

Silicon Anode for Li-ion Batteries

Patent Landscape Analysis

September 2024



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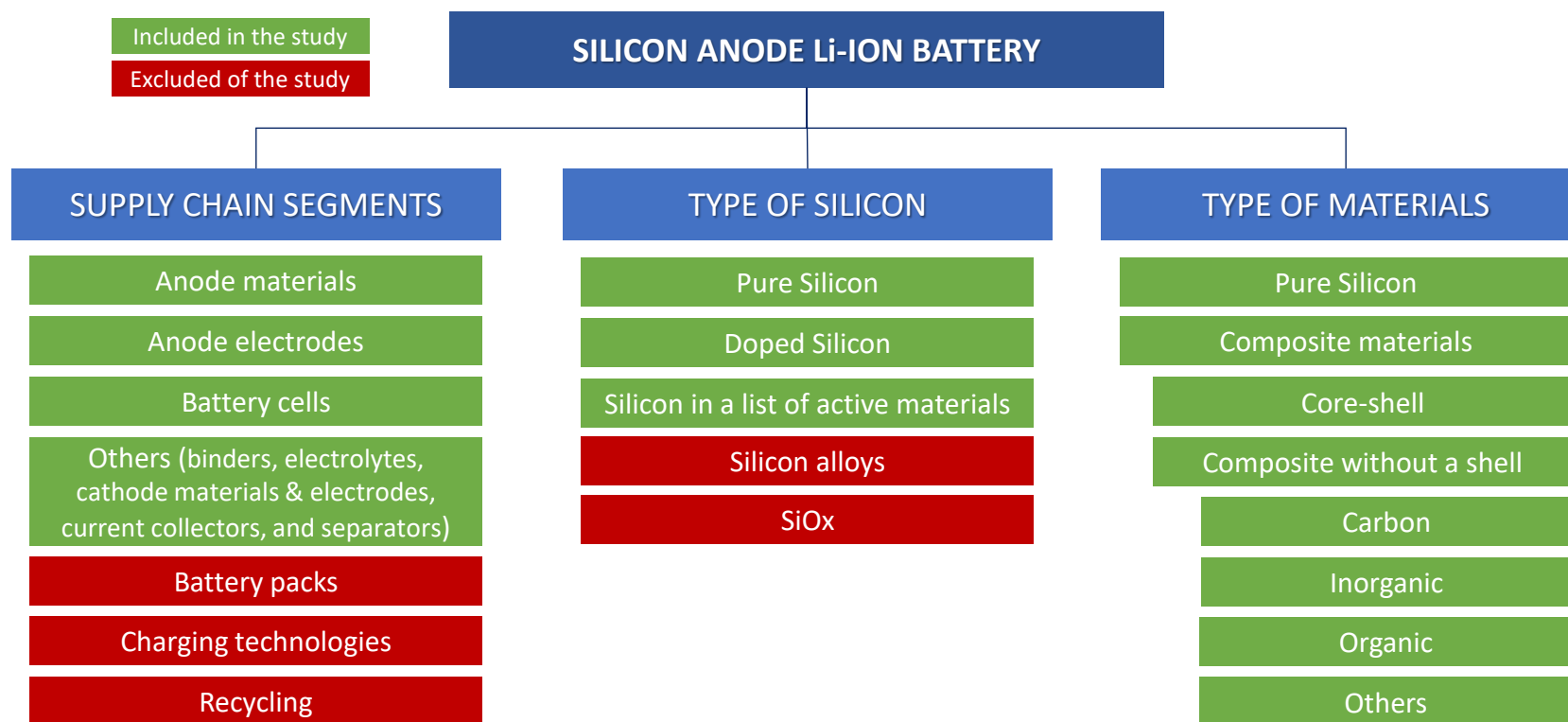
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INTRODUCTION

Scope of the report

- This report provides a detailed picture of the patent landscape related to **Silicon Anode for Li-ion Batteries**, covering the whole value chain (anode materials, anode electrode, battery cells, electrolytes, binders, etc.)
- We have selected and analyzed more than **38,750 patents and patent applications** published **worldwide** up to **September 2023**, representing more than **18,200 patent families** (inventions) relevant to the scope of this report.
- The patent search strategy has been implemented using advanced search equations in the patent database and by a cautious patent selection performed by the analyst to get the most relevant corpus.
- More details are available in METHODOLOGY part.

