

LMFP for Li-ion Batteries

*Lithium Manganese Iron Phosphate (LMFP),
from cathode materials to battery cells*

Patent Landscape Analysis

January 2026

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• Time evolution of patent publications		• Main IP players by typology and headquarters countries		• Chinese companies: CATL, BYD, EVE Energy, ATL, Gotion/Guoxuan High Tech Power Energy, SVOLT, Envision/AESC, COSMX/COSLIGHT, Sunwoda, Cornex New Energy, CALB (China Aviation Lithium Battery), Wanxiang A123 Systems, Tafel New Energy Technology/Zenergy, JEVE (Tianjin EV Energy), Deyi Energy Technology, Lishen, Phylion, Hithium Energy Storage Technology, Ganfeng Lithium, NIO, GAC Group, Geely Holding, Trina Storage, FAW, Dongfeng Motor, Li-Auto, Battero Technology, WeLion New Energy Technology, Liongo New Energy Technology, Hengtron Nanotech, and more
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ONE-HOUR PRESENTATION

The author of the report is available to address any questions you may have.

A **one-hour online presentation** of the report is included with your purchase. This session offers the opportunity for a direct interaction with the author, including a presentation of the results and a dedicated Q&A session.

Feel free to contact the author to schedule a meeting.



Contact us



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MAIN PATENT ASSIGNEES MENTIONED IN THE REPORT

INDUSTRIALS

CATL, LG Chem/LG Energy Solutions, Samsung, Dynanonic, BYD, EVE Energy, Murata/Sony, ATL, Guoxuan High Tech Power Energy/Gotion, SVOLT, Toyota, Taiheiyo Cement, Toshiba, Sumitomo Chemical/Tanaka Chemical, Tinci Materials Technology, Envision/AESC, Global Graphene, COSMX/COSLIGHT, Sumitomo Metal Mining, Sunwoda, General Motors, Rongbay Technology, HydroQuébec, Reliance New Energy/Lithium Werks, Epsilon Carbon/Johnson Matthey, and more.

R&D LABORATORIES

SEL, Kyushu University, AIST, Tokyo Metropolitan University, Central South University, Institute of Physics, Tsinghua University, Beijing Institute of Technology, Hanyang University, UNIST, KAIST, RIST, KERI, CEA, CNRS, Fraunhofer, Université de Montréal, University of Chicago, University of Michigan, Lockheed Martin/UT-Battelle, and more.

INTRODUCTION

Key information on LMFP

Lithium Manganese Iron Phosphate (LMFP) is a promising emerging cathode material for lithium-ion batteries. Derived from LFP, it retains key advantages (structural stability, safety, low cost, relatively good cycle life) while offering a 10–20% higher energy density thanks to manganese substitution. LMFP still faces challenges such as low electronic conductivity, slow lithium-ion diffusion, and performance degradation linked to Mn^{3+} . Current research focuses on chemo-physical modifications to overcome these limitations and enable large-scale commercialization. LMFP developments are mainly led by major Chinese battery manufacturers, with new North American companies also advancing LMFP technology for EV and ESS applications.

Strength

- Higher energy density than LFP
- Lower cost per kWh than NMC
- **Abundance and low cost of Mn**
- Higher voltage
- Better low temperature performance than LFP
- High thermal stability and safety
- High voltage platform
- Leverage existing LFP manufacturing processes and infrastructure

Weakness

- Reduced calendar and cycle life compared to LFP, due to the Jahn-Teller distortion of Mn and metal dissolution into electrolyte.
- **Poor electrical conductivity lithium-ion diffusion**
- Like LFP, SOC estimation is challenging
- Dual voltage plateau worsens cell consistency, causing mileage data fluctuations in BMS
- Limited compaction at cathode electrode level

Opportunity

- **Mid-to-Long Range EVs**
- Heavy-duty vehicles (trucks and buses)
- Blend cathode with NCM for high-voltage batteries
- Potential to replace LFP in EV applications
- Improvements similar to LFP

Threat

- Lack of industry standardization causes product inconsistencies
- Scaling challenges
- Advanced modifications required for LMFP increase process complexity
- **Underdeveloped supply chain**
- Supply Chain geographically concentrated in China especially for Mn precursor

Research focus

- Improve electrical conductivity, lithium-ion diffusion and stability (overcome JanT distortion and metal dissolution) thanks to:
 - Nanostructuring and morphology control (nanosizing, spherical/microspheres, nanorods, nanoplates, crystal orientation control)
 - Surface coating (carbon and/or non-carbon materials (ion-conductive materials, metal oxides/phosphates, other cathode materials)
 - Ion-doping at Li site (Na, K, Mg)
 - Ion-doping ant Mn/Fe site (Mg, Y, V, Co, Ni, Cr, Zn, Nb)
 - Anionic doping (B, P, F)
 - Composition and structure design (gradient surface layer).
- Develop green synthesis routes (Hydrothermal, Solvent-free mechanochemical, Direct regeneration recycling, Microwave-assisted synthesis, etc.)

INTRODUCTION

Comparison of battery performances in function of their technologies

SAMPLE

Performance Metrics for Key Battery Chemistries	Lithium Ion								Sodium ion	Lithium Metal	Solid State	Lithium Sulfur
	High Voltage LCO Gr	NMC Gr	NCA Gr	LFP Gr	LMFP Gr	LMO Gr	High Voltage LNMO Gr	High Ni Majority Silicon	NaMOx Hard Carbon	High Ni Lithium Metal	High Ni Lithium Metal	Sulfur Lithium Metal
Gravimetric Energy Density Wh/kg (cell level)	180-200	250-300	250-280	160-205	190-230	100-150	150-165	325-350	130-160	400-450	300-450	300-500
Volumetric Energy Density Wh/L (cell level)	400-700	650-800	600-750	250-400	400-580	300-400	400-650	750-1000 +	150-300	700-1000	700-900	450-650
Cycle Life (C/2+ rate) (>80%)	750	1500	1000	3000	2000	500	750	500	6000	400	500	300
Calendar aging (Qual)	Avg	Avg	Avg	Good	Avg	Low	Poor	Low	Avg	Avg	-	Avg
Self Discharge (%/Month)	1.00%	0.25%	2.50%	0.50%	1.00%	2.00%	-	5.00%	0.20%	-	-	1.00%
Charge Rate Capability (Qual)	Avg	Avg	Avg	Avg	Avg	Avg	Avg	Good	Avg	Low	Low	Avg
Discharge Rate Capability (Qual)	Good	Avg	Avg	Avg	Avg	Good	Avg	Good	**Avg	Avg	Avg	Avg
Safety (Active Materials)	Avg	Low	Low	Avg	Avg	Avg	Low	Low	Good	Poor	**Poor	**Avg
Possible Form Factors and Challenges	No Issue	No Issue	No Issue	No Issue	No Issue	No Issue	No Issue	*High Swelling*	No Issue	handling issues	Manufacturing Challenges	No Issue
Nominal Voltage (V) Voltage Range (V)	3.6 (3.0 - 4.5)	3.7 (2.5 - 4.3)	3.6 (3.0-4.3)	3.2 (2.5 - 3.65)	3.7 (2.75 - 4.0)	3.8 (3 - 4.3)	4.7 (3.0 - 5.0)	3.5 (2.5 - 4.2)	3.1-3.7 (1.5 - 4.2)	3.7 (2.5 - 4.2)	3.7 (2.5 - 4.2)	2.1 (1.5 - 3)
Cathode Specific Capacity (mAh/g)	274	215	200	170	160	148	147	215	170	215	215	1675
High Temperature Operation (60C+)(Qual)	Low	Avg	Low	Good	Good	Low	Low	Avg	Good	Low	**Low	Good
Low Temperature Operation (10C-)(Qual)	Poor	Good	Good	Poor	Avg	Avg	Avg	Good	Poor	Low	**Low	Poor
Recycle Value (Li, Co, Ni, Cu) for Cost/Effort	Good	Avg	Avg	Low	Low	Low	Avg	Avg	Poor	**Avg	**Avg	Low

Best 5
Good 4
Avg 3
Low 2
Poor 1

* Cell design and components other than the cathode can make a very large difference in cell performance metrics

* Marker [-] indicates no spec sheet available to make judgement.

