

BATTERY MATERIALS ANALYSIS FOR SAFE, EFFICIENT, LONG LASTING, RELIABLE ENERGY STORAGE

eurofins | EAG Laboratories

Why Choose Eurofins EAG for Battery Materials Analysis?

For today's cutting-edge batteries, understanding the electrochemical processes and material changes occurring during cycling is essential. At EAG, we deliver specialized analytical services that support testing throughout the battery life cycle including purity testing of raw and recycled materials, materials R&D, battery manufacturing, and failure analysis.

Experience and Scientific Excellence

- With decades of experience in battery materials testing, EAG technical experts have been exposed to a variety of problems from purity of raw materials to failure analysis. We help our clients identify and solve these problems.
- EAG provides unmatched scientific excellence with over 1,000 highly-educated employees. Through a consultative approach, our experts work closely with clients to utilize the most appropriate techniques to find the answers our clients want.

Dedicated Battery Lab

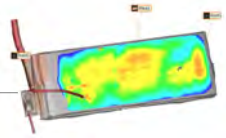
- EAG is the only independent battery testing lab with 'turnkey' materials and failure analysis based testing capabilities in the United States.
- We are continuously investing in our tools and capabilities to better serve the needs of this cutting-edge industry.
- Our battery lab has both a glovebox and dry room facilities to safely open batteries and diagnose components in as-is conditions.
- EAG has developed an air free transfer system for our battery lab which is connected to an expanding network of services within EAG Laboratories.

Client Confidentiality and IP Security

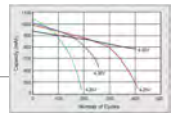
- At EAG, client confidentiality is core to our business. We have protocols and systems in place to ensure that client information and data remain secure at all times.
- EAG testing laboratories are ISO 9001, ISO 17025 and ISO 27001 certified. We have a Data Integrity Masterplan and training to support client data security and integrity throughout the data life cycle.

Comprehensive Guidance Through Every Phase of Your Battery Life Cycle

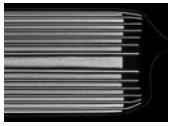
COMPONENT EXTRACTION



Dimension
(Blue Laser Scan)



Performance
(EC Testing)



Failure Analysis
(X-ray CT)

Electrolyte/Gas

De-formulation
GC-MS
NMR
LC-MS
ICP-MS

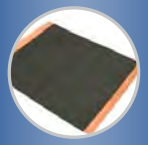
Gas Analysis
RGA
GC-MS

Cathode

- Morphology (SEM)
- Composition (APT, XRF, XRD)
- Thickness (FIB, SEM)
- CEI comp (XPS, TEM)
- % inorganic vs. organic (TGA)
- Heat gen temp (DSC)
- Electrochemistry (capacity, rate tests, EIS)
- Grain boundary composition (APT)

- Particle Size (LD)
- Purity Analysis (ICP, GDMS)

Anode



- Morphology (SEM)
- Composition (XRF, XRD)
- Thickness (FIB, SEM)
- SEI comp (XPS, TEM)
- % inorganic vs. organic (TGA)
- Electrochemistry (capacity, rate tests, EIS)

- Particle Size (LD)
- Purity Analysis (ICP, GDMS, XRD, Raman)

Separator

- Morphology (SEM)
- Thickness (FIB, SEM)
- Comp. (XRD, FTIR)
- Air permeability (Gurley)
- Porosity*
- Shutdown T (DSC, Gurley)
- Thermal shrinkage
- Penetration force*

- Particle Size (LD)
- Organic Composition (FTIR, pyrolysis GC-MS)
- % inorganic vs. organic (TGA)
- Inorganic Composition (XRD, EDS)

RAW MATERIAL EXTRACTION

*INDICATES PLANNED FUTURE CAPABILITY

Raw Materials and Battery Recycling

EAG Laboratories places a strong emphasis on the importance of material consistency in the manufacturing of batteries, specifically focusing on the composition and impurity levels of raw electrode materials. Small levels of unwanted contaminants may influence the characteristics of materials in terms of physical, electrical or other properties. EAG offers trace elemental analysis to identify and detect unwanted impurities.

Impurity and Contaminant Identification

Precise data about the elemental composition and trace impurities in battery materials can be crucial for quality control or failure analysis. In such scenarios, EAG Laboratories can undertake comprehensive impurity and contaminant identification for one or multiple components of your battery. This entails the identification and quantification of each elemental impurity or contaminant that could impact the battery's performance or safety. Our seasoned experts have carried out impurity tracking on numerous battery types, utilizing specialized methods to identify and quantify even the most elusive impurities. This specialized expertise equips us to tackle the most complex battery characterization challenges using the techniques listed below.

