

## Silicon Anode for Li-ion Batteries

Patent Landscape Analysis – September 2024

Who are the key players and newcomers in the global IP race for the promising silicon anode-based Li-ion batteries?

#### **REPORT OUTLINE**

- Silicon Anode Li-ion Batteries
- Patent Landscape Analysis
- September 2024
- PDF >100 slides
- Excel file >18,200 patent families
- Reference: KM24004
- 4,990 EUR for a multi-user license

#### **KEY FEATURES**

- Global patenting trends, including time evolution of patent publications, countries of patent filings, etc.
- Main patent assignees and IP newcomers in the different segments of the supply chain.
- Key players' IP position and the relative strength of their patent portfolio.
- Patents categorized by supply chain segments (materials, anode, battery cell, other battery components).
- Recent patenting activities of key players.
- Focus on startups, pure players, and IP newcomers.
- Excel database containing all patents analyzed in the report, including patent segmentations and hyperlinks to an updated online database.

#### **RELATED REPORTS & MONITORS**

- Silicon Anode for Li-ion Batteries Patent Landscape 2022
- Solid-State Li-ion Batteries with Inorganic Solid Electrolytes - Patent Landscape Report
- Solid-State Batteries Patent Monitoring Service (annual subscription)

## The recognized potential of the silicon-based anode for Li-ion batteries has led to significant investments in bringing this technology to market.

Silicon-based anodes in Li-ion batteries offer superior electrochemical performance, including higher energy density, greater gravimetric and volumetric capacity, suitable thermodynamic lithiation potentials, and higher average voltage.

Today, the use of silicon-based anodes in Li-ion batteries is becoming a reality, with billions od dollars flowing into silicon anode start-ups (IDTechEx, 2021) and a market for silicon anode material for Li-ion batteries projected to reach \$24 billion by 2034 (IDTechEx, 2024). Several material manufacturers, such as Advano, Sila Nanotechnology, Elkem, Group14, NanoGraf, OneD Materials, and Nexeon, have announced the commercial production of silicon active materials for Li-ion batteries. Likewise, several battery manufacturers have announced the commercial availability of silicon anode Li-ion cells, including Amprius, Sionic Energy (formerly NOHMS), Farasis Energy, Enovix, StoreDot, Samsung, Panasonic, PPES (a joint venture between Toyota and Panasonic), Murata, and Enevate/EnerTech. In the automotive sector, there have been significant strategic acquisitions and partnerships. Tesla acquired battery manufacturer Maxwell Technologies in 2019 and battery start-up SiLion in 2021. That same year, PPES and Nexeon announced a partnership focused on silicon anode development, and StoreDot entered into a strategic framework agreement with EVE Energy, while partnering with Group14 Technologies to accelerate commercialization of StoreDot's XFC lithium-silicon cells for electric vehicles. Additionally, automotive OEMs such as Daimler, Porsche, and GM have recognized the potential of silicon anodes and have invested in and partnered with silicon anode companies.

In this highly competitive and dynamic environment, it is increasingly crucial to have a strong understanding of the patent landscape and the strategies of key players in technology and intellectual property (IP). To meet this need, Knowmade is releasing a new Silicon Anode Batteries Patent Landscape report, which aims to clarify the current positions of IP players, analyze their IP strategies, and reveal where industry leaders, newcomers, and start-ups are focusing their R&D efforts.

#### Silicon Anode Battery Patent Landscape Time evolution of patent publications Patent families expected in 2023 according to the current trend 1843 1397 Before 2015 2016 2017 2018 First publication year Main players entering the silicon anode-based Li-ion battery patent landscape LG Chem Panasonic SANYO BOSCH MuRata CATL TING **⑤** 桑德集团 MERKE Solid Power SONY SHOWA SAMSUNG cornex BIR GERAPE SUNUDDE gm NEC Shin Etsu & BAK COSMX SVOLT UNIST CES HANYANG Gotion northvolt SEKISUI FUJIFILM EVEIZ纬锂能 GSYUASA ne xeon MITSUBISHI CHEMICAL **&TDK** 駐华新劇 theion KOLON 新柯力化工 umicore amphus ()ENEVATE Yinlong H-CUBE O Source: Silicon Anode for Li-ion Batteries - Patent Landscape, KnowMade, September 2024