Ratings marked with "***"are based on published data but have no commercial cells

For more details and sources, please visit: [Battery Talk: Battery Application Break Down 1/01/2025 \(Version 3.0\)](#)

INTRODUCTION

LMFP Manufacturing processes (1/2)

SAMPLE

The synthesis of Lithium Manganese Iron Phosphate cathode materials generally relies on two broad categories: **solid-phase methods and liquid-phase methods**. These methods are often combined with necessary high-temperature sintering or carbon coating steps to optimize the material's performance

Process	Description	Advantages	Challenges
Solid-Phase synthesis (SSS)	The solid-phase method involves the direct mixing of solid precursors (containing lithium, iron, manganese, and phosphorus) followed by high-temperature calcination. Mixing methods are mainly planetary ball milling or spray drying. Calcination is usually a two-step heating process: first, pre-sintering (300–500 °C) to decompose organic material, followed by sintering at elevated temperatures (600–850 °C) to enhance crystallization and promote olivine-type crystal growth.	Most mature, simplest, and most suitable process for large-scale industrial production due to its relative simplicity and high yield	The process is limited by diffusion kinetics, requires high temperatures and long processing times, which can lead to particle aggregation and non-uniform particle size distribution.
Hydrothermal and Solvothermal Methods	These methods conduct chemical reactions in a closed system under high temperature and pressure conditions, with the solvent being water (hydrothermal) or an organic solvent (solvothermal). Raw materials are dissolved in the solvent and held in a high-pressure reactor to complete the chemical reaction.	The hydrothermal method is a viable commercial route for olivine production. It offers control over material morphology, nanoscale particle size, Fe/Mn repartition and crystal structure. It typically requires lower reaction temperatures and less energy consumption compared to SSS.	Requires specialized equipment (autoclaves) capable of withstanding high pressures, which complicates industrial scale-up. Post-treatment may be necessary due to atomic misalignments.
Co-precipitation	This method achieves mixing at the atomic level by simultaneously precipitating metal ions (Mn^{2+} , Fe^{2+} , PO_4^{3-}) from a solution by adjusting the pH and other conditions. The precursor mixture is precipitated, separated, washed, and then subjected to calcination. It can be combined with spray drying and high-temperature sintering.	Uses inexpensive and available raw materials. The process is relatively simple and suitable for industrial application.	Difficult to control the crystallization process and requires ensuring a homogeneous distribution of Mn and Fe to avoid phase separation
Sol-gel	The sol-gel method involves hydrolyzing and condensing metal alkoxides or inorganic metal salts in a liquid phase to form a sol-gel system, followed by drying and high-temperature treatment. A sol-gel system is formed, then slowly polymerized into a 3D spatial network structure (gel), dried to obtain a gel-like precursor, and finally subjected to high-temperature treatment to get the final product.	Facilitates the uniform introduction of multiple metal ions. The resulting materials typically have a high specific surface area, uniform crystal size, and high purity. It allows for controllable particle size (~100 nm) and is suitable for forming thin films and coatings.	The process is complex, involves lengthy drying and processing cycles, and uses expensive raw materials, making it generally unsuitable for industrial mass production. Poor reproducibility can occur.

INTRODUCTION

LMFP Manufacturing processes (2/2)

Process	Description	Advantages	Challenges
Molten-State Synthesis (MSS)	This method involves the synthesis of the material in a molten state. MSS is used for the dry preparation of LMFP. The process involves melting precursors, which may be followed by grinding (milling) of the resulting ingot.	Recognized for its potential in large-scale production of olivine materials via molten ingot synthesis.	A major drawback is its high energy consumption and the requirement for a long grinding process of the prepared ingot.
Mechanochemical Method	Involves mixing precursors via high-energy mechanical activation, sometimes combined with sintering steps	A widely studied approach. Enables the production of nanoparticles, often leading to uniform structures. Mechanochemical activation followed by calcination can yield materials with excellent cycle performance.	The properties of the resulting LMFP can show variations depending on whether mechanochemical or solvothermal methods were used.
Temperature-Programmed Calcination	A simple, specific solid-state strategy developed to in-situ synthesize (M-LMFP) materials with innovative carbon coating and phase doping structures (Fe ₂ P and amorphous Li ₄ P ₂ O ₇). It relies only on the carbon and Fe-containing components derived directly from the raw materials to form beneficial secondary phases.	This method achieves surface modifications without introducing additional reducing gases or cumbersome processes. It is an extremely scalable strategy for large-scale production.	An imbalance in the ratio of the generated doping phases (Fe ₂ P and amorphous Li ₄ P ₂ O ₇) can be detrimental to cycling stability, potentially hindering Li ⁺ transport due to chemical inhomogeneity
Ionothermal Processes	The synthesis involves multiple types of ionic liquids, often followed by high-energy dry ball milling and high-temperature treatment.	Primarily recognized for fundamental research. Can potentially regulate crystal morphology. The use of ionic liquids can create specific synthesis environments.	Emerging method for LMFP synthesis.
Two-Phase Mixing Strategy	Involves synthesizing LMFP and then physically blending it with other materials, such as NCM or LFP, to improve energy density and safety, although this requires high uniformity during blending. Strategies range from simple physical mixing during slurry preparation to sophisticated interface enhancement methods. Structural modification can involve adding LMFP as a coating or skeletal structure to other materials.	Combine advantages of different cathode active materials. Achieves a more balanced performance profile, combining the high energy density of layered oxides with the intrinsic safety and long cycle life of olivine phosphates. LMFP blending improves the safety and stability of layered oxides (NCM) by protecting against degradation and dissolution.	Homogeneity is a major challenge due to the significant differences in physical properties (e.g., particle size or density) between the constituent materials. The performance of the blend can be limited by the degradation of the less stable component (e.g., NCM). Complexity arises from the need to optimize the ratio and interface of the mixed materials.

INTRODUCTION

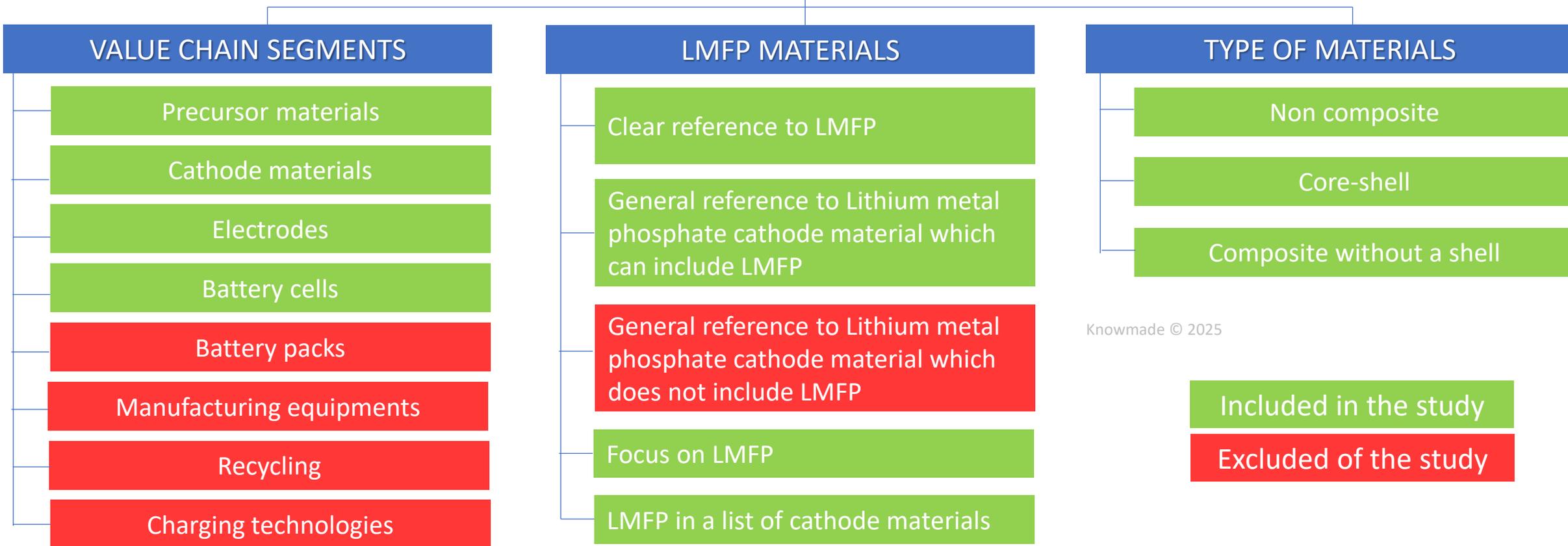
Scope of the report

This report provides a detailed picture of the patent landscape related to **LMFP: from cathode materials to battery cells**. We have selected and analyzed more than **16,800+ patents and patent applications** published **worldwide** up to **July 2025**, representing more than **7,810 patent families** (inventions) relevant to the scope of this report.