SAMPLE



Yours needs are out of scope of this report?
You want a deeper analysis on technologies or companies
Contact us for a custom report



INTRODUCTION

Reading guide: find the right information in the report

SAMPLE

Report sections



Your concern →
Information you get

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**

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**

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**

TECHNOLOGY

*For R&D teams,
engineers, scientists*

Innovators

Technology trends
Technology mapping

Current R&D activities
Technology roadmap

IP

*For IP teams,
patent attorneys*

Main patent owners
IP risks/opportunities

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

Blocking patents
Geo/Tech coverage
Link between patents
and products

MARKET

*For executives,
business developers*

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

Benchmarking
Markets of interest
Future developments

Future products
Potential partners
Potential targets

PLAYER

*Zoom in a
competitor / partner*

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

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

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

MAIN TRENDS AND IP PLAYERS

General trends, main patent assignees, new entrants, typology and originating countries

SAMPLE

IP dynamics

An acceleration of patenting activity over the past 5 years

Time evolution of patent publications

36,750+ patent applications grouped in 18,200+ patent families

Year	Number of Patents
Before 2001	68
2001	99
2002	75
2003	144
2004	152
2005	210
2006	215
2007	254
2008	239
2009	265
2010	344
2011	446
2012	634
2013	645
2014	843
2015	847
2016	978
2017	1397
2018	1563
2019	2000
2020	2500
2021	3000
2022	3500
2023	4000

Timeline of main IP players

Historical IP players and new entrants

Patent publication year: 2000

Main established IP players with continuous patenting activity related to silicon anode batteries: FUJIFILM, NEC, KJT, Shin-Etsu, TORAY.

patent publications by country

IP dynamics by publication country

patent assignees by typology

Players come from all levels of the supply chain and all countries

Typology	Material manufacturers	Both material and battery manufacturers	Battery manufacturers	Electronics / Tier one suppliers	End-users	R&D labs
China	TINCO, BTR, Sunway, MCL, NEW MATERIALS, L'WAHA					

Main patent assignees

Ranking of patent assignees according to the number of their patent families (inventions)

Rank	Assignee	Number of Patent Families
1	840	840
2	771	771
3	551	551
4	482	482
5	477	477
6	333	333
7	243	243
8	230	230

IP portfolio focus on 2 segments

Established IP players: BASF, DONGJIA UNIVERSITY, EVONIK

IP portfolio focus on 1 segment

Established IP players: PPG, DAIKIN, Sany Tech. Equip., SUPERALD, GDI, theion, Guangong Haoshi Tech.

KEY IP PLAYERS

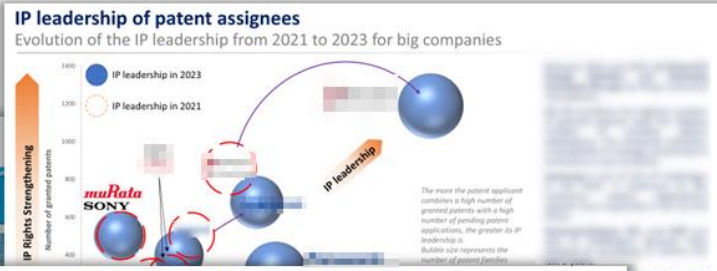
IP strategies, Geographical coverage of patents, recent patenting activities

SAMPLE

Geographic coverage of alive patents

Patenting activity of main patent assignees

Assignee	Number of granted patents	Number of pending patent applications
18217	12665	2490
946	12665	1396
1778	904	1107
552	879	1071
482	861	1121
677	808	75
339	887	16
245	80	1
280	95	1
272	871	80
183	539	106
141	515	77
139	332	44
136	314	24
134	319	14
134	305	24
130	88	1
127	324	20
125	60	7
113	31	1



Patenting activity and IP strategy of main patent applicants

Most active players VS. Less active players / Domestic IP strategy VS. Global IP strategy

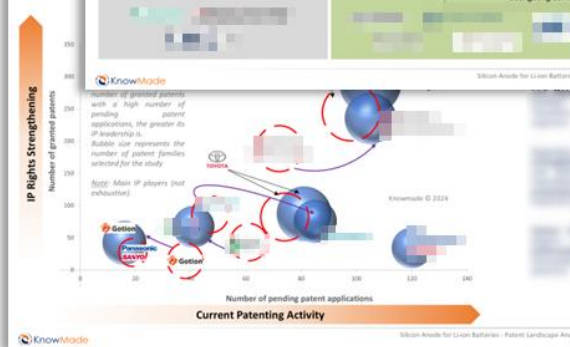


Key IP players

Main blocking IP players and newcomers



IP leadership Evolution



Patent Applications



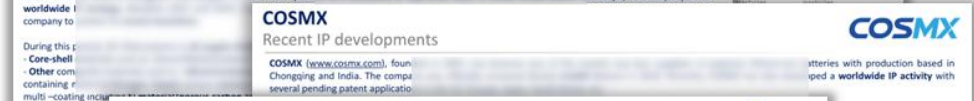
Main Patent Assignees with Granted Patents



