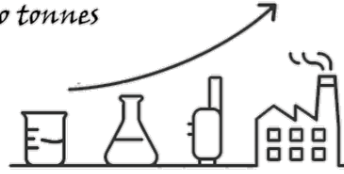




Your Partner in Process Scaling: Test Tubes to tonnes



SUPPLY CHAIN

Final / Draft

Work in progress

BY

Delta 3 Core Tech LLC
1600 Claymore Rd.
Chapel Hill, NC 27516

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PREPARED BY:

Dr Palash Gangopadhyay, PhD
Delta 3 Core Tech LLC

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A Strategic Assessment of the U.S. Battery Testing Infrastructure and the Global Cathode Active Material Supply Chain

Executive Summary

This report provides a comprehensive analysis of two critical segments of the global lithium-ion battery value chain. Part I delivers a detailed directory of testing and measurement service providers within the United States, essential for material qualification, cell validation, and regulatory compliance. Part II presents a global landscape analysis of Cathode Active Material (CAM) manufacturers, geographically structured to support strategic sourcing and supply chain diversification.

The analysis reveals a distinct bifurcation in the U.S. battery testing market. The ecosystem is clearly divided between highly specialized **materials characterization laboratories**, which focus on the chemical, physical, and thermal properties of powders and components, and **cell-level validation and abuse testing facilities**, which assess the safety, performance, and regulatory compliance of assembled cells, modules, and packs. This structural division necessitates a multi-vendor strategy for any entity seeking to bring a battery product from material development to market certification.

The global CAM manufacturing landscape is undergoing a profound geopolitical realignment. While Asia—led by China, South Korea, and Japan—maintains its position as the dominant hub for production volume and technological innovation, a new, policy-driven "Western" supply chain is rapidly emerging in North America and Europe. Spurred by legislation such as the U.S. Inflation Reduction Act (IRA), this nascent ecosystem is characterized by significant capital investment and the formation of complex, vertically integrated partnerships that span raw material processing, precursor and cathode synthesis, and end-of-life recycling. Key technological trends, including the commercial ascent of Lithium Iron Phosphate (LFP) chemistry and the strategic imperative to design cobalt-free, high-nickel cathodes, are further shaping this competitive dynamic. For stakeholders, navigating this evolving landscape requires not only a technical evaluation of supplier capabilities but also a sophisticated assessment of their supply chain resilience, geopolitical alignment, and integration into these emerging regional ecosystems.

Part I: Directory of U.S. Battery Testing and Analytical Service Providers



This section provides a detailed analysis of third-party laboratories in the United States capable of performing the critical measurements required for battery material qualification and cell validation. The section is segmented by the primary focus of the testing services to align with distinct stages of the R&D and quality assurance lifecycle.

1.0 Materials Characterization Services: The Foundation of Quality

The laboratories profiled in this subsection specialize in the chemical, physical, and thermal analysis of raw and synthesized battery materials, including precursors, cathode and anode powders, electrolytes, and recycled black mass. Accurate characterization at this stage is fundamental to predicting and ensuring final cell performance, safety, and longevity.

1.1 Chemical Composition and Purity Analysis (ICP-OES/MS, GDMS)

Verifying the elemental composition and purity of battery materials is the first line of defense against performance degradation and safety failures. Trace impurities can act as catalysts for unwanted side reactions, leading to accelerated capacity fade and gas generation.

- **NSL Analytical Services:** NSL is a leader in testing primary constituent materials for batteries and recycled materials like black mass. The laboratory specializes in trace analysis techniques, including Inductively Coupled Plasma-Optical Emission Spectrometry (ICP-OES) and Mass Spectrometry (ICP-MS), to detect impurities, contaminants, and elemental migration in cathode materials after cycling. Their expertise in X-Ray Fluorescence (XRF) and wet chemistry methods provides a comprehensive suite of chemical composition testing. NSL's laboratories are accredited to the ISO/IEC 17025 standard, ensuring a high level of quality and data reliability.
- **Eurofins EAG Laboratories:** EAG stands at the forefront of trace and ultra-trace level chemical impurity analysis in battery raw materials. Its Syracuse, NY, facility is equipped with state-of-the-art instrumentation, including Glow Discharge Mass Spectrometry (GDMS) for bulk analysis and ICP-MS/OES for purity certification and performance tracking of cathode materials. ICP-MS, in particular, is ideal for contamination identification and raw material qualification.
- **Applied Technical Services (ATS):** ATS offers ICP-Atomic Emission Spectroscopy (ICP-AES) through its chemical analysis department to determine the composition of metal alloys and other materials relevant to the energy storage industry. The company's chemistry laboratory operates under ISO/IEC 17025 accreditation, providing quality-assured results for clients.
- **Intertek:** With a global network of laboratories, Intertek provides ICP-OES and ICP-MS analysis to ensure the purity and quality of raw materials. While serving diverse sectors, their expertise in trace metals testing is directly applicable to qualifying battery materials, where even parts-per-trillion impurities can impact performance.

