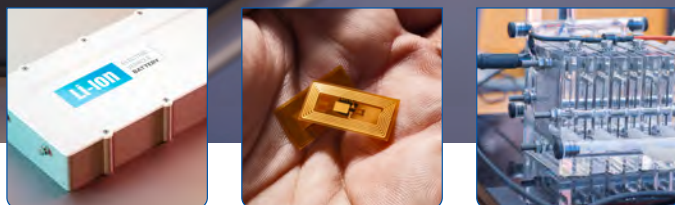


POWER UP YOUR ANALYSIS



In-Depth Battery Component Testing

Engineering the Battery-Powered Future



The role of batteries – and of battery component research and analysis – will be pivotal in the digital future. And as the world moves to embrace renewable energy sources and reduce our global CO₂ emissions, it will also be more dependent than ever on better battery technology, powering the demands of industries such as automotive, energy storage, and portable consumer goods like power tools, computers, and phones. So labs that analyze battery components need reliable, accurate solutions and services to help them to:

- Design and develop safer batteries that are resistant to heat and wear
- Continue to improve on battery performance
- Increase battery lifespan while reducing weight and mass

We're providing accurate analytical testing solutions to investigate battery materials. It's how we'll keep the future powered up.

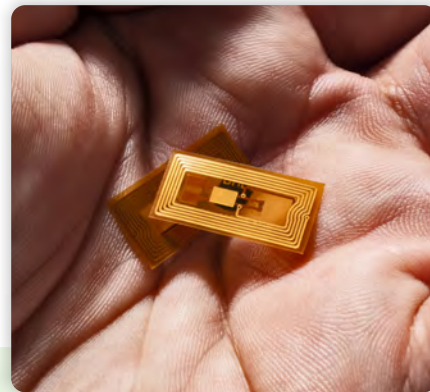
Powering Technology Advancements

Battery analysis is a complex business, so the need for trusted, reliable, and tested analytical solutions has never been greater. Whether you're doing battery engineering and R&D, researching existing battery materials, or are focused on recycling and reuse, you rely on high-quality data for in-depth understanding of battery performance – at every stage of battery life.



Lithium-Ion

Lithium-comprised batteries are widely used in the surging EV markets, so they're a key focus for ongoing research. And with growing analytical demands around Li-ion technology, validating the standards of battery components and materials is of increasing importance.



Solid-State

R&D efforts into ceramics and solid polymers is at the forefront of innovation, and scientists are using advanced material characterization to address impediments to wider adoption of solid state battery technology in the marketplace.



Fuel-Cell/Hydrogen

Fuel cells work like batteries but don't need recharging. Researchers are working to overcome fuel cells' durability, reliability, and safety challenges, which will help lower costs, increase performance – and enhance commercial value.

Anode/Cathode and Binder Testing

Each part of the battery is built from a specific material for a defined purpose. Researchers and manufacturers need analytical solutions to gain more understanding and secure quality across a diverse range of materials.

Much battery R&D is centered around the use of ICP-OES and ICP-MS in characterizing and developing optimal anodic materials, including graphite, the material of choice for today's battery anodes.

Elemental analysis using ICP-OES and ICP-MS measures ratio compositions and impurities of nickel, manganese, and cobalt (NMC) materials widely used in cathodes. Battery manufacturers, mining companies, academic institutions, and contract labs employ these solutions to assess quality of raw materials and address impacts on manufacturing costs, safety, and the environment.

Thermal behavior and advanced material characterization using FT-IR, DSC, and TGA technologies are key to evaluating binder material for high temperature stability and safety and superior ion transportation, leading to better rate capability at high current discharge.

Let's Talk Mining

There's been significant growth in the marketplace for rare earth elements (REEs), including cerium, yttrium, lanthanum, neodymium, and a handful of others, which has helped expand and diversify the mining industry. These REEs exhibit many optical, electrical, and magnetic properties that play a role in chemical catalysts, rechargeable batteries, electronic devices, fiber optics, and ceramics and glass. REEs are vital for today's and tomorrow's industries, so there's growing pressure for analytical solutions that accurately characterize and quantify REE content as companies begin to utilize them in their workflows. [Read more here.](#) ▶



More About Anode/Cathode and Binder Testing

[Learn more about ICP-OES or ICP-MS used in the determination of impurities in metals such as nickel.](#) ▶

[Read about measurement of impurities in high-purity copper concentrate using the NexION 5000 system.](#) ▶

[See how we demonstrate the direct determination of 14 REEs in high-purity europium oxide.](#) ▶

Electrolyte Testing

Electrolytes serve as a catalyst for making batteries conductive by promoting the movement of ions from cathode to anode on charge, and in reverse on discharge.

