From Technologies to IP Business Intelligence

Solid-State Li-ion Batteries

with Inorganic Solid Electrolytes

Patent Landscape Analysis

October 2021

Solid Power's 22-layer, 20Ah all solid-state lithium metal cell compared to the company's first-generation 10-layer, 2Ah cell.

KnowMade
Patent & Technology Intelligence

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THE AUTHORS

Dr. Fleur Thissandier
Fleur works for Knowmade in the field of Materials Chemistry and Energy storage. She holds a PhD in Materials Chemistry and Electrochemistry from CEA/INAC, (Grenoble, France). She also holds a Chemistry Engineering Degree from the Superior National School of Chemistry (ENSCM Montpellier, France). Fleur previously worked in battery industry as R&D Engineer.
Contact: fleur.thissandier@knowmade.fr

Dr. Nicolas Baron
Nicolas is CEO and co-founder of Knowmade. He manages the company's development and strategic direction, and personally leads the Electronics & Telecom department. He holds a PhD in Physics from the University of Nice Sophia-Antipolis (France) and a Master degree in Intellectual Property Strategies and Innovation from the IEEPI (Strasbourg, France).
Contact: nicolas.baron@knowmade.fr

KnowMade

Knowmade is a Technology Intelligence and IP Strategy consulting company specialized in analysis of patents and scientific information. The company helps innovative companies and R&D organizations to understand their competitive landscape, follow technology trends, and find out opportunities and threats in terms of technology and patents.

Knowmade's analysts combine their strong technology expertise and in-depth knowledge of patents with powerful analytics tools and methodologies to turn patents and scientific information into business-oriented report for decision makers working in R&D, Innovation Strategy, Intellectual Property, and Marketing. Our experts provide prior art search, patent landscape analysis, scientific literature analysis, patent valuation, IP due diligence and freedom-to-operate analysis. In parallel the company proposes litigation/licensing support, technology scouting and IP/technology watch service.

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

CONTEXT

A growing number of companies from the whole supply chain (material, battery, car makers) are working on solid-state batteries. In 2020 and 2021, several companies (Toyota, Samsung, etc.) have revealed first battery cells. Most of major companies operating on solid-state batteries plan a mass-production and commercialization by 2025.

In this context, **Knowmade** releases this year a new **patent landscape report** covering the whole value chain of **solid-state Li-ion batteries with inorganic solid electrolytes** from **materials** of **electrolytes** to **electrodes** and **battery cells**. Knowmade's analysts have selected and analyzed more than **14,400 patents and patent applications** representing more than **7,300 patent families** (inventions) filed by more than **1,000 different entities**. This 2021 report is complementary to our previous report focused on solid electrolytes materials and published in 2019.

In this **Solid-State Batteries Patent Landscape** report 2021, Knowmade's analysts give a comprehensive picture of the solid-state battery competitive landscape and technology developments from a patent perspective.

- What are the **IP dynamics** and **key trends** for patents filings, company, countries, and technology?
- Who are the **IP leaders**, **most active** players and **newcomers**?
- Who are the **new players** or **companies** that are **under the radar**?
- What is the **IP portfolio strength** of key players, and their **technology/application focus**?
- What is the status of **patented technologies**, and trends for each **technology/application**?
- What are the **strategic and technological paths** leading companies and newcomers are following for **inorganic-electrolyte-based solid-state battery** technologies?

In this 2021 edition, Knowmade's analysts detail the **IP landscape** and noteworthy **recent patents** related to electrolyte materials, electrodes and battery cells.

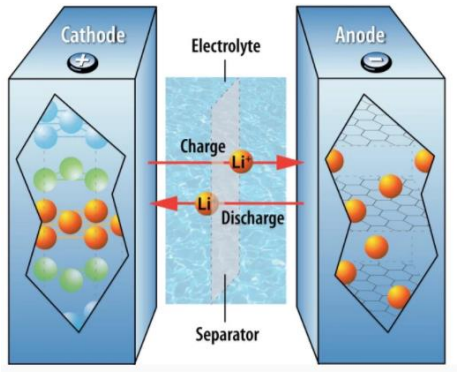
All year long, Knowmade's analysts **investigate the solid-state battery patent landscape** to get a deep understanding of the technology/IP evolution and business impact. This 2021 edition is part of a **collection of battery analyses** including **Solid Electrolytes for Li-ion Batteries**, **NMC Li-ion Batteries**, **Silicon Anode** (in progress), etc. Solid-state battery patents and technologies are also tracked and analyzed in the **Solid-State Batteries Patent Monitor.**