1.2 Particle and Powder Property Analysis (Laser Diffraction, BET, Density)

The physical properties of cathode and anode powders directly influence how they are processed into electrodes and, ultimately, the energy and power density of the final battery cell.



- **NSL Analytical Services:** NSL provides a comprehensive suite of powder characterization services. This includes particle size distribution analysis via laser diffraction (capable of both wet and dry dispersion down to submicron resolution) and traditional sieve analysis. For surface properties, the lab uses gas adsorption techniques, including Krypton BET for low-surface-area materials like Nickel-Cobalt-Aluminum (NCA) and Lithium Cobalt Oxide (LCO). Furthermore, they conduct a full range of powder density measurements, including Apparent, Bulk, Tap, and Solid density, which are critical for optimizing electrode calendaring and volumetric energy density.
- **Eurofins EAG Laboratories:** EAG offers particle size distribution analysis using laser diffractometry, covering a wide dynamic range from 0.02 μm to 2000 μm . This technique is applicable to both dry powders and liquid suspensions, making it versatile for various stages of material processing.
- **Applied Technical Services (ATS):** The ATS particle size distribution analysis laboratory uses a laser diffraction analyzer to evaluate powder and liquid samples in accordance with ASTM B822. This service is crucial for industries such as automotive and additive manufacturing, where particle characteristics dictate final product quality.
- **Contextual Analysis:** The importance of these measurements cannot be overstated. Particle size distribution affects slurry viscosity and the uniformity of the electrode coating. Surface area influences the rate of lithium-ion intercalation, impacting the battery's power capability. Powder density is a key determinant of the final electrode density after calendaring, which in turn governs the cell's volumetric energy density.

1.3 Thermal Properties and Stability Analysis (DSC, TGA)

Understanding the thermal behavior of battery components is paramount for ensuring safety, particularly in preventing thermal runaway events.

- **NSL Analytical Services:** NSL performs Thermogravimetric Analysis (TGA) and Differential Scanning Calorimetry (DSC) on non-active components such as polymer binders, separators, and solid electrolytes. These analyses determine critical properties like glass transition temperature, melting points, and decomposition pathways, providing essential data for material selection and safety modeling.
- **Significance of DSC/TGA:** DSC is an indispensable tool for assessing the thermal safety of electrolytes and their interaction with electrode materials. It precisely measures heat flow, identifying the onset temperature and magnitude of exothermic reactions that can trigger thermal runaway. TGA complements this by measuring mass loss as a function of temperature, indicating material decomposition. Data from these techniques are critical inputs for designing effective battery thermal management systems (BTMS). Intertek also offers DSC analysis as part of its broader thermal analysis services.

1.4 Contaminant and Moisture Analysis (Ion Chromatography, Karl Fischer Titration)

Moisture and ionic contaminants are highly detrimental in lithium-ion battery systems, leading to the breakdown of the electrolyte and corrosion of components.



- **NSL Analytical Services:** NSL utilizes Karl Fischer titration to precisely quantify water content in battery materials, from parts-per-million levels up to 100%. The lab employs multiple variants of the technique—volumetric, coulometric, and oven desorption—to handle a wide range of sample types, including reactive materials and insoluble solids like metal powders.
- **Ion Chromatography (IC) Applications:** IC is a sensitive technique used to identify and quantify ionic impurities (e.g., fluoride, chloride, sulfate) and degradation byproducts in raw materials, electrolytes, and processed components. Several laboratories offer these services. Intertek provides IC analysis to detect ionic contamination across its global network. The QA-Group in Germany also uses IC to assess ionic contamination on component surfaces in accordance with IPC standards. The instrumentation and methodologies for these analyses are well-established, with companies like Thermo Fisher Scientific providing detailed application notes for detecting various anions and lithium salts in battery electrolytes.