SAMSUNG Recent IP developments



ATL Recent IP developments



COSMX Recent IP developments



NEXEON Recent IP developments



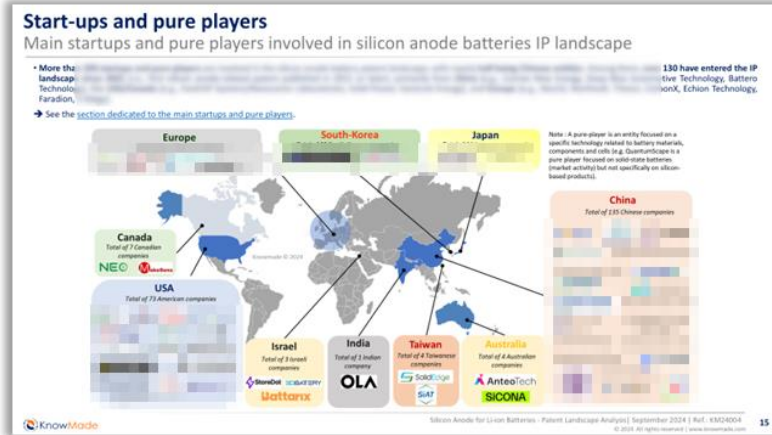
Recent IP developments



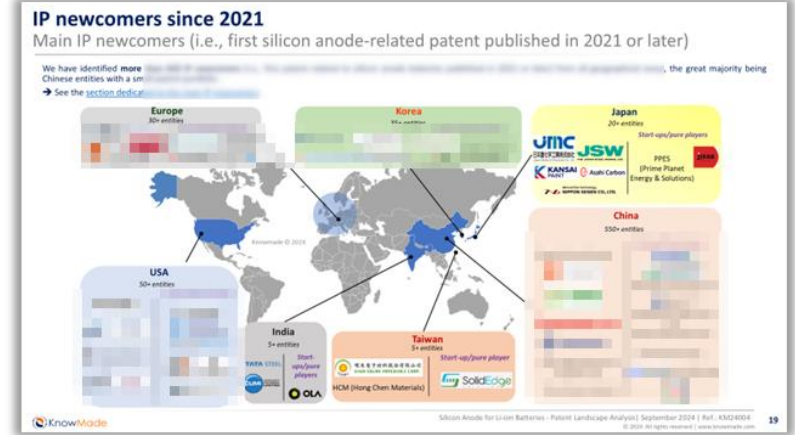
STARTUPS, PURE PLAYERS AND IP NEWCOMERS

IP portfolios held by startups, pure players and IP newcomers from various countries

290+ start-ups and pure players



650+ IP newcomers since 2021



Start-ups and pure players involved in silicon anode battery IP landscape
Main European start-ups and pure players (1/2)

Start-ups and pure players involved in silicon anode battery IP landscape
Main South-Korean start-ups and pure players (1/2)

Start-ups and pure players involved in silicon anode battery IP landscape
Main American/Canadian start-ups and pure players (1/6)

Start-ups and pure players involved in silicon anode battery IP landscape
Main Chinese start-ups and pure players (1/3)

Patent assignee	Headquarters	Company Type	Creation date	Anode Electrode	Battery Cell	Other Components*
China	China	Material manufacturer	2013	1	1	
China	China	Material manufacturer	2021			
China	China	Material manufacturer	2016	2	1	3
China	China	Battery Manufacturer	2021	1	1	
China	China	Electronics companies / Tier one suppliers	2019	1		2
China	China	End-users	2015	1	1	1

IP newcomers since 2021
Main IP newcomers (i.e., first silicon anode-related patent published in 2021 or later)

IP newcomers' patent portfolio
Main Chinese IP newcomers (1/3)

IP newcomers' patent portfolio
Main South-Korean IP newcomers (2/3)

IP newcomers' patent portfolio
Main American IP newcomers (1/4)

IP newcomers' patent portfolio
Main European IP newcomers (1/3)

Patent Assignee	Headquarters	Company Type	Creation date	Battery cell	Other components*
Material manufacturer	2013				
Material manufacturer	2021				
Material manufacturer	2016			2	1
Battery Manufacturer	2021				
Electronics companies / Tier one suppliers	2019			1	
End-users	2015			1	1

ORDER FORM

Silicon Anode for Li-ion Batteries

Patent Landscape Analysis – September 2024

Ref.:KM24004



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:

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

PRODUCT ORDER

4,990 EUR – Multi user license*

For price in dollars, please use the day's exchange rate.
For French customer, add 20% for VAT.