SAMPLE

LMFP: From cathode materials to battery cells

Included: Lithium metal batteries and Li-ion batteries / Excluded: Other solid-state batteries (Li-S battery, Li-Air battery, Na-ion battery, Mg-ion battery, etc.)



INTRODUCTION

Found the right information in the report

SAMPLE

Report sections



Your concern



Information you get



TECHNOLOGY

*For R&D teams,
engineers, scientists*

IP

*For IP teams,
patent attorneys*

MARKET

*For executives,
business developers*

PLAYER

*Zoom in a
competitor / partner*

PATENT LANDSCAPE OVERVIEW

- **Ranking of players** (enforceability, current activity, geo/tech coverage, prior-art contribution, etc.)
- **Patent filings dynamics per player**
- **IP collaborations** (co-filings, IPR transfers)
- **Patent litigation/oppositions**

Innovators

Main patent owners
IP risks/opportunities

Ecosystem
(competitors, newcomers,
partners, clients)
Main trends
IP vs Market

IP position vs Market
position
Player relationships
(collaborations/
dependencies)

SEGMENTS ANALYSIS

- **Patent filings dynamics per segment**
- **IP leaders per segment** (enforceability, current activity, blocking potential)
- **Key patents per segment**
- **Recent patenting activity per segment**

Technology trends
Technology mapping

Blocking players
IP risks/opportunities
in each segment
(FTO, litigation, licensing)

Benchmarking
Markets of interest
Future developments

IP position and level
of investment in each
segment
Key IP developments

IP PROFILE OF KEY PLAYERS

- **Patent portfolio summary** (portfolio size, IP activity evolution, patents legal status, geo/tech coverage, strengths/weaknesses, etc.)
- **Key patents**
- **Recent patenting activity**

Current R&D activities
Technology roadmap

Blocking patents
Geo/Tech coverage
Link between patents
and products

Future products
Potential partners
Potential targets

R&D investment level
Key inventions
Current IP activities
Strengths / Weaknesses

INTRODUCTION

Patent database

SAMPLE

With the present report is provided an extensive **Excel database with the 7,810+ patent families** (inventions) analyzed in this study. This useful patent database allows for multicriteria searches and includes patent publication numbers, **hyperlinks to an updated online database** (original documents, legal status, etc.), priority date, title, abstract, patent assignees, patent's current legal status, and **segments** (precursor, cathode active material, cathodes, battery cells, other components of battery cells).

Family number (Questel unique family ID from FamPat database)	Patent numbers (publication numbers)	Title	Abstract	Current legal status (Pending, Granted, Revoked, Expired, Lapsed)	Current patent assignees (as mentioned in the patent database)	Patent assignee name used in the report	Earliest application date of the family (yyyy-mm-dd)	Earliest publication date of the family (yyyy-mm-dd)	Earliest grant date of the family (yyyy-mm-dd)	Expected expiry dates (yyyy-mm-dd)	Biblio Summary (Link to full patent description and original document)	Supply chain segmentation				
												Precursors	Cathode active materials	Cathodes	Battery cells	Other components of battery cells
113068468	KR10-2025-0007972	(KR10-2025-0112217)	(KR10-2025-0112217)	(KR10-2025-0112217)	LG ENERGY SOLUTIONS LTD	LG Chem/LG Energy	2024-05-13	2025-01-14	2025-07-18	(KR10-2025-0112217)	Open			X		
115451701	CN120389032	(CN120389032)	(CN120389032)	(CN120389032)	MINMETALS NEW MCC (China MinMetals)	MCC (China MinMetals)	2025-06-30	2025-07-29		(CN120389032)	Open		X			
111681998	WO2024/205306	(WO2024/205306)	(WO2024/205306)	(WO2024/205306)	RESEARCH INSTITUTE OF CHEMISTRY	RICT (Research Institute of Chemistry)	2024-03-29	2024-10-03		(WO2024/205306)	Open		X			
115368004	CN120357154	(CN120357154)	(CN120357154)	(CN120357154)	CATL - CONTEMPORARY	CATL (Contemporary)	2025-06-23	2025-07-22		(CN120357154)	Open				X	
115355204	CN120348920	(CN120348920)	(CN120348920)	(CN120348920)	HUNAN YUNENG TECHNOLOGY CO., LTD.	BYN (Yuneng) Chem	2025-06-23	2025-07-22		(CN120348920)	Open		X			
115348563	CN120356926	(CN120356926)	(CN120356926)	(CN120356926)	HUNAN HONGYUAN TECHNOLOGY CO., LTD.	Hunan Hongyuan Tech	2025-06-23	2025-07-22		(CN120356926)	Open		X			
115344368	CN120341270	(CN120341270)	(CN120341270)	(CN120341270)	HUNAN HONGYUAN TECHNOLOGY CO., LTD.	Hunan Hongyuan Tech	2025-06-20	2025-07-18		(CN120341270)	Open		X			
115334171	CN120341344	(CN120341344)	(CN120341344)	(CN120341344)	SHANGHAI CHENGLI ELECTRIC CO., LTD.	Chenli Electric	2025-06-20	2025-07-18		(CN120341344)	Open		X			
115331438	CN120341340	(CN120341340)	(CN120341340)	(CN120341340)	SHANGHAI CHENGLI ELECTRIC CO., LTD.	Chenli Electric	2025-06-20	2025-07-18		(CN120341340)	Open		X			
115316493	CN120341343	(CN120341343)	(CN120341343)	(CN120341343)	SHANGHAI CHENGLI ELECTRIC CO., LTD.	Chenli Electric	2025-06-20	2025-07-18		(CN120341343)	Open		X			
115316408	CN120341341	(CN120341341)	(CN120341341)	(CN120341341)	SHANGHAI CHENGLI ELECTRIC CO., LTD.	Chenli Electric	2025-06-20	2025-07-18		(CN120341341)	Open		X			
115318419	CN120328502	(CN120328502)	(CN120328502)	(CN120328502)	SICHUAN FUJIAN NI SICHUAN FUJIAN NEW MATERIALS CO., LTD.	Sichuan Fujian New	2025-06-19	2025-07-18		(CN120328502)	Open					
115260706	CN120319872	(CN120319872)	(CN120319872)	(CN120319872)	GUANGZHOU TINCI MATERIALS TECHNOLOGY CO., LTD.	Tinci Materials Tec	2025-06-19	2025-07-15		(CN120319872)	Open				X	
115265114	CN120319762	(CN120319762)	(CN120319762)	(CN120319762)	SUZHOU QINGTAO ENERGY DEVELOPMENT CO., LTD.	QingTao Energy D	2025-06-17	2025-07-15		(CN120319762)	Open			X		
115317620	CN120341336	(CN120341336)	(CN120341336)	(CN120341336)	SHENZHEN MAOLUE TECHNOLOGY CO., LTD.	Maolue Technology	2025-06-16	2025-07-18		(CN120341336)	Open				X	
115317620	CN120319802	(CN120319802)	(CN120319802)	(CN120319802)	MINMETALS NEW MCC (China MinMetals)	MCC (China MinMetals)	2025-06-30	2025-07-29		(CN120319802)	Open					

INTRODUCTION

Interactive dashboard (optional)

SAMPLE

An optional **interactive dashboard** can be provided with this report, transforming the analysis into a true decision-support tool that puts you in control. It enables you to explore the patent landscape dynamically by applicant, technology, geography, publication period, or legal status, and to drill down instantly into key insights, from high-level trends to individual players and patents. Tailored to the specific needs of R&D, IP, strategy, and business development teams, the dashboard delivers immediate visual answers to critical questions, enabling faster and more informed strategic decision-making across your organization.