The major problems associated with electrolytes is their high flammability and slow diffusion, which can be ameliorated by using solid-state materials having higher diffusivity and low flame susceptibility. Off-gassing measurements are performed to do safety testing.

Research on electrolyte solutions focuses on functional electrolyte additives, flame-resistant or nonflammable electrolyte solutions, and new electrolyte salts.

Let's Talk Chemicals

Nanotechnologies are at the forefront of exciting advances in the chemicals industry, including use of nanoparticles as catalysts. The chemicals industry relies on catalysts to shorten reaction times throughout the production workflow. Nanotechnology developers strive to produce catalysts that are highly selective and active while having low energy requirements and long lifespans. These performance characteristics are achieved by carefully considering key chemical and physical characteristics during particle development, such as:

- Size, shape, and spatial distribution
- Surface composition and electrical structure
- Thermal and chemical stability

[Read more about chemicals in batteries here.](#) ►



More About Electrolyte Testing

[Learn more about GC/MS for determination of carbonates in lithium-ion battery electrolytes.](#) ►

[Learn more about the quality control of polymer electrolyte membrane fuel cells by TGA.](#) ►

Separator and Membrane Testing

Most conventional batteries use separators – gelatinous membranes that prevent short-circuiting of the electrodes. Separators should have uniform thickness, adequate mechanical strength during cell fabrication, and chemical and electrochemical stability. Smart separator materials have been developed that melt in situations like an accidental short circuit, overcharging/discharging, or thermal runaway.

In lithium-ion batteries, dendritic formations can short-circuit electrodes, which can ignite flammable electrolytes. Rigorous material characterization technology tests for properties such as mechanical strength during cell fabrication and chemical and electrochemical stability. Research is now focusing on separator materials that offer superior heat resistance and are less prone to degradation.

Let's Talk Polymers

In most batteries, energy is stored by exploiting metals or metal ion-based reactions. But most modern batteries couldn't function without the help of polymers.

Polymers perform several important tasks in battery cells: as binders in electrode slurries, in separators and membranes, and as active materials, where charge is stored in organic moieties. A common binder material for the cathode is polyvinylidene fluoride, whereas styrene-butadiene copolymer plays the role of binder in the anode.

[Read more about polymers in battery cells here.](#) ►



More About Separator and Membrane Testing

[See how TEA technology can help in determining thermal properties of batteries.](#) ►

[Get a compendium of testing applications for polymers, plastics, rubbers, and advanced materials.](#) ►

What's Next for Battery R&D?

Manufacturers and contract labs need to perform investigations to improve the performance properties of battery assemblies, from cathodes, anodes, and electrolytes to separators and membranes to battery packaging. Lowering the cost and enhancing overall quality and performance are key to improving today's battery technologies – and developing tomorrow's. That means:

- Improving energy density
- Developing high-capacity lithium-ion anodes
- Increasing the stability of electrolytes
- Researching high-voltage, high-capacity cathode materials



More About Battery R&D:

[Read about high-precision analysis of battery materials using our Avio® 550 Max ICP-OES.](#) ►

Investigating Properties of Cathodes, Anodes, Electrolytes, and Separators

TESTING NEEDED	TECHNOLOGY	PRODUCTS
Cathode/Anode Analysis	FT-IR, ICP-OES, ICP-MS, DSC, TGA	Avio 220, Avio 550, NexION 5000, Spectrum 3, DSC 8000, TGA 8000, STA 6000
Separator Analysis	FT-IR, DSC, TGA, Hyphenation (TG-IR-GC/MS)	Spectrum 3, Spotlight 400, DSC 8000, TGA 8000, STA 6000, EGA 4000
Electrolyte/Solvent Composition	ICP-OES, GC/MS, Hyphenation (TG-IR-GC/MS)	Avio 550, Clarus SQ 8, TG-IR-GC/MS



For research use only. Not for use in diagnostic procedures.

Quality Assurance, Quality Control

It's critical that you have processes in place for in-manufacture safety testing of all types of materials and components used in batteries destined for electric vehicles, electronics and energy storage.

Manufacturers need the tools and technologies to test for a whole host of safety, performance, and compositional parameters, including:

- Safety, energy/power, capacity, longevity
- Rechargeability, intercalation, and contamination
- Regulatory compliance
- *In situ* analysis for real-time performance under everyday workloads



Get the LIB Guide:

[Read "Lithium-Ion Battery Analysis: Complete Solutions for Your Lab." ►](#)

Testing for Safety, Performance, Composition, and Impurities

TESTING NEEDED	TECHNOLOGY	PRODUCTS
Storage Management/Safety	GC/MS, Hyphenation (TG-IR-GC/MS)	Clarus SQ 8, TG-IR-GC/MS
Degradation Analysis Technology	FT-IR, FT-IR Imaging, GC/MS, DSC, TGA, Hyphenation (TG-IR-GC/MS)	Spectrum 3, Spotlight 400, Clarus SQ 8, DSC 8000, TGA 8000, STA 6000, TG-IR-GC/MS
Impurity Investigation	FT-IR, FT-IR Imaging, ICP-OES, ICP-MS	Spectrum 3, Spotlight 400, Avio 220, Avio 550, NexION 2000, NexION 5000



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End of Life Is Just The Beginning

Batteries will continue to drive the automotive, storage infrastructure, and portable consumer goods industries. And so the recycling and safe disposal of batteries become paramount considerations for the safety and well-being of the people and the environment.