All reports are delivered electronically in pdf format at payment reception.

**The report can be shared with the employees of the company purchasing the report. Subsidiaries and joint-ventures are excluded. 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). This watermark also reaffirms that report sharing is not allowed.*

I hereby accept Knowmade's Terms and Conditions of Sale
Signature:

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 information** and **scientific literature** into actionable insights, providing high value-added reports for **decision-makers** working in **R&D, Intellectual Property, Innovation Strategy, and Marketing**

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



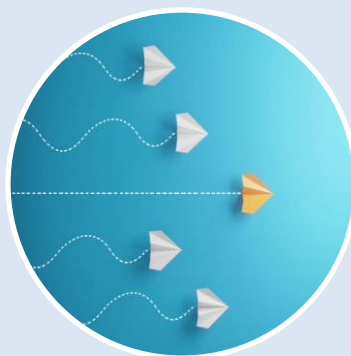
WHAT INFORMATION CAN YOU GET ?



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 ADDED VALUE

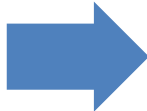
Search

- ✓ **Strong technical expertise of our analysts with PhD degree**
- Best-in-class databases (e.g., Orbit Intelligence by Questel)
- Comprehensive search queries and keywords
- Manual selection of relevant and related patents/sci papers
- Manual segmentation by technology & application



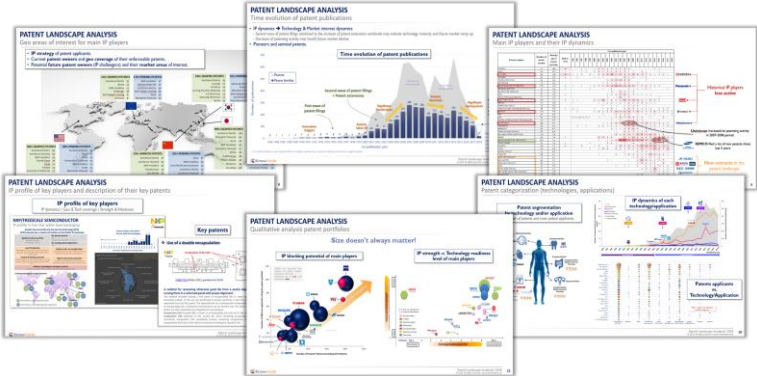
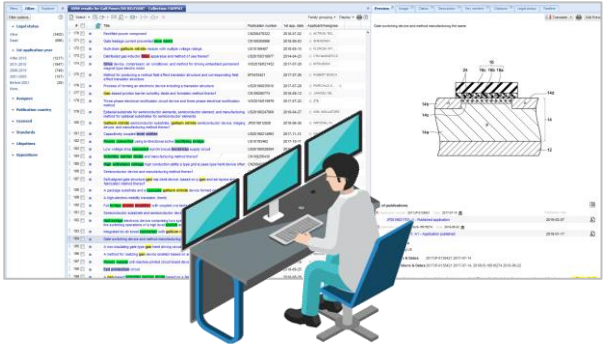
Analytics

- ✓ **Statistical analysis** (main trends)
- ✓ **Qualitative analysis** (key players, key patents, key scientific findings)
- ✓ **Innovative methodologies** to deliver relevant analysis (metrics)
- ✓ **Business-oriented data** representation and graphics



Analysis

- ✓ **Technical expertise**
 - Highly specialized analysts (PhD)
 - Benefit from knowledge capitalization
- ✓ **In-depth IP analysis compared with market**
- ✓ **Capability to work with market research firms and IP law firms**



KNOWMADE OFFER

CUSTOM SERVICES

(Tailor-made analysis)

To meet your needs and budget/lead time constraints

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

- Format
- PDF file with analyses.
 - Excel file with data.
 - 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
- PDF file with analyses.
 - Excel file with patent data.

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
- PDF file with analyses.
 - Excel file with patent data.
 - Direct access to the analyst.

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



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



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



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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