[Request a demo](#)

Navigate easily through the data and quickly get strategic insights



Easily filter the data



Landscape at a glance



Assess technology segment impact



Deep dive by publication country



Understand IP dynamics



Identify key players and newcomers by country and technology segment

Key IP players



IP newcomers



Select a player to view its IP profile

Understand IP strategy, positioning, strengths & weaknesses



Browse patent families and spot key patents

List of patent families



Select a patent family and explore it in depth

Patent full text + Geographic coverage + Citations analysis



Patents on LMFP Precursors

Main patent assignees, newcomers, key players, key patents, notable recent patents

SAMPLE

The collage features several overlapping report pages:

- LMFP PRECURSORS Main and key IP players have**: A table categorizing players into 'Key blocking IP players no more active since 2023', 'Key blocking still active not leaders', and 'Key blocking IP leaders'. It lists companies like Shandong Energy Institute, BYN, EVE, and others across different value chain positions.
- LMFP PRECURSORS Patents on precursor**: A detailed table with columns for Material manufacturers, Battery manufacturers, Both Material & Battery manufacturers, Electronic companies / Tier One suppliers, and End-users & Integrators. It lists companies like SUMITOMO METAL MINING, Neq, and others.
- LMFP PRECURSORS dominate the LMFP precursor patent landscape**: A bar chart titled 'Ranking of patent assignee according to the number of patent families*'. It shows the top 10 assignees, with the first being the most prominent.
- LMFP PRECURSORS key IP players have**: A table with columns for Assignees, Value Chain Position, Headquarters Country, Typology, Size, Recent, Grant, Pend, PABP, GSI, and Key patent. It lists companies like MCC (China MinMetals Corporation) and Route JJ.
- LMFP PRECURSORS Key patents on precursors**: A table with columns for Patent number & assignee, Legal status, Material Type / Key Features, and Advantage Provided. It details patents from KNOWLITECH.
- LMFP PRECURSORS Recent patents (1/3)**: A table listing recent patent entries with their titles and brief descriptions.
- LMFP PRECURSORS Established IP Holders vs. Emerging Innovators in LMFP Precursor Technologies**: A scatter plot titled 'IP Leadership' showing the relationship between the number of pending patent applications and the number of granted patents for various companies.
- LMFP for Li-ion Batteries - Patent Landscape Analysis**: Multiple pages of detailed analysis, including bubble charts and text descriptions of patent families and their technical significance.



The categories to which each patent belongs are available in the Excel file provided with the report

Patents on LMFP Cathode Materials

Main patent assignees, newcomers, key players, key patents, notable recent patents

SAMPLE



The categories to which each patent belongs are available in the Excel file provided with the report

LMFP CATHODE ACTIVE MATERIALS

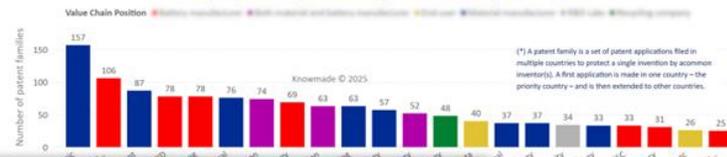
Patents on cathode materials are filed by



LMFP CATHODE ACTIVE MATERIALS

dominate the LMFP cathode materials patent landscape

Ranking of patent assignee according to the number of patent families*



LMFP CATHODE ACTIVE MATERIAL

Main and key IP players



LMFP CATHODE ACTIVE MATERIALS

key IP players have different

Assignees	Value Chain Position	Headquarters Country	Typology	Size	Recent	Grant	Pend	PABP	GSU	Key patents
Battery	Established	Established	Established	Established	High	High	High	High	High	High
Material	Established	Established	Established	Established	High	High	High	High	High	High
Battery	Established	Established	Established	Established	High	High	High	High	High	High
Battery	Established	Established	Established	Established	High	High	High	High	High	High
Material & battery	Established	Established	Established	Established	High	High	High	High	High	High
End-user	Established	Established	Established	Established	High	High	High	High	High	High
End-user	Established	Established	Established	Established	High	High	High	High	High	High
R&D Labs	Established	Established	Established	Established	High	High	High	High	High	High
Battery	Established	Established	Established	Established	High	High	High	High	High	High
Battery	Established	Established	Established	Established	High	High	High	High	High	High
R&D Labs	Established	Established	Established	Established	High	High	High	High	High	High
R&D Labs	Established	Established	Established	Established	High	High	High	High	High	High
Material	Established	Established	Established	Established	High	High	High	High	High	High
Start-up	Established	Established	Established	Established	High	High	High	High	High	High
Other SME	Established	Established	Established	Established	High	High	High	High	High	High
End-user	Established	Established	Established	Established	High	High	High	High	High	High
Material / Tier 1	Established	Established	Established	Established	High	High	High	High	High	High
Material	Established	Established	Established	Established	High	High	High	High	High	High
R&D Labs	Established	Established	Established	Established	High	High	High	High	High	High
Material	Established	Established	Established	Established	High	High	High	High	High	High
Battery	Established	Established	Established	Established	High	High	High	High	High	High
Battery	Established	Established	Established	Established	High	High	High	High	High	High

LMFP CATHODE ACTIVE MATERIALS

Historical IP players are



LMFP CATHODE ACTIVE MATERIALS

Recent patents - Elemental doping

Recent patents in LMFP cathode materials focus on elemental doping strategies to enhance performance. Key findings include the use of various dopants to improve structural stability and electrochemical performance. The report highlights several recent patent applications and their implications for the field.

LMFP CATHODE ACTIVE MATERIALS

Established IP players are challenged by



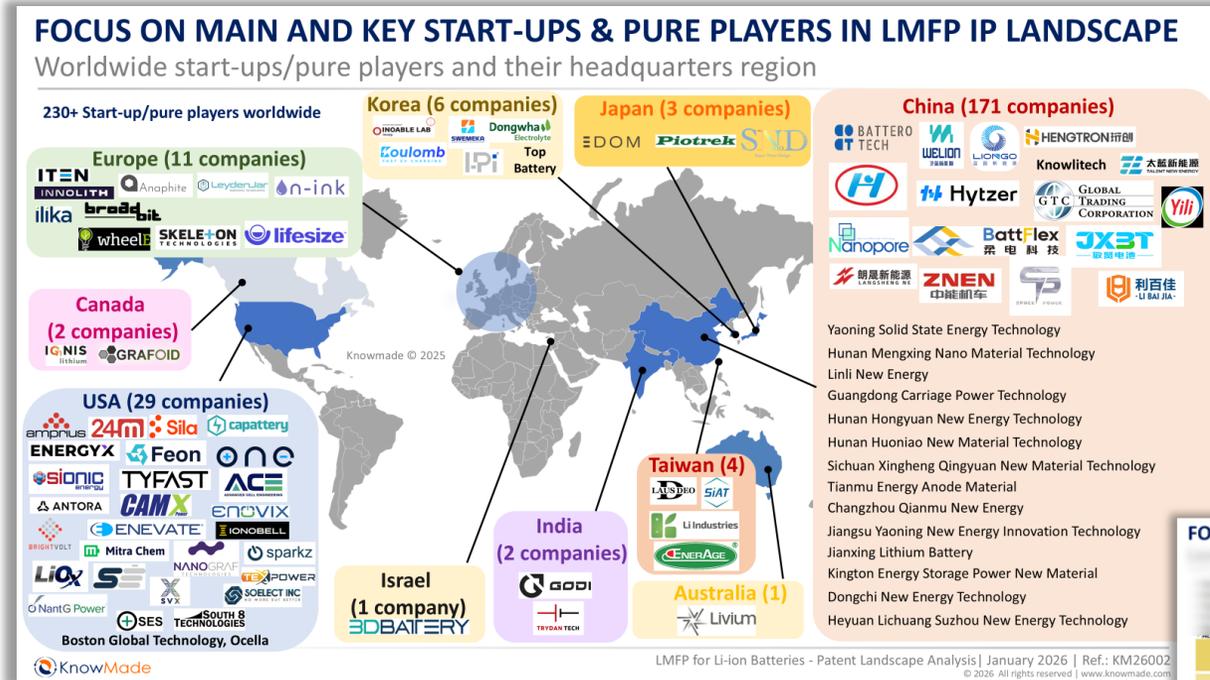
LMFP CATHODE ACTIVE MATERIALS

Key LMFP cathode active materials (1/3)

Patent number & assignee	Material Type / Key Features	Advantage Provided
[Patent 1]	A cathode material with high capacity and stability.	High capacity and stability for use as cathodes in lithium-ion batteries.
[Patent 2]	Carbon-coated (C-LiM1) cathode material with improved conductivity.	Improved conductivity and cycle life.
[Patent 3]	Alkali metal salt cathode material with high voltage.	High voltage and high energy density.
[Patent 4]	Lithium-Coo cathode material with enhanced performance.	Enhanced performance and stability.
[Patent 5]	Alkali/Transition metal cathode material with improved synthesis.	Improved synthesis process for large-scale production.
[Patent 6]	Alkali/Transition metal cathode material with low cost.	Low cost and good performance.
[Patent 7]	Alumina-coated cathode material with improved stability.	Improved stability and cycle life.
[Patent 8]	Lithium ion cathode material with improved electrochemical performance.	Improved electrochemical performance and stability.
[Patent 9]	Lithium ion cathode material with improved rate capability.	Improved rate capability and power performance.