Glow Discharge Mass Spectrometry (GDMS)
- Elemental composition
- Impurity identification down to trace and ultra-trace mass fraction levels

Inductively Coupled Plasma Optical Emission Spectrometry (ICP-OES)
- High precision elemental concentrations

Inductively Coupled Plasma Mass Spectrometry (ICP-MS)
- Purity certification and cleaning validation
- Contamination identification
- Supply chain efficiency support

Instrumental Gas Analysis (IGA)
- Measure levels of atmospheric species (C, N, O, H, and S)

Laser Ablation Inductively Coupled Plasma Mass Spectrometry (LA-ICP-MS)
- High precision elemental and stable isotope analyses of solid materials
- Spatially resolved defect and inclusion analysis of solid materials

Scanning Electron Microscopy (SEM) and Transmission Electron Microscopy (TEM)
- High-resolution and high-depth-of-field images of the sample surface and near-surface

X-Ray Fluorescence (XRF)
- Elemental composition

Failure Analysis

In a landscape where battery manufacturers and users alike are always seeking higher performance and better safety features, meticulous battery characterization is indispensable. Such characterization spotlights any manufacturing or design flaws that could adversely affect battery performance or safety.

At EAG Laboratories, batteries are scrutinized using both in-situ and destructive testing methodologies aimed at augmenting performance and safety. Our selection of characterization techniques is tailored to the specificity of the information required, the desired accuracy level, and the available budget. While non-destructive testing (2D X-ray and CT analysis) enables us to garner valuable insights without dismantling the battery, certain investigation may necessitate more time-consuming and destructive methods for a thorough understanding of failure mechanisms and potential design improvements.

In-depth Investigation

Battery Teardown: We can methodically take apart a battery, focusing on isolating specific components or materials that might be the culprits behind the diminished performance or failure.

Controlled Environment: Using a controlled environment specifically for moisture sensitive battery materials, we have the ability to transfer samples to instruments for analysis without exposure to air or moisture, ensuring that samples remain uncorrupted.

Materials Characterization: We can analyze the elemental and molecular makeup of battery components to ascertain any deviations or anomalies that might have emerged during the battery's operational lifecycle.

Advanced Microscopy: We can visualize the intricate patterns, formations, and microstructures within the battery. These techniques can unearth microscopic defects or changes that may be the root cause of a battery failure. Microscopy can also determine the composition and chemical state at high resolution.

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Battery Characterization Techniques

Atom Probe Tomography (APT)
- 3D spatial and composition imaging up to 10 ppm
- Grain boundary and impurity analysis of active materials

Auger Electron Spectroscopy (AES)
- Elemental mapping and particle depth profiling

Cryogenic Focused Ion Beam and Scanning Electron Microscopy (Cryo-FIB/SEM) and Cryogenic Transmission Electron Microscopy (Cryo-TEM)
- Accurate FIB cross-sectioning and SEM/TEM measurements of beam sensitive materials

Electron Energy Loss Spectroscopy (EELS) and Energy Dispersive X-ray Spectroscopy (EDS)
- Elemental analysis and mapping and SEI characterization

Fourier Transform Infrared Spectroscopy (FTIR)
- Chemical composition before and after cycling
- Material identification (binder, separator)
- Carbon phase identification and structural analysis (graphite, carbon black, nanocarbon)

Gas Chromatography Mass Spectrometry (GC-MS)
- Electrolyte characterization
- Characterization of volatile organic species

Liquid Chromatography Mass Spectrometry (LC-MS) and Ion Chromatography (IC)
- Electrolyte characterization

NanoIR
- Identification of organic contaminants on the micro and nanoscales

Plasma Focused Ion Beam (FIB)
- Higher current Xe plasma and faster milling than conventional FIB
- FIB/SEM tomography to understand electrode grains in large scale

Raman Spectroscopy
- Carbon characterization

Scanning Electron Microscopy (SEM) and Transmission Electron Microscopy (TEM)
- High-resolution imaging of battery layers, including thickness and microstructure

Thermogravimetric Analysis (TGA) and DSC (Differential Scanning Calorimetry) with TGA
- Measurement of thermal properties

Time-of-Flight Secondary Ion Mass Spectrometry (TOF-SIMS)
- Organic composition and SEI characterization

X-Ray Photoelectron Spectroscopy (XPS)
- Chemical state, structure and compositional analysis of battery layers

X-Ray Diffraction (XRD)
- Materials identification, phase analysis and structural studies of battery components

Comprehensive Testing & Support

Our battery lab specializes in advanced techniques and applications for comprehensive battery analysis. We ensure batteries consistently meet performance criteria through:

Electrolyte Stability Testing

Electrolyte stability testing offers crucial insights throughout the battery's lifecycle, from material selection in the R&D phase to quality control and failure analysis. Our lab is adept at evaluating the composition, chemical stability of electrolytes and associated degradation pathways in batteries.

Electrochemical Characterization

Our lab is fully equipped with battery cyclers that can work with various sizes of batteries to provide galvanostatic and potentiostatic cycling tests. We can provide insights on the performance, cycle life, rate capability, coulombic efficiency and kinetics of different battery chemistries and structures. We can further investigate the electron and ion transport mechanisms with the help of electrochemical impedance spectroscopy (EIS).