1.5 Microstructural and Elemental Mapping (SEM/EDS)

Visualizing the morphology and elemental distribution within battery materials provides crucial insights into synthesis quality and degradation mechanisms.

- **NSL Analytical Services:** NSL employs Scanning Electron Microscopy (SEM) coupled with Energy Dispersive X-Ray Spectroscopy (EDS/EDX) for high-resolution imaging and elemental mapping. This powerful combination allows for the analysis of particle morphology, coating uniformity, and the migration of elements within electrodes before and after battery cycling, which is key to understanding failure modes.
- **Eurofins EAG Laboratories:** EAG also offers extensive SEM and related microscopy techniques to investigate morphology, particle size, and defects in battery electrodes, providing critical support for R&D and failure analysis investigations.

Table 1: Summary of U.S. Materials Characterization Laboratory Capabilities

Laboratory	ICP-OES/MS	Laser Diffraction	DSC / TGA	Ion Chromatography	Karl Fischer	SEM / EDS	ISO/IEC 17025 Accredited
NSL Analytical Services	✓	✓	✓		✓	✓	✓
Eurofins EAG Laboratories	✓	✓	✓	✓		✓	Yes (Site-Specific)
Applied Technical Services (ATS)	✓	✓	✓	✓	✓	✓	✓
Intertek	✓		✓	✓			Yes (Site-Specific)



2.0 Cell, Module, and Pack Validation Services: From Prototype to Certification

This subsection details laboratories equipped for performance, safety, and regulatory testing of assembled battery cells, modules, and full packs. These tests simulate real-world conditions, from normal operation to extreme abuse scenarios, and are essential for product validation and gaining market access.

2.1 Mechanical and Environmental Abuse Testing (Crush, Shock, Vibration)

These tests evaluate the battery's resilience to physical stresses that could be encountered during transportation or in its end-use application, such as an automotive collision.

- **MGA Research:** A premier provider of battery abuse testing, MGA has decades of experience and operates dedicated facilities in Akron, New York, and Holly, Michigan. The company conducts a comprehensive range of tests, including nail penetration, crush, vibration, shock, and thermal/altitude simulations. Their capabilities are vertically integrated, covering testing from the individual cell level up to full vehicle thermal propagation studies.
- **LabTest Certification:** With a U.S. facility in Las Vegas, Nevada, LabTest offers a wide array of environmental tests that simulate the entire lifecycle of a battery. These include vibration, impact, crush, drop, and mechanical shock tests, ensuring products can withstand the rigors of shipping, storage, and operation.
- **Southwest Research Institute (SwRI):** SwRI's Mechanical & Environmental Battery Testing Laboratory is certified under ISO 9001 and maintains an ISO 17025 accreditation. The institute has specialized expertise in conducting component qualification and testing for demanding clients like the U.S. Department of Defense and NASA, making them a top choice for high-reliability applications.
- **SGS:** As a global entity, SGS provides a network of battery testing laboratories that offer abuse, durability, and environmental testing services. This global footprint is advantageous for companies targeting international markets.

2.2 Electrical Abuse and Performance Testing (Overcharge, Short-Circuit)

Electrical abuse tests are designed to verify the safety mechanisms of the battery and its management system under fault conditions.

- **MGA Research:** MGA's capabilities include critical electrical abuse tests such as overcharge, over-discharge, and extensive load cycling. These tests are designed to push cells beyond their specified limits to ensure the safety of end-users, manufacturers, and transporters.
- **LabTest Certification:** LabTest conducts a suite of electrical tests including abnormal charging, abusive overcharge, forced discharge, and short-circuit testing. These procedures are performed according to key industry safety standards such as UL 1642 (Lithium Batteries) and UL 2054 (Household and Commercial Batteries).



2.3 Transportation and Regulatory Certification (UN/DOT 38.3)

Compliance with transportation regulations is a non-negotiable requirement for bringing any lithium battery product to market. The UN/DOT 38.3 standard is the globally recognized benchmark for ensuring batteries can be transported safely, especially by air.