Start-ups & Pure Players

IP dynamics, level of patent activity, geographical & technical coverage, IP strengths, and potential for reinforcement



IP profile of 15+ start-ups & pure players:

Amplus/Berzelius, Ignis Lithium, I-TEN, Innolith/Alevo, Battero Technology, WeLion New Energy Technology, Liongo New Energy Technology, Hengtron Nanotech, Chongqing Tailan New Energy, Haopeng New Energy, Zhongke Shenlan Huize New Energy, Yaoning Solid State Energy Technology, Hunan Mengxing Nano Material Technology, Linli New Energy, Tianmu Energy Anode Material, Knowlitech.



Battery Manufacturers

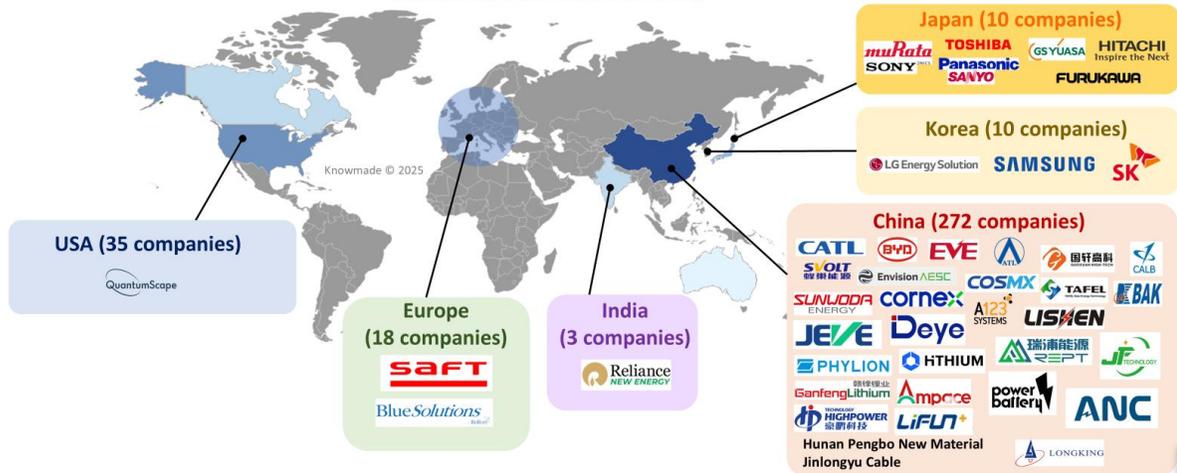
IP dynamics, level of patent activity, geographical & technical coverage, IP strengths, and potential for reinforcement

SAMPLE

FOCUS ON MAIN AND KEY BATTERY MANUFACTURERS

Worldwide main and key battery manufacturers and their headquarters region

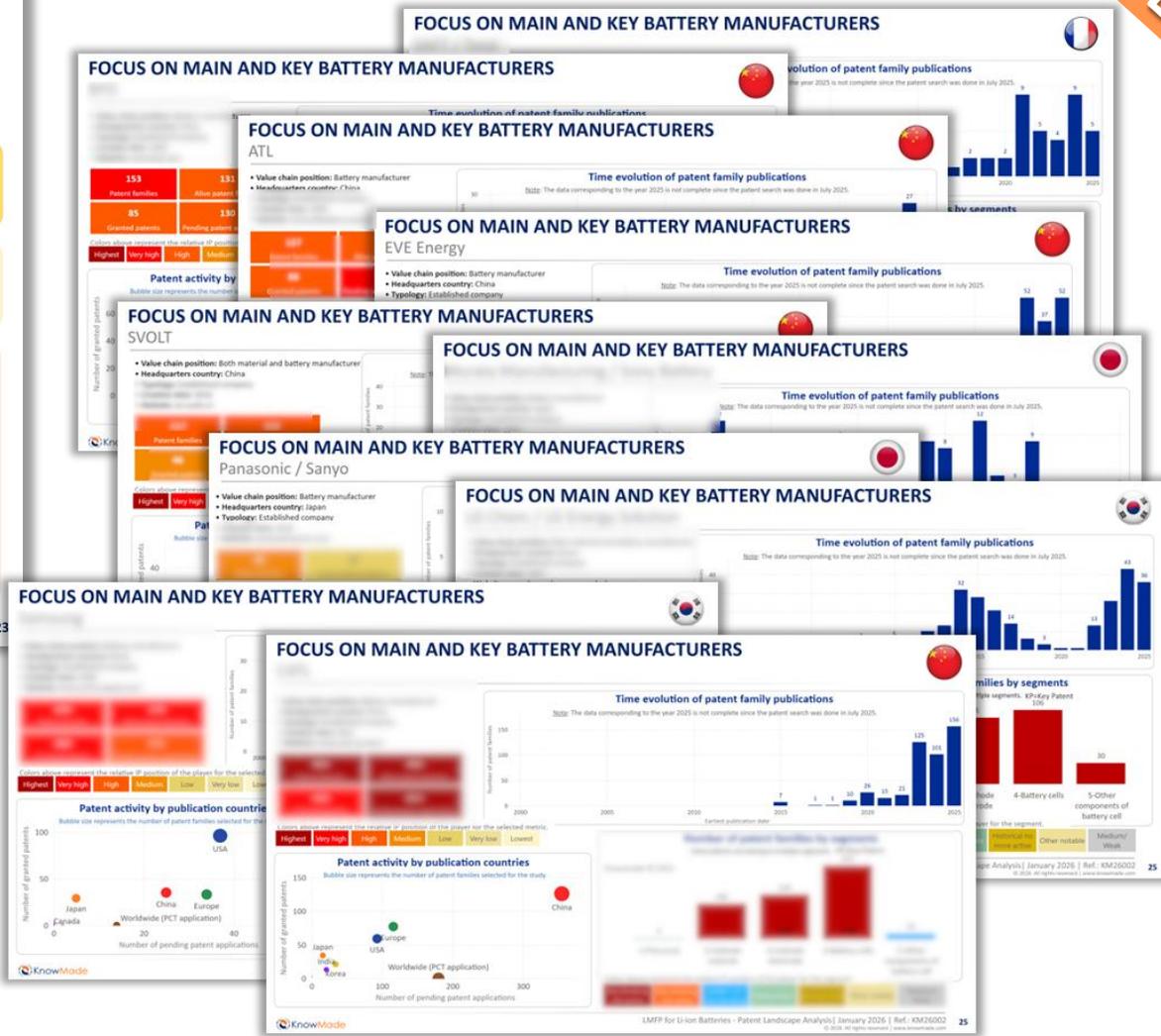
Main and key battery manufacturers and their headquarters region
359 battery manufacturers worldwide, including 51 being also material manufacturers
Only main and key companies are reported on this map.