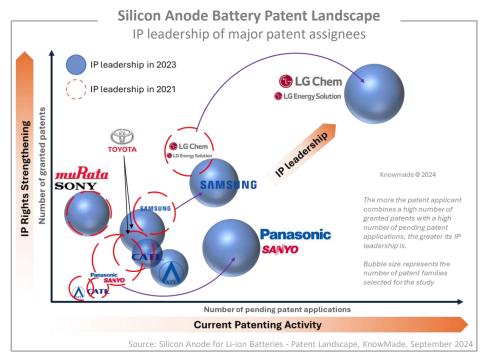
#### A dynamic IP landscape

In this report, Knowmade's analysts have selected and analyzed over 36,700 patents and patent applications from more than 18,200 patent families (inventions) related to silicon anode-based Li-ion batteries. These include patents covering silicon-based materials for anode, silicon-based anodes, and battery cells using a silicon-based anode. The number of patents has increased by more than 47% compared to the initial corpus analyzed in 2021 for our <u>first report</u>, with nearly 6,000 new inventions identified and included in this updated 2024 IP report. This significant rise clearly demonstrates a strong interest in the technology from various entities, including large companies, start-ups, and R&D labs. Over the past two years, several notable companies, such as **Northvolt**, **Solid Power**, and **OLA Electric Mobility**, have entered the patent landscape. Additionally, several IP players already identified in 2021, including **LG Chem/LGES**, **Panasonic/Sanyo**, **Samsung**, and **ATL**, have significantly strengthened their patent portfolios.

## Understanding the main trends, the key players' IP position and IP strategy

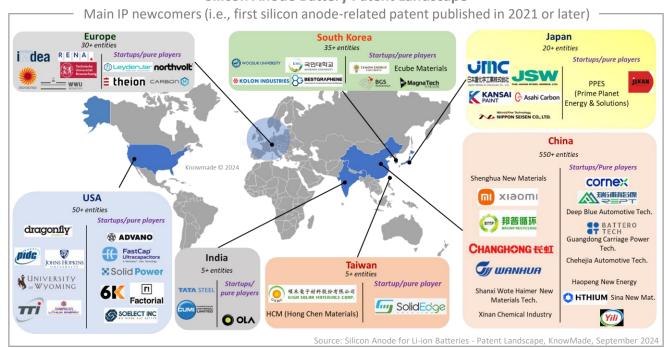
IP competition analysis should reflect the vision of players with a strategy to enter and develop their business in the silicon anode Liion battery market. this Knowmade's analysts provide comprehensive overview of the competitive IP landscape and latest technological developments in this field. The report covers IP dynamics and key trends in terms of patents applications, patent assignees, filing countries, and patented technologies. It also identifies the IP leaders, most active patent applicants, and new entrants in the IP landscape. The report also sheds light on under-the-radar companies and new players in this field.

# **Evolution of leading players' positions** and entry of new patent applicants



LG Chem/LGES is leading the silicon anode battery patent landscape, with strong IP competition from Samsung, Murata, Panasonic/Sanyo, and Toyota. Additionally, we have identified over 290 start-ups and pure players involved in the patent landscape, and more than 650 new entrants who filed their first silicon anode-related patents in 2021 or later, most of whom are Chinese entities. In dedicated sections of the report, we focus on the IP portfolios held by key players, start-ups, and newcomers from various countries.

#### Silicon Anode Battery Patent Landscape





#### <u>Useful Excel patent database</u>

This report also includes an extensive **Excel database with** all patents analyzed in this study, including **patent information** (numbers, dates, assignees, title, abstract, etc.) and **hyperlinks to an updated online database** (original documents, legal status, etc.), and **affiliation segments** (anode material, anode, battery cell, other battery cell components).



#### **Companies mentioned in the report** (non-exhaustive)

LG Chem/LG Energy Solution, Panasonic/Sanyo, Samsung, Murata Manufacturing/Sony, Toyota, ATL (Amperex Technology), COSMX / COSLIGHT, Guoxuan High Tech Power Energy / Gotion, CATL (Contemporary Amperex Technology Ltd), Global Graphene, SVOLT / Fengchao Energy Technology, General Motors, NEC, SK Group, Enevate, Resonac (Showa Denko / Hitachi Chemical), Shanshan Energy Technology, Mitsubishi Chemical, BYD, EVE Energy, Bosch/SEEO, A123 Systems (Wanxiang group), Sunwoda, Nissan, Tafel New Energy Technology / Zenergy, BTR New Energy Material, Amprius / Berzelius, Nexeon, Mitsui Mining & Smelting, Envision / AESC, Tinci Materials Technology, TDK, Hitachi , JEVE (Tianjin EV Energy), Huawei, Hyundai/Kia, WeLion New Energy Technology, Wacker Chemie, BAK Battery, Hitachi Maxell, GS Yuasa, Mitsui Chemicals, Tianmu Energy Anode Material, CALB (China Aviation Lithium Battery), Yinlong Energy, Furukawa, Toshiba, Kaijin New Energy Technology, Smoothway Electronic Materials, Kunlunchem, Chery Automobile, Fujifilm, MU Ionic Solutions, Ube Corporation, Shin Etsu Chemical, Sumitomo Electric Industries, MGL New Materials, Sound Group, Zeon, FAW (China First Automobile Works), BMW, Umicore, Sekisui Chemical, Capchem Group, Novolyte Technologies, and more.