INTRODUCTION

Solid-state batteries : Definitions

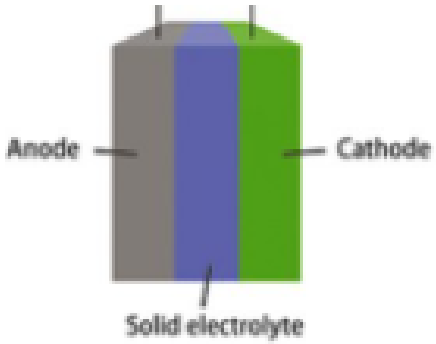
- Solid-state batteries are batteries with **all components in a solid-state** (electrode, electrolyte etc.). They use **same chemistries** than liquid/gelled batteries (i.e. Lithium-ion batteries, Li-Air batteries, Li-S batteries, Na-ion batteries, Mg-ion batteries etc.) but they have a solid electrolyte.
- In a solid-state batteries, two electrodes are separated by a solid-state electrolyte layer instead of a separator impregnated with a liquid of gelled electrolyte. Solid electrolytes allow the movement of ions without the need for a liquid or soft membrane separating the electrodes. Solid electrolytes can be classified in three categories: inorganic, polymer and inorganic/polymer composites.

Conventional liquid battery



Source: Argonne National Laboratory

All-solid-state battery



Source: University of Geneva

- Solid-state batteries have been developed to **enhance battery safety** (not flammable, no leakage, no thermal runaway, restrict dendrites formation etc.) and **enable the use of lithium metal** (improved energy density).

Main advantages and drawbacks of solid-state batteries

Advantages	Drawbacks
• Improved safety (not flammable, no leakage, no thermal runaway, restrict dendrite formation) • High tolerance to high temperature thus less safety protection/cooling systems are needed • Improved energy density: It allows the replacement of conventional anodes with lithium metal (higher capacity), thinner cells, large ESW • No separator membrane required • Simpler cell/pack design	• Lower power density (for the moment) due to lower ionic conductivity of solid electrolyte and resistance induced at electrode/electrolyte interface • Requires different manufacturing processes than liquid batteries • High mechanical constraints in the cell • More expensive • Operation at low temperature may be challenging. • High pressure is required to maintain electrode contact • Electrochemical stability issues with some electrolytes

Today, developed and commercialized solid-state batteries are mainly **Lithium metal and lithium-ion batteries**. This trend is also observed in patents. However, in 2017, some companies published new patent families related to other solid batteries technologies. **Toyota, Denso** and several **Chinese universities** published new patent families related to solid Li-Air batteries (WO2017159420, JP2017168190). **Tokyo Electric Power** and several Chinese universities published new patent families related to solid Li-S batteries (WO2017155011). **Toyota** and **Karlsruhe Institute of Technology** published new patent families related to solid electrolytes for magnesium batteries (US9716289, US9640836) both already granted. **SK Innovation, Toyota, Sila Nanotechnology** and **Foschungszentrum Jülich** published new patent families related to solid-state sodium-ion batteries (WO2017059838, WO2017106563, WO2017102011, KR20170078210).

INTRODUCTION

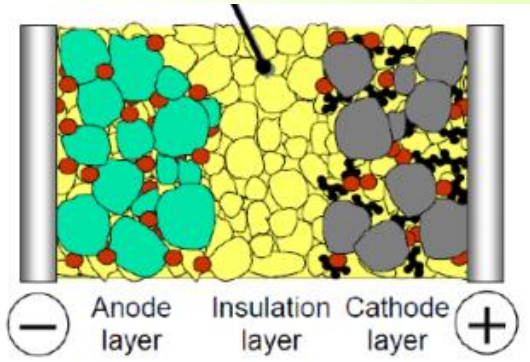
Solid thin-film battery vs “Bulk” solid battery

Solid-state batteries can be classified in two categories: **Thin-film solid-state batteries** and **“bulk” solid-state batteries**. Thin-film technology approach proven for thin-film solid-state batteries are not directly applicable for bulk solid-state batteries. Thus, new processes and materials have to be developed to get bulk solid-state batteries reaching market requirements (performances, stability, costs).