- **MGA Research:** MGA provides ISO 17025 accredited testing for the complete series of UN 38.3 tests. Their expertise in this area helps clients navigate the complex regulatory requirements for shipping lithium batteries.
- **LabTest Certification:** LabTest offers comprehensive testing and certification services to both national and international standards, explicitly including UN/DOT 38.3, to facilitate global market access for their clients' products.
- **SGS:** SGS leverages its global network and regulatory expertise to assist clients in achieving compliance with transportation standards and other market-specific regulations for cells, batteries, and modules.

Table 2: U.S. Battery Safety and Certification Laboratory Compliance

Laboratory	UN/DOT 38.3	UL 1642 / UL 2054	UL 2580 / SAE J2464	ISO/IEC 17025 Accredited
MGA Research	✓		✓	✓
LabTest Certification	✓	✓	✓	✓
Southwest Research Institute (SwRI)	✓	✓	✓	✓
SGS	✓	✓	✓	✓

The Bifurcated U.S. Testing Ecosystem

A strategic analysis of the U.S. battery testing landscape reveals that the market is not monolithic but is instead segmented into two highly specialized, non-overlapping domains. On one side are the **material-level analytical chemistry laboratories**, and on the other are the **system-level physical and electrical abuse testing facilities**. This structural division has significant implications for companies navigating the product development and certification pathway.

The first segment, represented by firms like NSL Analytical and Eurofins EAG, focuses on the micro-scale. Their expertise lies in characterizing the fundamental properties of powders and chemical solutions. This requires a significant investment in sophisticated analytical instrumentation such as mass spectrometers, electron microscopes, and thermal analyzers, operated in controlled, cleanroom-like environments to prevent sample contamination. The personnel are typically chemists and materials scientists with deep expertise in analytical techniques and data interpretation.

The second segment, exemplified by MGA Research and Southwest Research Institute, operates at the macro-scale. Their core competency is in assessing the safety and durability of fully assembled



cells, modules, and packs under extreme conditions. This work necessitates a completely different set of capital equipment, including high-force hydraulic crush systems, large-scale vibration tables, and specialized containment chambers designed to safely manage catastrophic battery failures involving fire and explosion. The expertise here resides with mechanical and electrical engineers who design and execute tests according to rigorous safety and regulatory standards.

This bifurcation is a logical consequence of the disparate requirements for equipment, facility infrastructure, safety protocols, and personnel skill sets. A laboratory optimized for trace metal analysis is not equipped to handle a thermal runaway event in a 10 kWh battery module, and vice versa.

The primary strategic implication for any organization developing a new battery technology is the unavoidable need for a multi-vendor qualification and testing strategy. A single testing partner cannot provide end-to-end services from powder to pack. A company must first engage with analytical labs like NSL or EAG to validate the purity, particle size, and thermal stability of their cathode and anode materials. Once these materials are used to produce prototype cells, those cells must then be shipped to a separate, specialized facility like MGA or SwRI for safety, abuse, and transportation certification testing. This adds layers of complexity to project management, requiring careful coordination of timelines, logistics for shipping potentially hazardous prototype materials between facilities, and management of multiple vendor contracts and budgets.

Part II: Global Landscape of Cathode Active Material (CAM) Manufacturers

This section presents a geographically structured global survey of CAM manufacturers, providing detailed profiles of their product portfolios, production footprints, and strategic positioning. This analysis is critical for supply chain diversification, strategic sourcing, and understanding the competitive landscape.

3.0 North America: Building a Regional Supply Chain

The North American CAM market is in a phase of rapid expansion, driven largely by government incentives, most notably the U.S. Inflation Reduction Act (IRA). These policies are designed to onshore the electric vehicle supply chain, reduce historical dependence on Asian imports, and foster a secure and resilient regional manufacturing base.

3.1 United States

The U.S. is becoming a major hub for both homegrown CAM innovators and large-scale production facilities established by global leaders.