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## Recent patenting activity of key players 48 Samsung, LG Chem/LG Energy Solution, Panasonic/Sanyo, ATL, COSMX,

Nexeon, Enevate, Ionobell, Enwires

- Focus on start-ups and pure players

   Mapping of 290+ startups and pure players involved in the silicon anode battery patent landscape
- Chinese startups and pure players
- South Korean startups and pure players
- Japanese startups and pure players
- North American startups and pure players
- European startups and pure players
- Others (Taiwanese, Israeli, Indian, Singaporean, Australian, etc.)

### Focus on IP newcomers since 2021 • Manning of 650+ IP newcomers that published their first patent related

- Mapping of 650+ IP newcomers that published their first patent related silicon anode batteries in 2021 or later.
- Chinese IP newcomers
- South Korean IP newcomers
- Japanese IP newcomers
- American IP newcomers
- European IP newcomers
- Others (Taiwanese, Canadian, Indian, etc.)

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- Methodology for patent search, selection and analysis
- Terminology

KNOWMADE PRESENTATION 110

#### **AUTHORS**



#### **Arnaud Capgras**

• Key IP players and newcomers

Arnaud works for Knowmade in the field of Materials Chemistry and Energy storage. He holds a Chemistry-Process Engineering Degree from the Chemistry and Chemical Engineering School of Lyon (CPE Lyon, France). He also holds the International Industrial Property Studies Diploma (Patents) from the CEIPI (Strasbourg, France).

Contact: arnaud.capgras@knowmade.fr



#### **Dr. Nicolas Baron**

Nicolas is CEO and co-founder of KnowMade. He manages the development and strategic orientations of the company and personally leads the Semiconductors department. He holds a PhD in Physics from the University of Nice Sophia-Antipolis, and a Master of Intellectual Property Strategies and Innovation from the European Institute for Enterprise and Intellectual Property (IEEPI) in Strasbourg, France.

Contact: nicolas.baron@knowmade.fr

#### **ABOUT KNOWMADE**

**KnowMade** is a technology intelligence and IP strategy consulting company specialized in analyzing patents and scientific publications. The company helps innovative companies, investors, and R&D organizations to understand competitive landscape, follow technological evolutions, reduce uncertainties, and identify opportunities and risks in terms of technology and intellectual property.

**KnowMade**'s analysts combine their strong technology expertise and in-depth knowledge of patents with powerful analytics tools and methodologies to turn patent information and scientific literature into actionable insights, providing high added value reports for decision makers working in R&D, innovation strategy, intellectual property, and marketing. Our experts provide prior art search, patent landscape analysis, freedom-to-operate analysis, IP due diligence, and monitoring services.

**KnowMade** has a solid expertise in Compound Semiconductors, Power Electronics, Batteries, RF Technologies & Wireless Communications, Solid-State Lighting & Display, Photonics, Memories, MEMS & Sensors, Semiconductor Packaging, Medical Devices, Medical Imaging, Microfluidics, Biotechnology, Pharmaceutics, and Agri-Food.





# ORDER FORM Silicon Anode for Li-ion Batteries

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SHIP TO	PAYMENT METHODS
Name (Mr/Ms/Dr/Pr):	Order online: Click <u>here</u>
Job Title:	Check To pay your invoice using a check, please mail your check to the
Company:	following address:  KnowMade S.A.R.L.
Address:	2405 route des Dolines, Le Drakkar 06560 Valbonne Sophia Antipolis
City:	FRANCE
State:	<ul> <li>Money Transfer</li> <li>To pay your invoice using a bank money wire transfer, please</li> </ul>
Postcode/Zip:	contact your bank to complete the process. Here is the information you will need to submit the payment:
Country:	Payee: KnowMade S.A.R.L. Bank: Banque Populaire Méditerranée, CAP 3000 Quartier du
VAT ID Number for EU members:	lac, 06700 St Laurent du Var IBAN: FR76 1460 7003 6360 6214 5695 139
Tel:	SWIFT: CCBPFRPPMAR
Email:	 Paypal To pay your invoice via PayPal, you must first register at
Date:	www.paypal.com. You can then send money to KnowMade S.A.R.L. by entering our email address contact@knowmade.fr as the recipient and entering the invoice amount.
	RETURN ORDER BY

#### **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**:

Mail: KnowMade S.A.R.L. 2405 route des Dolines, Le Drakkar,

E-mail: contact@knowmade.fr

06560 Valbonne Sophia Antipolis, FRANCE





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

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.

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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.





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- 4.3 In no event shall the Seller be liable for:
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- 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.
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