At the end of battery life, analytical tools can help you to monitor and manage off-gassing and toxic elements that may end up in landfill and aid in the separation and identification of materials and chemicals that can be reused in the manufacturing process.

Let's Talk Compliance

CTIA Battery Certification Program – CTIA operates six device certification programs covering everything from battery quality to cybersecurity for connected devices.

ISO 13485 – The ISO standard addresses medical devices that contain batteries, such as pacemakers.

IEC/EN 62133 – This international standard specifies requirements and tests for the safe operation of portable sealed secondary cells and many batteries containing alkaline or other non-acid electrolytes.

Post-Separation Identification for Sustainability and Environmental Protection

TESTING NEEDED	TECHNOLOGY	PRODUCTS
Post-Separation Identification	ICP-OES, GC/MS, FT-IR, DSC, TGA	Avio 220, Avio 550, Spectrum 3, Spotlight 400, Clarus SQ 8, DSC 8000, TGA 8000, STA 6000
Environmental Monitoring	ICP-OES, ICP-MS, GC/MS	Avio 220, Avio 550, NexION 2000, Clarus SQ 8
Analysis of Alloys	ICP-OES	Avio 220, Avio 550



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Innovation That Pushes Your Science Forward

Whether you're designing and developing safer batteries, improving battery performance and lifespan, or researching better ways to separate and reuse battery components, our trusted solutions help you achieve accurate results that much faster. Because when your lab runs smoothly, you have more time to concentrate on your science.

Elemental Analysis



Gas Chromatography



Fourier-Transform Infrared (FT-IR)



Avio 550 Max/220 Max ICP-OES

The fully simultaneous, high-throughput Avio® 550 Max uses a vertical plasma and has been designed to handle even the most complex, high-matrix specimens without dilution, delivering performance, productivity, and faster return on investment.

Our robust, matrix-tolerant Avio 220 Max system with plug-and-play performance is ideal for labs with low- to medium-throughput requirements.



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Elemental Analysis



Gas Chromatography



Fourier-Transform Infrared (FT-IR)



NexION 5000 ICP-MS

Battery analysis laboratories need trace-element analysis that delivers superior interference removal, extremely low detection limits, and outstanding background equivalent concentrations (BECs) are crucial.

Our NexION 5000 ICP-MS combines the simplicity of a reaction/collision cell with multi-quadrupole technology that transcends traditional triple quad.



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Elemental Analysis



Gas Chromatography



Fourier-Transform Infrared (FT-IR)



Clarus 590/690 GC / Clarus SQ 8 GC/MS

Our Clarus® systems provide the high performance, capacity, and throughput analytical labs demand. Clarus 590/690 GC instruments deliver superior sensitivity, industry-leading TurboMatrix™ sample-handling technology with headspace, thermal desorption, liquid autosampling and SPME options, plus multiple detectors and a full line of accessories and consumables.

The Clarus SQ 8 GC/MS system offers unsurpassed sensitivity and unparalleled stability for identification and quantitation of volatile and semivolatile compounds. It's designed to deliver high throughput, rugged dependability, and great results.



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Elemental Analysis



Gas Chromatography



Fourier-Transform Infrared (FT-IR)



Spectrum 3

From routine identification and verification to advanced research applications, our Spectrum 3™ FT-IR spectrometer enables you to quickly, confidently, and cost effectively analyze a wide range of samples. It delivers sampling flexibility and performance in mid-, near-, and far-infrared ranges in a single instrument to advance research and new product development in battery and polymer technologies.



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Elemental Analysis



Gas Chromatography



Fourier-Transform Infrared (FT-IR)



Spotlight 400

With Spotlight™ 400 FT-IR and Spotlight 400N FT-NIR imaging systems, you get uncompromising data quality and clear, complete, highly detailed results. Spotlight FT-IR systems are purpose-built for demanding imaging applications. You're able to switch between sampling modes – standard transmission, reflection, ATR imaging, and more – with ease, and your images can be collected at high speeds with extraordinary signal-to-noise ratio.