- **Ascend Elements:** A key player in the circular economy model, Ascend Elements manufactures Nickel-Manganese-Cobalt (NMC) precursor CAM (pCAM) and finished CAM directly from recycled lithium-ion batteries. Their patented Hydro-to-Cathode® process significantly reduces the carbon footprint compared to traditional manufacturing. The company operates a pilot facility in Westborough, MA, a finishing site in Novi, MI, and is constructing a \$1 billion manufacturing campus in Hopkinsville, KY, positioning itself as a cornerstone of the domestic supply chain.
- **Sparkz Inc.:** With a strategic focus on re-shoring the supply chain, Sparkz is pioneering the U.S. production of cobalt-free Lithium Iron Phosphate (LFP) cathodes, which it markets under the brand FeCAM™. The company is establishing manufacturing facilities in California and West Virginia to produce these cost-effective and safe materials for the domestic market.
- **Stratus Materials:** Stratus is a U.S.-based developer of proprietary manganese-rich, cobalt-free CAM, branded as LXMO™. Their technology targets the growing demand for sustainable and high-performance batteries in light- to medium-duty EVs and energy storage systems.
- **Lithium Werks:** The company has announced plans for a major North American facility dedicated to the production of LFP cathode powders and its patented, high-power Nanophosphate® powder, originally developed at MIT. The facility will also produce finished electrodes for battery cell manufacturers.
- **Global Players in the U.S.:**
 - **LG Chem:** The South Korean chemical giant is making a landmark investment of over \$3 billion to construct the largest CAM manufacturing facility in the U.S. in Clarksville, Tennessee. Scheduled to begin production in 2025, the plant will have an ultimate annual capacity of 120,000 tons of advanced Nickel-Cobalt-Manganese-Aluminum (NCMA) cathode materials, enough to power 1.2 million EVs.
 - **BASF:** The German chemical company operates a cathode production facility in Elyria, Ohio, producing nickel-cobalt-metal materials. In a significant move towards a circular economy, BASF is also establishing a CAM production site in Battle Creek, Michigan, which will use recycled metals as feedstock in partnership with other supply chain players.
- **Critical Raw Material Suppliers:**
 - **Albemarle:** While not a direct CAM manufacturer, Albemarle is a foundational pillar of the U.S. battery supply chain. As a leading global lithium producer, it supplies the essential battery-grade lithium carbonate (used for LFP and mid-nickel cathodes) and lithium hydroxide (critical for high-nickel cathodes) from its extensive U.S. and global operations.
 - **Arcadium Lithium (formerly Livent):** Arcadium is another critical upstream supplier, specializing in the production of high-purity lithium hydroxide. Its largest and most diverse manufacturing facility is located in Bessemer City, North Carolina, making it a key domestic source of this vital raw material for high-performance CAM.

3.2 Canada

Canada is leveraging its natural resources and strategic location to build a complementary piece of the North American battery ecosystem, focusing on precursor materials and CAM production.



- **Electra Battery Materials:** Electra is strategically focused on a critical bottleneck in the supply chain: precursor materials. The company is developing North America's first cobalt sulfate refinery in Ontario, which will provide an essential ingredient for pCAM synthesis. Electra is also advancing its battery recycling capabilities to create a closed-loop system.
- **Targray:** A key distributor and supplier, Targray offers a complete portfolio of cathode materials to the North American market, including NCA, Lithium Manganese Oxide (LMO), LCO, and NCM chemistries.
- **Global Players in Canada:**
 - **POSCO Future M:** In a joint venture with General Motors, the South Korean firm is constructing a 30,000 ton-per-year high-nickel CAM plant in Bécancour, Quebec, directly linking a major materials producer with a leading automotive OEM.
 - **Umicore:** The Belgian materials giant had announced and commenced construction on a large-scale cathode and precursor material plant in Loyalist, Ontario. However, these plans have been paused as the company adapts its investment strategy to evolving market conditions.

3.3 Mexico

Mexico is rapidly emerging as a strategic manufacturing hub for CAM, positioned to supply the vast North American automotive industry. It is important to distinguish that this analysis focuses on cathode active materials for batteries, not "cathodic protection" systems for corrosion control, which is a separate industry also present in Mexico. The Mexican market is seeing a clear trend toward advanced, high-nickel (e.g., NMC811) and cobalt-free (LFP, LMFP) chemistries. The landscape is currently dominated by global players establishing local production facilities to serve regional customers. Recent market developments include Umicore inaugurating a new NMC plant, BASF forming partnerships with local automakers, and both POSCO Chemical and LG Chem expanding their NCA and LFP production capacities, respectively, within the country.