The present report

“Bulk” solid-state batteries

- Large batteries such as those used in electric cars
- **Maturity**:
  Inorganic: Under development
  Polymer: Commercialized by Blue Solutions
  (Operate at 60-80°C)
- **Applications**:
  Electric vehicles, Consumer devices



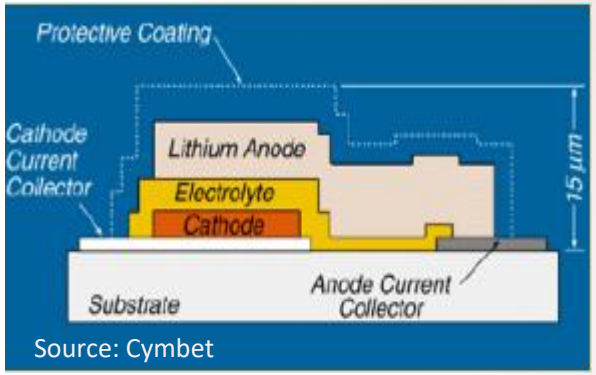
Source: Toyota

Potential future market players

BlueSolutions, Panasonic, SAMSUNG, 24M, HYUNDAI, NISSAN, dyson, SAKTI3, TOYOTA, CATL, HITACHI, JIAWEI, ProLogium, LG Chem, TOSHIBA, FISKER, HONDA, TESLA, ionic MATERIALS, solid energy, PATHION, QuantumScape, nanoOne, Volkswagen, Continental, A123 SYSTEMS, SolidPower, PLANAR Energy Devices, microvast, NGK, Wildcat Discovery Technologies, MITSUI KINZOKU, Empa Materials Science and Technology, KalpTree Energy

Thin-film solid-sate batteries

- Miniature batteries with very small energy capacity
- **Maturity:**
  Commercially available
- **Applications**:
  Consumer electronics,
  Microelectronics



Source: Cymbet

Main market players

cea, CYMBET CORPORATION, POLYPLUS, Infinite Power Solutions, I-TEN, Prieto Battery, Panasonic, Front Edge Technology, Inc. A Thin Film Battery Company, APPLIED MATERIALS, Johnson Battery Technologies, EXCELLATRON, STMicroelectronics, ilika, BRIGHTVOLT SMALL POWERED SOLUTIONS

SCOPE OF THE REPORT

Included in the study

Excluded of the study

This report provides a detailed picture of the patent landscape related to **solid-state batteries with inorganic solid electrolytes**, covering the whole value chain (electrolyte materials, electrodes, battery cells). We have selected and analyzed more than **14,400 patents and patent applications** published **worldwide** up to **February 2021**, representing more than **7,500 patent families** (inventions) relevant to the scope of this report.

SOLID-STATE Li-ION BATTERY

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.)

SUPPLY CHAIN SEGMENTS

- Electrolyte materials
- Electrodes
- Battery cells
- Battery packs
- Charging technologies

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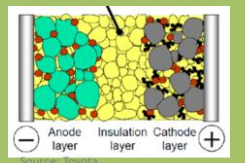
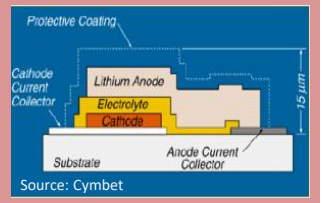
TYPE OF BATTERIES