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Differential Scanning Calorimetry (DSC) / Thermogravimetry Analyzer (TGA)



Hyphenated Systems



DSC 8500

Our DSC 8500 instrument helps you push the envelope on your research, offering deeper insights and the best user experience available. DSC applications include the determination of melting point, glass transition, and crystallization. It's also used to differentiate the type of polymer or analyze mixtures. Different cooling devices assure analysis over a wide temperature range, and autosampler options help increase productivity.



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Differential Scanning Calorimetry (DSC) / Thermogravimetry Analyzer (TGA)



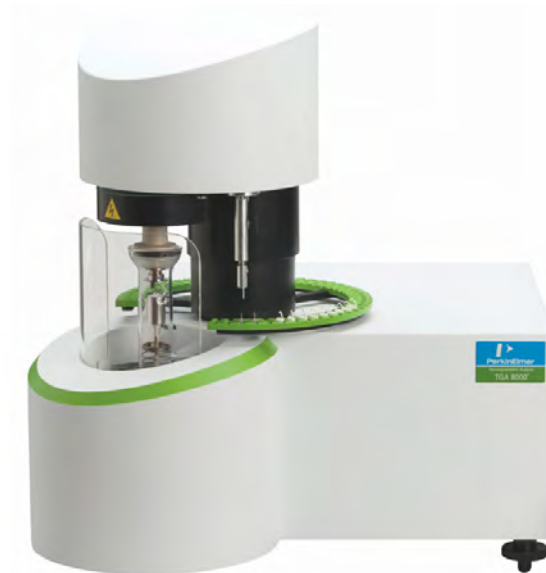
Hyphenated Systems



TGA 8000

Thermogravimetric analysis (TGA) is one of the members of the family of thermal analysis techniques used to characterize a wide variety of materials. TGA provides complimentary and supplementary characterization information to the most commonly used thermal technique, DSC.

The TGA 8000 system gives you total control of your sample atmosphere, both temperature and gas, due to its broad temperature range, fast heating rates, and integral mass-flow controllers. This easy-to-use instrumentation performs complex characterizations with minimal operational attendance thanks to a new 48-position autosampler.



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Differential Scanning Calorimetry (DSC) / Thermogravimetry Analyzer (TGA)



Hyphenated Systems



DMA 8000

Dynamic mechanical analysis (DMA) is a technique used to investigate thermal mechanical properties of materials as a function of temperature, humidity, dissolution media, or frequency. The DMA 8000 system's innovative design, high functionality, and flexible operation make it ideal for advanced research and routine quality testing in polymers and composites.



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Differential Scanning Calorimetry (DSC) / Thermogravimetry Analyzer (TGA)



Hyphenated Systems



Hyphenated Systems

Good things happen when great technologies connect. Our hyphenated solutions couple two or more instruments to increase the power of analysis and save time by acquiring more information from a single run. Our TGA and STA systems, coupled with FT-IR, MS, or GC/MS systems, deliver the industry's most complete line of advanced evolved gas analysis (EGA) platforms for materials characterization. Applications include identifying and quantitating components in batteries and polymers, determining leachables in packaging, identifying additives or contaminants, and more.

[Visit our hyphenated solutions webpage for more information.](#) ▶



Get the Most Out of Your Instruments and Your Analysis

You invest great efforts into your research – and we do the same with our consumables and accessories, tested and validated to fit your lab's requirements. That's why we developed a full range of quality consumables and accessories suitable for a range of battery component analytical applications. Below is a selection of the most commonly required parts.



Concentric Meinhard Nebulizer



Concentric Meinhard Nebu GC Column, SPE, Graphite Tubes, LC Columns, AA Lamp, Torch, Syringe lizer



GC Capillary Columns



Headspace Vials, Syringe, Liners, Septa, and GC Capillary Column



ICP Cones, Torch, Baffled Cyclonic Spray Chamber



ICP-ICPMS Torch



Thermal Analysis Sample Pans and Covers

These products offer reliable performance, help control operating costs, and maximize instrument uptime. Like our trusted instruments, our consumables and accessories offer the best performance, over and over. [Click here to browse and shop.](#)

Smarter Questions, Faster Analysis

Our enterprise software solutions empower you to meet stricter regulation and the needs of an ever-changing world with an integrated data platform that leads to breakthrough innovation, accelerated product development, and speed to market.



ChemDraw®

A powerful chemical drawing tool that accelerates chemistry communication and reporting

Signals™ Notebook

The future-proof electronic notebook solution that covers a comprehensive set of scientific use cases, spanning biology, chemistry, formulations, analysis, and more.

TIBCO Spotfire®

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

E-Notebook™

Document analyses and leverage the knowledge gained from previous experiments.

Lead Discovery Premium

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

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 utilized 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.

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.



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

Information and 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.

For more information visit www.perkinelmer.com/battery

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

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