4.0 Europe: A Focus on Sustainability and Automotive Demand

The European CAM market is being shaped by the aggressive electrification targets of its domestic automotive industry and a strong policy emphasis on creating a sustainable, circular, and localized battery value chain under frameworks like the EU Battery Regulation.

- **Umicore (Belgium):** A global leader in materials technology, Umicore is at the forefront of Europe's battery ambitions. The company operates Europe's first gigafactory for cathode materials in Nysa, Poland, and has extensive R&D and production sites in Belgium. Umicore is notable for being the first company in Europe with a complete, circular battery materials value chain, from raw material sourcing to recycling. Its technology portfolio includes materials for EVs and electronics, with active R&D in manganese-rich HLM technology and next-generation solid-state battery materials.
- **BASF (Germany):** As a leading global supplier, BASF offers one of the broadest CAM portfolios in the industry, including various grades of NCM, NCA, and LCO tailored for different performance requirements such as high energy, power, or lifetime. Its European production footprint is substantial, with a major CAM and recycling facility in Schwarzheide, Germany, and



a pCAM plant in Harjavalta, Finland.

- **Johnson Matthey (UK):** Johnson Matthey developed the eLNO® family of advanced, nickel-rich cathode materials designed for high energy density and fast charging. The company had been constructing a production facility in Konin, Poland, and had planned a second in Finland. However, recent strategic shifts have led to the sale of these assets, with players like Ronbay Technology acquiring the Polish facility to establish a European foothold.
- **IBU-tec / IBUvolt (Germany):** IBU-tec has positioned itself as a key independent European manufacturer of LFP battery materials through its IBUvolt brand. From its facility in Weimar, Germany, it produces various LFP grades (e.g., IBUvolt® LFP400, LFP402) and has secured a major supply contract with Volkswagen's battery company, PowerCo, with a targeted annual capacity of over 3,000 tons by 2028.
- **Easpring Finland New Materials Oy (Finland):** This joint venture between China's Beijing Easpring (70%) and the state-owned Finnish Minerals Group (30%) is constructing a large-scale CAM plant in Kotka, Finland. The first phase of the project targets an annual capacity of 60,000 tons, with commercial production slated to begin in 2027, marking a significant addition to Europe's domestic production capabilities.

5.0 Asia: The Epicenter of Global Production

Asia remains the undisputed global leader in CAM research, development, and production volume. The region's top companies in South Korea, Japan, and China continue to drive technological innovation and command the majority of the global market share.

5.1 South Korea

- **LG Chem:** A dominant global supplier, LG Chem manufactures a diverse portfolio of advanced cathode materials, including high-nickel NCM(A) (with Ni >80%), mid-nickel NCM, and is developing innovative precursor-free synthesis routes to reduce environmental impact. While its primary production base is in Korea, the company is making massive investments to expand its footprint in the United States.
- **POSCO Future M:** A subsidiary of the steel giant POSCO, this company has rapidly become a vertically integrated powerhouse in battery materials. Its portfolio covers the full spectrum of modern cathodes, including ultra-high-nickel, high-voltage mid-nickel, and lithium-manganese-rich (LMR) materials. With massive production campuses in Pohang and Gwangyang, South Korea, and a global capacity target of 1 million tons by 2030, POSCO is a formidable competitor.
- **Kumyang Co., Ltd. (in partnership with SMLAB):** This partnership is focused on cutting-edge cathode technology, specifically single-crystalline, ultra-high-nickel (Ni >97%) and LMR materials. Their unique dry production process represents a significant innovation in manufacturing. The companies are expanding their production capacity in South Korea to over 42,000 tons annually.



5.2 Japan

- **Nichia Corporation:** A long-standing leader in materials science, Nichia manufactures a wide range of cathode materials, including LCO, NMC, NCA, and LFP. The company leverages its deep expertise in powder synthesis, originally developed for its phosphor business, and strategically concentrates all its CAM manufacturing at its Aratano and Tatsumi plants in Tokushima, Japan, to maintain tight quality control and foster innovation.
- **Sumitomo Metal Mining Co., Ltd.:** Sumitomo is a top-tier producer of high-performance NCA and NMC cathode materials, supplying major automotive battery manufacturers. The company operates a comprehensive supply chain and is engaged in a strategic collaboration with Toyota to develop and mass-produce cathode materials for next-generation solid-state batteries.
- **Tanaka Chemical Corporation:** Tanaka specializes in developing and manufacturing custom-made battery materials. Its portfolio includes cathode materials for Nickel-Metal Hydride (NiMH) batteries and, more significantly, precursors for lithium-ion batteries, including ternary Ni-Co-Mn and other nickel-based materials. They supply these critical precursors to major automakers and battery manufacturers from their production sites in Japan.