KnowMade LMFP for Li-ion Batteries - Patent Landscape Analysis | January 2026 | Ref.: KM26002 © 2026 All rights reserved | www.knowmade.com

IP profile of 45+ battery manufacturers:

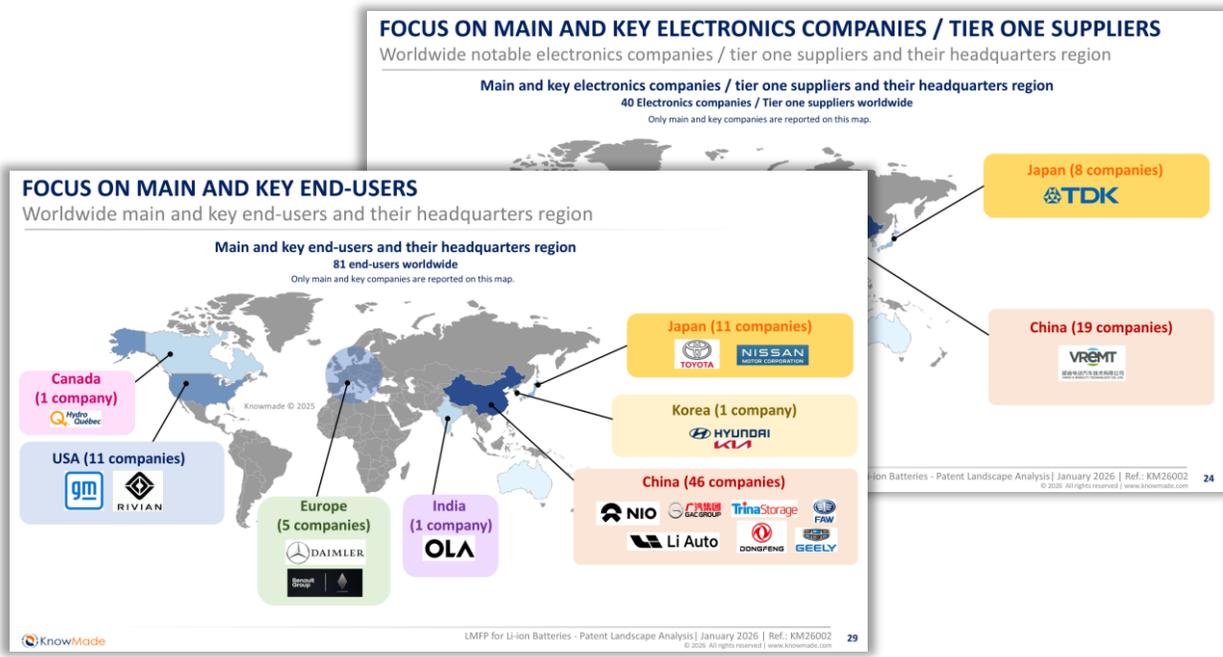
LG Chem/LG Energy Solution, Samsung, SK Group, Murata Manufacturing/Sony Battery, Toshiba, Panasonic/Sanyo, GS Yuasa, Hitachi, Furukawa, CATL, BYD, EVE Energy, ATL, SVOLT, Gotion/Guoxuan High Tech Power Energy, Envision/AESC, COSMX/COSLIGHT, Sunwoda, Cornex New Energy, CALB (China Aviation Lithium Battery), Wanxiang A123 Systems, Tafel New Energy Technology/Zenergy, JEVE (Tianjin EV Energy), Deyi Energy Technology, Lishen, Phylion, Hithium Energy Storage Technology, Ganfeng Lithium, REPT Energy, Ampace, Reliance New Energy (Incl. Lithium Werks/Valence Tech.), Quantumscape, SAFT, Blue Solutions, and more.



End users, electronics companies, and tier one suppliers

IP dynamics, level of patent activity, geographical & technical coverage, IP strengths, and potential for reinforcement

SAMPLE



IP profile of 15+ End users, electronics companies, and tier one suppliers:

Toyota, Nissan, Hyundai/Kia, NIO, GAC Group, Geely, Trina Storage, FAW, Li-Auto, Dongfeng Motor, General Motors, Rivian, Hydro-Québec, Daimler, Renault/Ampère, Ola Electric Mobility, Bosch, TDK, Viridi E Mobility Technology, and more.



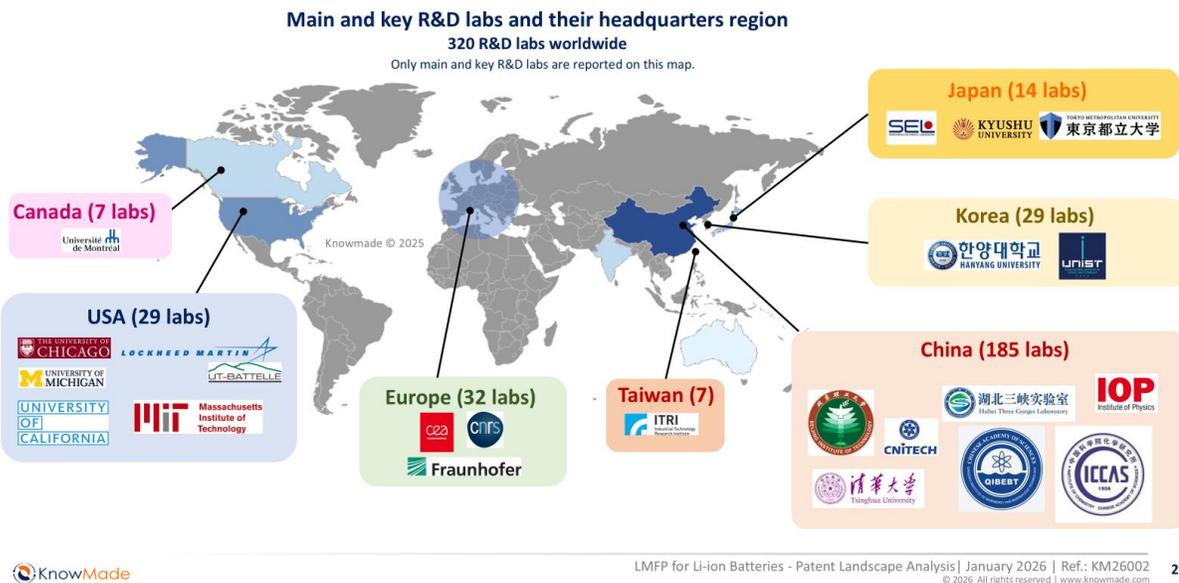
R&D Labs

IP dynamics, level of patent activity, geographical & technical coverage, IP strengths, and potential for reinforcement

SAMPLE

FOCUS ON MAIN AND KEY R&D LABS

Worldwide main and key R&D labs and their headquarters region



IP profile of 20+ R&D Labs:

Hanyang University, UNIST (Ulsan National Institute of Science & Technology), SEL, Kyushu University, Tokyo Metropolitan University, University of Chicago, Lockheed Martin Energy/UT-Battelle, University of Michigan, University of California, MIT (Massachusetts Institute of Technology), Université de Montréal, CEA, CNRS, Fraunhofer, ITRI (Industrial Technology Research Institute), Beijing Institute of Technology, Tsinghua University, Institute of Physics (CAS), Institute of Chemistry (CAS), Ningbo Institute of Industrial Technology (CNITECH), Qingdao Institute of Bioenergy and Bioprocess Technology (CAS), Hubei Three Gorges Laboratory.



ORDER FORM

LMFP for Li-ion Batteries

Patent Landscape Analysis – January 2026

Ref.:KM26002

SHIP TO

Name (Mr/Ms/Dr/Pr):

Job Title:

Company:

Address:

City:

State:

Postcode/Zip:

Country:

VAT ID Number for EU members:

Tel:

Email:

Date:

PRODUCT ORDER

- REPORT + DATABASE ⁽¹⁾: **4,990 EUR**
- REPORT + DATABASE ⁽¹⁾ + DASHBOARD⁽²⁾: **7,990 EUR**



For price in dollars, please use the day's exchange rate.

For French customer, add 20% for VAT.

The report (PDF), database (Excel), and access to the interactive online dashboard will be delivered electronically upon receipt of payment.

⁽¹⁾Report & Database are provided under a **multi-user license and can be shared internally** among employees of the purchasing organization. Subsidiaries and joint ventures are excluded from this license. Please be aware that the report is watermarked on each page, with the name of the recipient and the organization (the name mentioned in the PO).

⁽²⁾Access to the interactive dashboard is granted for **one year (12 months) to an unlimited number of authorized users** within the purchasing organization. Access codes must not be shared with any third party. The dashboard must not be used to produce analyses or reports that are resold, sublicensed, or otherwise made available to any external user or entity outside the purchasing organization.