- Large scale (or « bulk ») solid-state batteries



Source: Toyota

- Thin-film batteries or microbatteries

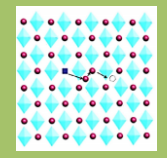


Source: Cymbet

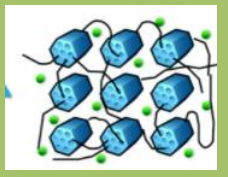
- Coin cells

TYPE OF ELECTROLYTES

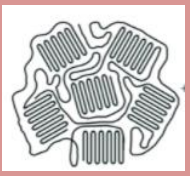
- Inorganic



- Inorganic/Polymer

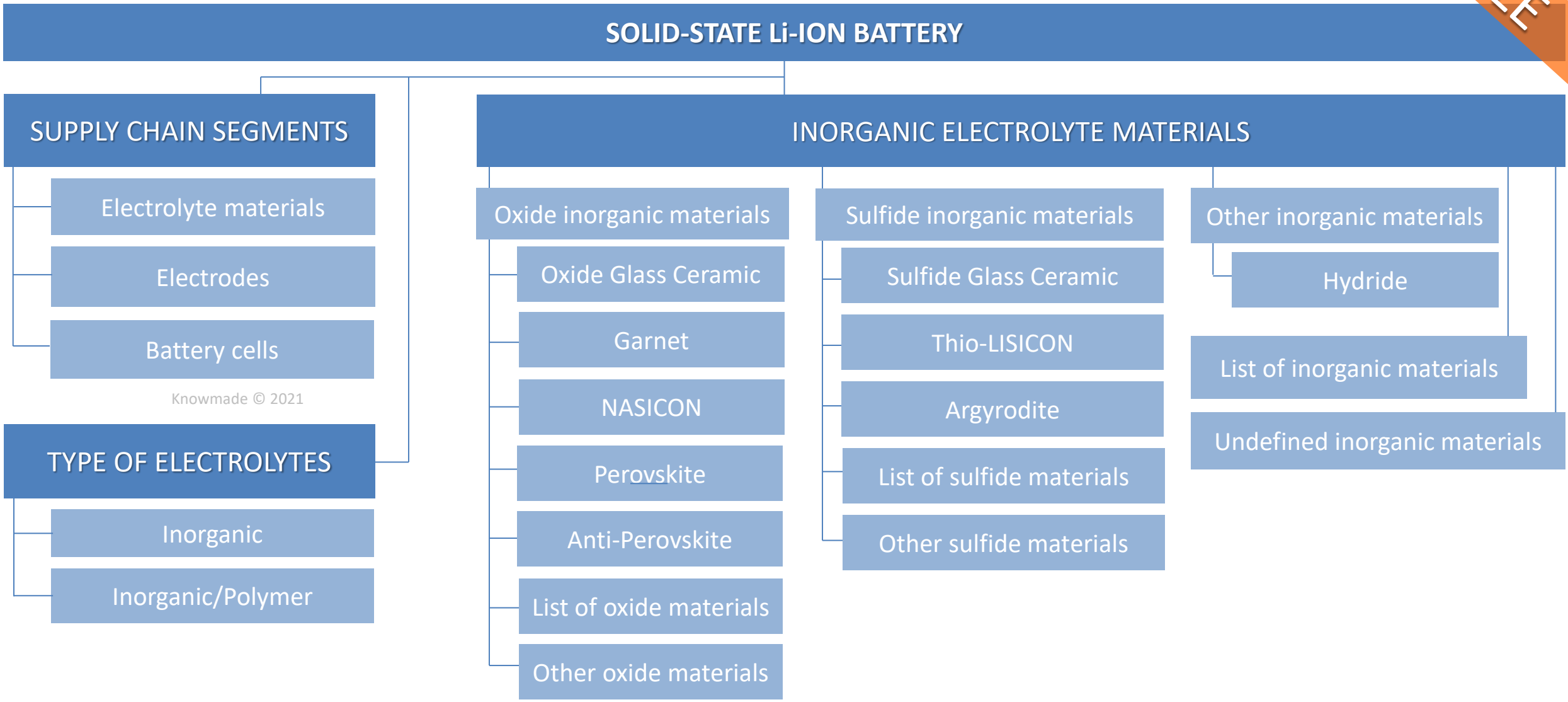


- Polymer



SEGMENTATION

The patents selected for the corpus of this report have been categorized as shown in the table. Note that patents can belong to multiple segments.



KEY FEATURES OF THE REPORT

- The report provides **essential patent data** for **batteries using inorganic solid electrolytes**, from **materials** of **electrolytes** to **electrode** and **battery cells**.
- It provides **in-depth patent analyses** of **key technologies** and **key players** including:
  - Main IP dynamics and key trends.
  - IP leaders, most active players and newcomers.
  - IP portfolio strength of key players, and their technology/application focus.
  - Time evolution of patents filings by company, countries, and technology.
  - Current legal status of patents.
  - Joint developments, IP collaborations and IP transfers between key organizations.
  - Insights into the status of technologies, identifying trends for each technology/application.
  - Key patents.