5.3 China

- **Ronbay Technology:** Ronbay is a major Chinese producer specializing in high-nickel NCM materials, such as NCM811, which are essential for high-energy-density EV batteries. The company has substantial production capacity across multiple sites in China (Zunyi, Ezhou, Yuyao) and is aggressively expanding its global footprint with facilities in South Korea and, notably, by acquiring a former Johnson Matthey plant in Poland to enter the European market.
- **XTC New Energy Materials (Xiamen) Co Ltd:** A subsidiary of the state-owned Xiamen Tungsten corporation, XTC produces a range of LCO and NCM materials (including Ni5, Ni6, Ni7, and Ni8 series). In a major strategic move, XTC is partnering with France's Orano to build a large, integrated industrial site in Dunkirk, France, that will encompass pCAM production, CAM synthesis, and battery recycling, creating a significant new player in the European value chain.
- **Beijing Easpring Material Technology:** Easpring is one of the world's leading producers of cathode materials and is the majority owner and technology provider for the new large-scale CAM plant being constructed in Kotka, Finland, demonstrating the global reach of China's top-tier battery material firms.

6.0 South America: Leveraging Resources to Move Downstream

Historically known as a primary source of raw materials, particularly lithium from brine deposits in the "Lithium Triangle," South America is now attracting significant investment in downstream processing and materials production to capture more value from its resources.

- The regional market is mirroring global trends, with growing demand for both LFP cathodes, prized for their safety and cost-effectiveness in energy storage and mass-market EVs, and high-nickel chemistries for high-performance vehicles. A key driver is the strategic goal of



localizing manufacturing to reduce reliance on imported materials and strengthen the regional EV battery value chain. **Key Developments:**

- **BYD (China):** The Chinese EV and battery giant is making a major strategic play to build an integrated South American supply chain. The company is investing \$290 million to construct the region's first cathode plant in Chile and is also establishing a lithium iron phosphate processing facility in Brazil. This follows the establishment of an LFP battery production plant in Manaus, Brazil, demonstrating a clear mine-to-megapack strategy.
- **Global Player Investment:** Market analyses indicate that major global CAM producers, including Umicore, BASF, POSCO Chemical, and LG Chem, are actively investing or forming partnerships to establish production facilities in South America, aiming to leverage the region's rich lithium resources and growing automotive market.
- **Upstream Leaders:**
 - **SQM (Sociedad Química y Minera de Chile):** SQM is one of the world's largest and lowest-cost producers of lithium. It is crucial to clarify that SQM is an upstream supplier, not a direct manufacturer of finished CAM. The company extracts lithium from the Salar de Atacama and processes it into high-purity lithium carbonate and lithium hydroxide. These products are then sold to CAM manufacturers globally as the essential lithium-bearing precursor, often referred to as "cathode material" in a broader sense.

Table 3: Global Cathode Manufacturer Product Portfolio Matrix

Company	HQ Region	Primary CAM Chemistries	Known/Planned CAM or pCAM Production Countries
Ascend Elements	North America	NMC (from recycled feedstock)	USA
Sparkz Inc.	North America	LFP (FeCAM™)	USA
Stratus Materials	North America	Mn-rich, Co-free (LXMO™)	USA
Electra Battery Materials	North America	pCAM (Cobalt Sulfate)	Canada
Umicore	Europe	NMC, HLM, Solid-State Materials	Belgium, Poland, Canada (Paused), Mexico
BASF	Europe	NCM, NCA, LCO	Germany, Finland, USA, Japan
IBU-tec / IBUvolt	Europe	LFP	Germany
Easpring	Asia	NCM, LCO, LFP	China, Finland (JV)
LG Chem	Asia	NCM, NCMA	South Korea, USA
POSCO Future M	Asia	NCM, NCA, LMR	South Korea, Canada, China, Indonesia, Mexico