I hereby accept Knowmade's Terms and Conditions of Sale

Signature:

PAYMENT METHODS

Check

To pay your invoice using a check, please mail your check to the following address:

KnowMade S.A.R.L.
2405 route des Dolines, Le Drakkar,
06560 Valbonne Sophia Antipolis
FRANCE

Money Transfer

To pay your invoice using a bank money wire transfer please contact your bank to complete this process. Here is the information that you will need to submit the payment:

Payee: KnowMade S.A.R.L.
Bank: Banque Populaire Méditerranée, CAP 3000 Quartier du lac, 06700 St Laurent du Var, France
IBAN: FR76 1460 7003 6360 6214 5695 139
BIC/SWIFT: CCBPFRPPMAR

Paypal

In order to pay your invoice via PAYPAL, you must first register at www.paypal.com. Then you can send money to the KnowMade S.A.R.L. by entering our E-mail address contact@knowmade.fr as the recipient and entering the invoice amount.

RETURN ORDER BY

E-mail: contact@knowmade.fr

Mail: KnowMade S.A.R.L., 2405 route des Dolines, Le Drakkar,
06560 Valbonne Sophia Antipolis, FRANCE

Terms and Conditions of Sales

DEFINITIONS

“Acceptance”: Action by which the Buyer accepts the terms and conditions of sale in their entirety. It is done by signing the purchase order which mentions “I hereby accept Knowmade’s Terms and Conditions of Sale”.

“Buyer”: Any business user (i.e. any person acting in the course of its business activities, for its business needs) entering into the following general conditions to the exclusion of consumers acting in their personal interests.

“Contracting Parties” or “Parties”: The Seller on the one hand and the Buyer on the other hand.

“Intellectual Property Rights” (“IPR”) means any rights held by the Seller in its Products, including any patents, trademarks, registered models, designs, copyrights, inventions, commercial secrets and know-how, technical information, company or trading names and any other intellectual property rights or similar in any part of the world, notwithstanding the fact that they have been registered or not and including any pending registration of one of the above mentioned rights.

“License”: For the reports and databases, 2 different licenses are proposed. The buyer has to choose one license:

1. One user license: a single individual at the company can use the report.

2. Corporate license: the report can be used by unlimited users within the company. Subsidiaries and joint ventures are not included.

“Products”: Reports are established in PowerPoint and delivered on a PDF format and the database may include Excel files.

“Seller”: Based in Sophia Antipolis (France headquarters), Knowmade is a technology intelligence company specialized in the research and analysis of scientific and technical information. We provide patent landscapes and scientific state of the art with high added value to businesses and research laboratories. Our intelligence digests play a key role to define your innovation and development strategy.

1. SCOPE

1.1 The Contracting Parties undertake to observe the following general conditions when agreed by the Buyer and the Seller. Any additional, different, or conflicting terms and conditions in any other documents issued by the buyer at any time are hereby objected to by the seller, shall be wholly inapplicable to any sale made hereunder and shall not be binding in any way on the seller.

1.2 This agreement becomes valid and enforceable between the Contracting Parties after clear and non-equivocal consent by any duly authorized person representing the Buyer. For these purposes, the Buyer accepts these conditions of sales when signing the purchase order which mentions “I hereby accept Knowmade’s Terms and Conditions of Sale”. This results in acceptance by the Buyer.

1.3 Orders are deemed to be accepted only upon written acceptance and confirmation by the Seller, within [7 days] from the date of order, to be sent either by email or to the Buyer’s address. In the absence of any confirmation in writing, orders shall be deemed to have been accepted.

2. MAILING OF THE PRODUCTS

2.1 Products are sent by email to the Buyer:

- within [1] month from the order for Products already released; or

- within a reasonable time for Products ordered prior to their effective release. In this case, the Seller shall use its best endeavours to inform the Buyer of an indicative release date and the evolution of the work in progress.

2.2 Some weeks prior to the release date the Seller can propose a pre-release discount to the Buyer.

The Seller shall by no means be responsible for any delay in respect of article 2.2 above, and including in cases where a new event or access to new contradictory information would require for the analyst extra time to compute or compare the data in order to enable the Seller to deliver a high quality Products.

2.3 The mailing of the Product will occur only upon payment by the Buyer, in accordance with the conditions contained in article 3.

2.4 The mailing is operated through electronic means either by email via the sales department. If the Product’s electronic delivery format is defective, the Seller undertakes to replace it at no charge to the Buyer provided that it is informed of the defective formatting within 90 days from the date of the original download or receipt of the Product.

2.5 The person receiving the Products on behalf of the Buyer shall immediately verify the quality of the Products and their conformity to the order. Any claim for apparent defects or for non-conformity shall be sent in writing to the Seller within 8 days of receipt of the Products. For this purpose, the Buyer agrees to

produce sufficient evidence of such defects.

2.6 No return of Products shall be accepted without prior information to the Seller, even in case of delayed delivery. Any Product returned to the Seller without providing prior information to the Seller as required under article 2.5 shall remain at the Buyer’s risk.

3. PRICE, INVOICING AND PAYMENT

3.1 Prices are given in the orders corresponding to each Product sold on a unit basis or corresponding to annual subscriptions. They are expressed to be inclusive of all taxes. The prices may be reevaluated from time to time. The effective price is deemed to be the one applicable at the time of the order.

3.2 Payments due by the Buyer shall be sent by cheque payable to Knowmade, PayPal or by electronic transfer to the following account:

Banque Populaire Méditerranée, CAP 3000 Quartier du lac, 06700 St Laurent du Var, France

BIC or SWIFT code: CCBPFRPPMAR

IBAN: : FR76 1460 7003 6360 6214 5695 139

To ensure the payments, the Seller reserves the right to request down payments from the Buyer. In this case, the need of down payments will be mentioned on the order.

3.3 Payment is due by the Buyer to the Seller within 30 days from invoice date, except in the case of a particular written agreement. If the Buyer fails to pay within this time and fails to contact the Seller, the latter shall be entitled to invoice interest in arrears based on the annual rate Refi of the «BCE» + 7 points, in accordance with article L. 441-6 of the French Commercial Code. Our publications (report, database, tool...) are delivered only after reception of the payment.

3.4 In the event of termination of the contract, or of misconduct, during the contract, the Seller will have the right to invoice at the stage in progress, and to take legal action for damages.

4. LIABILITIES

4.1 The Buyer or any other individual or legal person acting on its behalf, being a business user buying the Products for its business activities, shall be solely responsible for choosing the Products and for the use and interpretations he makes of the documents it purchases, of the results he obtains, and of the advice and acts it deduces thereof.

4.2 The Seller shall only be liable for (i) direct and (ii) foreseeable pecuniary loss, caused by the Products or arising from a material breach of this agreement

4.3 In no event shall the Seller be liable for:

a) damages of any kind, including without limitation, incidental or consequential damages (including, but not limited to, damages for loss of profits, business interruption and loss of programs or information) arising out of the use of or inability to use the Seller’s website or the Products, or any information provided on the website, or in the Products;

b) any claim attributable to errors, omissions or other inaccuracies in the Product or interpretations thereof.

4.4 All the information contained in the Products has been obtained from sources believed to be reliable. The Seller does not warrant the accuracy, completeness adequacy or reliability of such information, which cannot be guaranteed to be free from errors.

4.5 All the Products that the Seller sells may, upon prior notice to the Buyer from time to time be modified by or substituted with similar Products meeting the needs of the Buyer. This modification shall not lead to the liability of the Seller, provided that the Seller ensures the substituted Product is similar to the Product initially ordered.

4.6 In the case where, after inspection, it is acknowledged that the Products contain defects, the Seller undertakes to replace the defective products as far as the supplies allow and without indemnities or compensation of any kind for labor costs, delays, loss caused or any other reason. The replacement is guaranteed for a maximum of two months starting from the delivery date. Any replacement is excluded for any event as set out in article 5 below.

4.7 The deadlines that the Seller is asked to state for the mailing of the Products are given for information only and are not guaranteed. If such deadlines are not met, it shall not lead to any damages or cancellation of the orders, except for non-acceptable delays exceeding [4] months from the stated deadline, without information from the Seller. In such case only, the Buyer shall be entitled to ask for a reimbursement of its first down payment to the exclusion of any further damages.