- This report also includes an extensive **Excel database** with the **7,300+ patent families** analyzed in this study. This useful patent database allows for **multi-criteria searches** and includes patent publication numbers, hyperlinks to the original documents, priority date, title, abstract, patent assignees, patent's current legal status, and **segments** (electrode, battery cell, electrolyte inorganic, inorganic/polymer, argyrodites, sulfide glasses, thio-LISICON, oxide glass ceramics, perovskites/anti-perovskites, LISICON, garnet, NASICON, hydrides, etc.).

Disclaimer: This report **does not provide** any insight **analyses or counsel regarding legal aspects** or the **validity** of any individual patent. Knowmade is a research firm that provides technical analysis and technical opinions. Knowmade is not a law firm. The research, technical analysis and/or work proposed or provided by Knowmade and contained herein is not a legal opinion and should not be construed as such.

WHY STUDY THE PATENT LANDSCAPE

Understanding the **competitive landscape** and **technology developments** from a **patent perspective**

- **Key IP players** (key patents, IP strategy, technology roadmap)
- **Newcomers** (technology and markets of interest)
- **Technology trends & Emerging technologies**
- **Benchmark patent portfolios** (competitors' strength & weakness)
- **Key patents** (blocking, valuable)
- **Key technical solutions**
- **Risks** (patent infringement, new entrants, etc.)
- **Opportunities** (partnership, technology acquisition, licensing, etc.)