Kumyang / SMLAB	Asia	High-Ni NCM/NCA/NCMA, LMR	South Korea
Nichia Corporation	Asia	LCO, NMC, NCA, LFP	Japan
Sumitomo Metal Mining	Asia	NCA, NMC, Solid-State Materials	Japan
Ronbay Technology	Asia	High-Ni NCM, NCA	China, South Korea, Poland
XTC New Energy	Asia	LCO, NCM	China, France (JV)
BYD	Asia	LFP	China, Brazil, Chile

The "West vs. East" Strategic Bifurcation and the Rise of Integrated Partnerships

The global cathode active material market is undergoing a fundamental reorganization along geopolitical lines. While Asia, and particularly China, continues to dominate global production capacity, a distinct "Western" supply chain is being aggressively constructed across North America and Europe. This transformation is not merely the construction of isolated factories but the deliberate formation of complex, multi-party ecosystems designed for resilience, sustainability, and alignment with new regulatory frameworks.

The primary catalyst for this shift is policy. Legislation like the U.S. Inflation Reduction Act (IRA) provides powerful tax incentives and grants for sourcing battery materials and components domestically or from designated free-trade partners. This has directly triggered a wave of strategic investment decisions, such as LG Chem's \$3.2 billion commitment to a cathode plant in Tennessee and POSCO Future M's joint venture with GM in Quebec. These moves are explicit strategies to create IRA-compliant supply chains for the North American automotive market.

A defining characteristic of this new Western ecosystem is its reliance on integrated partnerships rather than the actions of standalone companies. This collaborative model is essential to de-risk the massive capital investments required and to build end-to-end value chains from the ground up. A prime example is the circular supply chain being established by BASF, Nanotech Energy, American Battery Technology Co. (ABTC), and Toda Advanced Materials. In this model, ABTC will recycle manufacturing scrap from Nanotech's battery plant; Toda and BASF will process the recovered metals into new pCAM and CAM; and Nanotech will use these recycled-content materials in its new batteries. Similarly, the partnership between XTC New Energy and Orano in France combines Chinese technological leadership in CAM production with French expertise in chemical processing and nuclear-grade project management to build a facility that integrates pCAM, CAM, and recycling. Furthermore, companies are pursuing deep vertical integration to secure control over critical chokepoints in the supply chain. POSCO Future M is not only building CAM plants but is also investing upstream in lithium and nickel resources and midstream in precursor production facilities to ensure a stable supply of feedstock for its operations. In Canada, Electra Battery Materials is focusing specifically on refining cobalt sulfate, a vital precursor



material, thereby addressing a key vulnerability in the North American supply chain. For supply chain strategists and procurement managers, these developments fundamentally alter the process of vendor qualification. A simple evaluation of a CAM manufacturer's technical specifications and price is no longer sufficient. A far more sophisticated assessment is now required, one that scrutinizes the supplier's entire partnership ecosystem and degree of vertical integration. A supplier with a secure, localized, and circular supply chain—one that includes domestic precursor production and integrated recycling—presents a significantly lower geopolitical and logistical risk profile than a competitor wholly dependent on imported precursors from a single, distant region. Strategic sourcing in the battery industry has evolved into a complex exercise in supply chain risk assessment.

Conclusion

The analysis presented in this report underscores a period of dynamic transformation across the lithium-ion battery value chain. In the United States, the testing and validation infrastructure is robust but distinctly segmented, requiring companies to engage multiple specialized partners for materials characterization and cell-level certification. Navigating this bifurcated landscape efficiently is a critical operational challenge for technology developers.

Globally, the cathode active material supply chain is fracturing along geopolitical lines, moving away from a single, Asia-centric model toward a multi-polar structure with emerging, resilient ecosystems in North America and Europe. This realignment is defined by strategic, multi-party partnerships and a strong push toward vertical integration and circularity. For automotive OEMs, battery manufacturers, and other stakeholders, the imperative is clear: supply chain strategy must now prioritize not only cost and technology but also geographic diversification, regulatory compliance, and the underlying resilience of a supplier's entire value network. Success in the coming decade will belong to those who can adeptly navigate this complex and rapidly evolving global landscape.

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