETE SERVICES FOR INCREASED PRODUCTIVITY AND EFFICIENCY

Today's lab leaders are facing several challenges, from tighter deadlines to increased budget scrutiny to teams with various degrees of comfort with lab equipment. Time that could be spent getting ahead is spent on noncore activities.

To help you overcome barriers to success, OneSource® Laboratory Services has built a team of trained scientists and engineers who bring their real-life knowledge to you, helping increase your productivity with recommendations on how to best utilize your assets. With this knowledge, you can get back to your core mission.

Labs of all sizes need to know their equipment will work as expected, every time they turn it on. From contracts and performance maintenance available for our instruments as well as other manufacturers' equipment to full lab asset management delivered globally, we can help you make the most of your important lab assets.

And for labs looking to introduce new equipment and techniques, we offer training at our facilities and at yours.

Click here to read about our multivendor and educational services

OneSource® Laboratory Services

OneSource Services

- Asset optimization
- Lab environment and instrument monitoring
- Asset location
- Education and training
- Technology and descriptive analysis
- Internet of lab things/lab of the future
- Remote support
- Multivendor services
- Compliance
- Lab support
- IT solutions
- Instrument qualifications

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Multivendor Services

With so many different vendors' instruments in your lab, it can be challenging to ensure everything is being maintained properly. Some labs struggle to get the most productivity and efficiency from all their instruments. Others streamline and simplify workflows to maintain regulatory compliance – and reduce the risk of noncompliance. Either way, you're always scrambling to figure out who to call for service as quickly as possible before you lose too much time…and money.

But what if there were a one-stop service contract option for your lab – from a company with decades of deep-seated multivendor experience – that repaired all your instruments, offered state-of-the-art validation and compliance services, and provided reliable preventative maintenance? There is. That's what OneSource Multivendor Service is all about.

Information on Educational Services

Whether you are looking for a basic instrument refresher course, simple troubleshooting techniques, general application support, or method optimization, our field application scientists or service engineers will come directly to your lab.

Through education, you will gain knowledge and insights into the latest techniques, not only increasing your confidence, but also unlocking the full potential of your instrument.

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For more information visit www.perkinelmer.com

PerkinElmer, Inc.
940 Winter Street
Waltham, MA 02451 USA
P: (800) 762-4000 or
(+1) 203-925-4602
www.perkinelmer.com

For a complete listing of our global offices, visit www.perkinelmer.com/ContactUs

231950 (64052) PKI