4.8 The Seller does not make any warranties, express or implied, including, without limitation, those of saleability and fitness for a particular purpose, with respect to the Products. Although the Seller shall take

reasonable steps to screen Products for infection of viruses, worms, Trojan horses or other codes containing contaminating or destructive properties before making the Products available, the Seller cannot guarantee that any Product will be free from infection.

5. FORCE MAJEURE

The Seller shall not be liable for any delay in performance directly or indirectly caused by or resulting from acts of nature, fire, flood, accident, riot, war, government intervention, embargoes, strikes, labor difficulties, equipment failure, late deliveries by suppliers or other difficulties which are beyond the control, and not the fault of the Seller.

6. PROTECTION OF THE SELLER’S IPR

6.1 All the IPR attached to the Products are and remain the property of the Seller and are protected under French and international copyright law and conventions.

6.2 The Buyer agreed not to disclose, copy, reproduce, redistribute, resell or publish the Product, or any part of it to any other party other than employees of its company. The Buyer shall have the right to use the Products solely for its own internal information purposes. In particular, the Buyer shall therefore not use the Product for purposes such as:

- Information storage and retrieval systems;

- Recordings and re-transmittals over any network (including any local area network);

- use in any timesharing, service bureau, bulletin board or similar arrangement or public display;

- Posting any Product to any other online service (including bulletin boards or the Internet);

- Licensing, leasing, selling, offering for sale or assigning the Product.

6.3 The Buyer shall be solely responsible towards the Seller of all infringements of this obligation, whether this infringement comes from its employees or any person to whom the Buyer has sent the Products and shall personally take care of any related proceedings, and the Buyer shall bear related financial consequences in their entirety.

6.4 The Buyer shall define within its company point of contact for the needs of the contract. This person will be the recipient of each new report in PDF format. This person shall also be responsible for respect of the copyrights and will guaranty that the Products are not disseminated out of the company.

7. TERMINATION

7.1 If the Buyer cancels the order in whole or in part or postpones the date of mailing, the Buyer shall indemnify the Seller for the entire costs that have been incurred as at the date of notification by the Buyer of such delay or cancellation. This may also apply for any other direct or indirect consequential loss that may be borne by the Seller, following this decision.

7.2 In the event of breach by one Party under these conditions or the order, the non-breaching Party may send a notification to the other by recorded delivery letter upon which, after a period of thirty (30) days without solving the problem, the non-breaching Party shall be entitled to terminate all the pending orders, without being liable for any compensation.

8. MISCELLANEOUS

All the provisions of these Terms and Conditions are for the benefit of the Seller itself, but also for its licensors, employees and agents. Each of them is entitled to assert and enforce those provisions against the Buyer.

Any notices under these Terms and Conditions shall be given in writing. They shall be effective upon receipt by the other Party.

The Seller may, from time to time, update these Terms and Conditions and the Buyer, is deemed to have accepted the latest version of these terms and conditions, provided they have been communicated to him in due time.

9. GOVERNING LAW AND JURISDICTION

9.1 Any dispute arising out or linked to these Terms and Conditions or to any contract (orders) entered into in application of these Terms and Conditions shall be settled by the French Commercial Courts of Grasse, which shall have exclusive jurisdiction upon such issues.

9.2 French law shall govern the relation between the Buyer and the Seller, in accordance with these Terms and Conditions.

KNOWMADE

Patent and Technology Intelligence

KNOWMADE PURPOSE

Turning **patent** and **scientific data** into **actionable insights** to support **decision-making in R&D, innovation, investment, and intellectual property.**

Competitive landscape | Technology trends | Opportunities / Risks | R&D and IP strategy



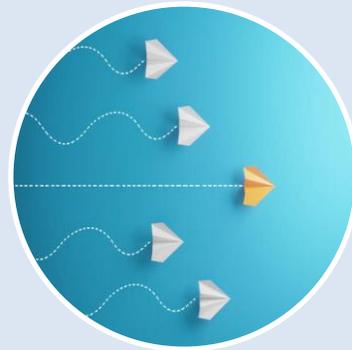
WHAT INFORMATION CAN YOU GET ?



INTELLECTUAL PROPERTY

*For IP teams,
patent attorneys*

- Risks and opportunities (FTO, litigations, licensing)
- Key patents
- Link between patents and products



TECHNOLOGY

*For R&D teams,
engineers, scientists*

- R&D activities
- Technological roadmap
- Position on the supply chain



MARKET

*For executives,
business developers*

- Identify competitors
- Compare IP with market position
- Evaluate the level of investment
- Future products & target markets

KNOWMADE OFFER

CUSTOM SERVICES

(Tailor-made analysis)

To meet your needs and budget/lead time constraints

- Specific and dedicated report.
- Prior-art search, literature review, patent landscape, freedom-to-operate, patent valuation, IP due diligence, technology scouting, monitoring service, etc.

Format

- Analysis report
- Patent data base
- Interactive dashboard
- Access to the analyst

REPORTS

(multi-client product)

To understand the competitive landscape and explore the emerging ecosystems and new technologies

- Stand alone report
- Patent landscape.
- Overview on IP dynamics, trends and players.
- Competitor, technology and strategy analysis.
- Benchmark of patent portfolios.
- Key IP players & key patents.

Format

- Analysis report
- Patent data base
- Interactive dashboard

MONITORS

(multi-client product)

To track the latest R&D developments and IP activities, and to be sensitive to weak signals

- Annual subscription
- Patent monitoring service.
- Quarterly updated patent data and technology trends.
- Current R&D and IP activities.
- Early detect weak signals, opportunities and risks.
- Open discussion with analyst.

Format

- Updated interactive dashboard
- Updated patent data base
- Access to the analyst (result presentations, Q&A sessions, additional research)

INSIGHTS

(free article & webinar)

To get unique information about industry and technology

- Analyst point of view about industry news (product release, M&A, start-up, fund-raising, etc.) from a patent perspective.

Format

- Knowmade website

MAIN FIELDS OF EXPERTISE

SEMICONDUCTORS

- Materials & Substrates
- Power electronics
- RF & Wireless datacom
- MEMS, Sensing & Imaging
- Photonics, Lighting & Display
- Memory
- Packaging

ENERGY

- Batteries
- Fuel-cells
- Solar PV
- Power management

HEALTHCARE

- New therapeutic tools
- Medical diagnostics
- Medical devices and imaging
- Drug discovery and delivery

AGRI-FOOD

- Food processing & formulation
- Vegan food
- Next-gen packaging
- Microbiology





Energy storage devices

- Batteries
- Fuel cells
- Supercapacitors
- Primary & Secondary devices
- Thin film & Microdevices
- Cylindrical, prismatic, pouch

Key technologies

Li-ion batteries

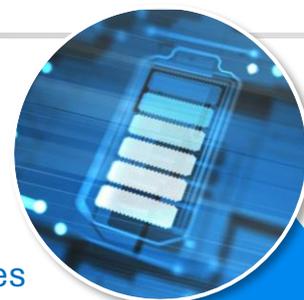
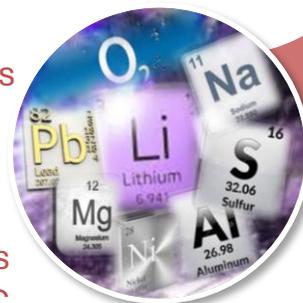
- LTO, Li-metal, silicon anodes
- NMC, NCA, LNMO, LFP cathodes
- Solid electrolytes

Post Li-ion batteries

- Na-ion
- Li-S
- Mg-ion
- Al-ion
- Ca-ion
- Zn-ion
- F-ion
- Li-air

Fuel cells

- PEMFC
- SOFC
- MCFC
- PAFC
- AFC



Whole supply chain

- Active Materials
- Battery electrodes, electrolytes, separators
- Fuel cell electrodes, membranes, catalysts, gas diffusion layer, bipolar plates, electrolytes
- Battery cells / Fuel cells
- Battery packs / Fuel cell stacks
- Manufacturing & Recycling

Energy

from materials and cells to modules and systems

All applications

- Automotive (BEV, FCEV)
- Consumer electronics
- Stationary energy storage

Power Management & Control

- Power electronics
- BMS
- Thermal management





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06560 Sophia Antipolis, France

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contact@knowmade.fr