Gas Evolution Analysis

Our gas testing laboratory specializes on comprehensive measurements of gases evolved from batteries and battery components. We are able to combine variety of specialized gas analysis techniques to measure the gases that are evolving in batteries at different stages of their life cycle.

Structure and Composition

Our battery experts specialize in investigating the intricate surface and compositional characteristics of battery materials. With expertise in analyzing structural integrity, phase transitions, and SEI layer formation, we delve deep into the microstructure of battery components. Utilizing advanced techniques, we provide crucial insights into how surface, chemical and compositional changes can affect battery longevity, efficiency, and safety.

Intellectual Property and Product Liability Support

Our battery experts offer specialized knowledge, technical consultation, and analytical backup for legal matters involving battery technologies. Whether it's intellectual property disputes or product liability cases, our team provides data interpretation and expert testimony. We've been instrumental in cases concerning battery failure, SEI layer research, and other high-stakes topics in the battery industry.

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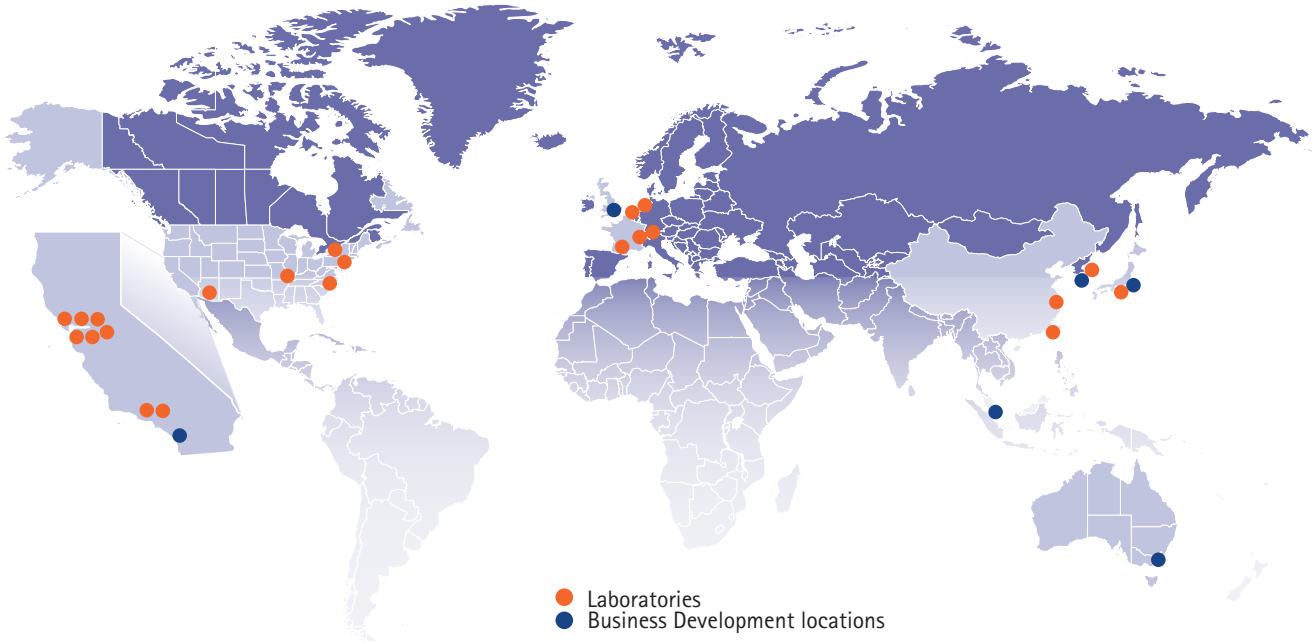

About Eurofins EAG Laboratories

When it comes to understanding the physical structure, performance, identity, chemical properties and composition of materials, no other scientific services company offers the breadth of experience, diversity of analytical techniques or technical ingenuity of Eurofins EAG Laboratories. We don't just perform testing, we drive commercial success—through thoughtfully designed investigations, technically superior analyses, and expert interpretation of data.

We deliver multi-disciplinary, problem-solving expertise to help our customers accelerate innovation, ensure quality and safety, and protect intellectual property. Whether you are seeking to reduce time-to-market, solve manufacturing problems or ensure regulatory compliance, turn to Eurofins EAG. We know how to bring the power of science to every phase of your product lifecycle.

- 20+ facilities located in the US, Europe, and Asia
- 2,500+ instruments
- 1000+ highly-educated employees
- Serving more than 5,000 clients worldwide
- Revenue sourced from more than 50 countries

Complete Lifecycle of Services

- PRODUCT INNOVATION & IMPROVEMENT
- INVESTIGATION & TROUBLESHOOTING
- QUALITY ASSURANCE
- MANUFACTURING SUPPORT
- FAILURE ANALYSIS
- REGULATORY COMPLIANCE
- MANUFACTURING & SUPPLY CHAIN SUPPORT
- CONSULTING & LITIGATION

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