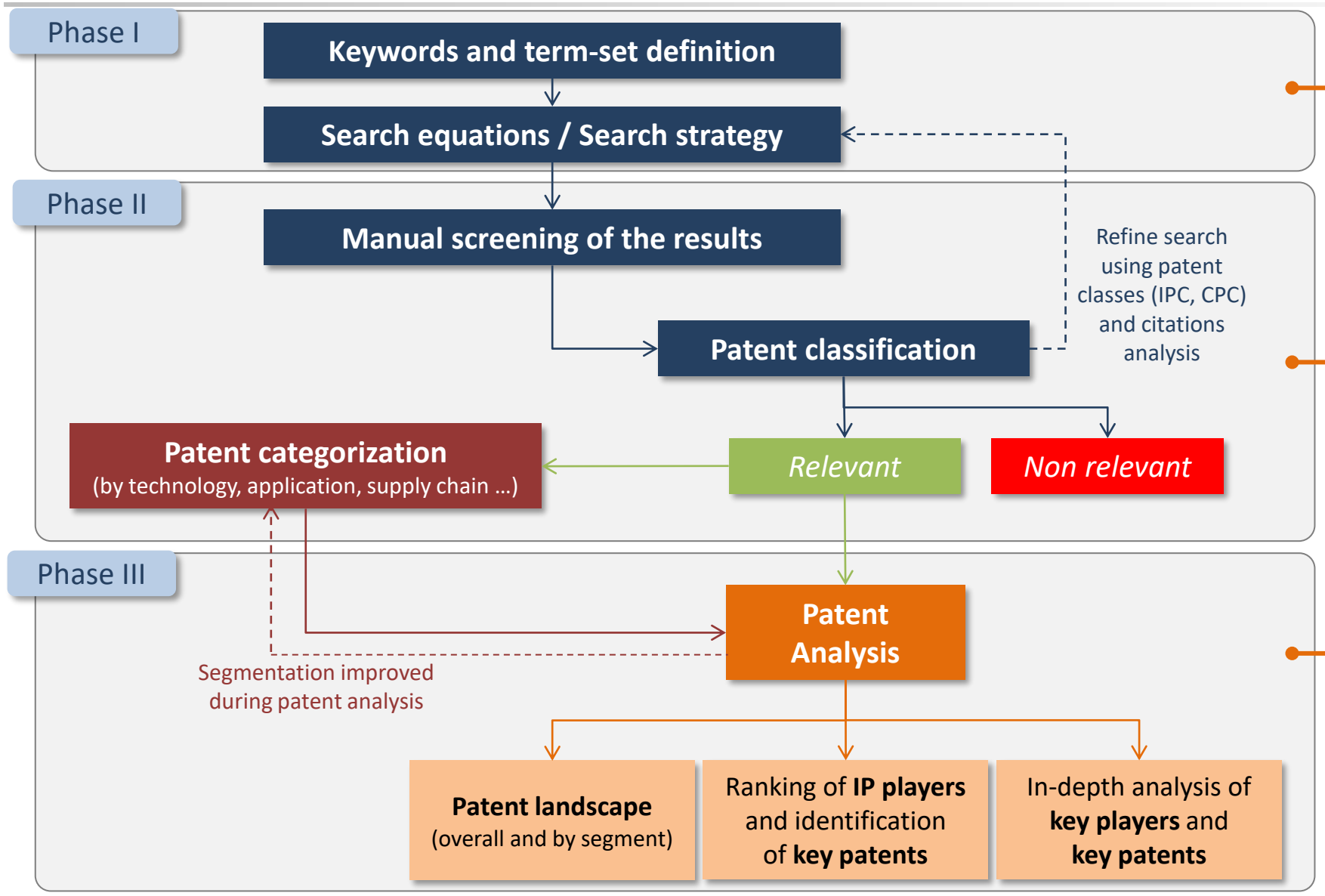
Perfectly complement market research

Give another point of view of the competitors, technologies and markets

Links between patents and
- Key market players
- Supply chain
- Technology Readiness Levels (TRL)
- Market product
- Emerging technologies/applications
- Forecast

METHODOLOGY

Methodology for patent search and analysis



Worldwide patent database (Questel-ORBIT)
Provides 100+ million patent documents from 100 offices (USA, Japan, Europe, China, Korea, Taiwan, Hong Kong, Singapore, etc.)

IP analysts with PhD degree combining **technical** and **patent expertise**. **Manual screening** of patent pools with patent classification between relevant & non relevant patent families based on their technical content & scope of the claims. **Categorization** of relevant patent families by technology, application or supply chain.

IP analysts using powerful **analytics tools** and **proprietary methodologies** for **IP business intelligence**.

INTRODUCTION

Challenges and envisioned technical solutions

INTRODUCTION
Challenges in battery field

Challenges	Improvement solutions
• Increase battery performances (energy and power density, charge duration, life duration, performances in extreme environments)	• **Develop new** electrode materials, **electrolytes** and separators • Decrease cells weight/volume • Improve the battery control by BMS and thermal management
• Improve battery safety (fire/explosion risks, environment contamination)	• Increase the tolerance to overcharging, deep charging, mechanical abuse • **Use solid/non-flammable electrolytes** or fire-retardant in electrolytes • Limit short-circuit risks (ceramic separator etc.) • Use non dangerous materials • Improve cells arrangements in battery packs to avoid fire propagation upon failure • Improve thermal management in battery packs (BMS + cooling systems + fire retardant products) • Improve BMS (circuit protection to maintain safe operations)
• Decrease battery costs	• Use of cheaper materials and processes • Lower the cost due to the increase of production and sales
• Adapt battery morphology to specific applications	• Micro-scale, flexible, cable etc.
• Decrease dependence to scarce materials	• Substitution for lithium, cobalt etc. • Less geopolitical dependence • Especially important for countries with high battery demand and small (no) material resources
• Decrease environmental impact	• No toxic materials, dangerous chemicals, heavy metals • Eco-friendly production • Materials easy to dispose/recycle

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INTRODUCTION
Challenges and improvement solutions for "Bulk" solid-state lithium battery

Challenges	Improvement solutions	
• Improve solid electrolyte performances (ionic conductivity at room temperature, electrochemical and chemical stability (notably against Lithium), resistance to mechanical stress induced by volume change during charge/discharge)		Detailed in this report
• Improve electrode/electrolyte interface		Detailed in the report "Bulk solid-state batteries: Technology and Patent Analysis"
• Develop manufacturing processes compatible with industrial production		
• Improve Lithium metal stability		Not detailed in this report
• Decrease battery costs		

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INTRODUCTION
Overview of main technical issues for "Bulk" solid-state lithium batteries

Solid Electrolytes	Electrode/electrolyte interface	Battery manufacturing
Improve solid electrolyte performances to improve battery performances (energy and power densities, capacity, maximum voltage) and stability	Improve electrode/electrolyte interface to reduce global battery cell resistance and thus improve its power density and stability	Develop manufacturing processes compatible with industrial production to enable their large scale production and commercialization

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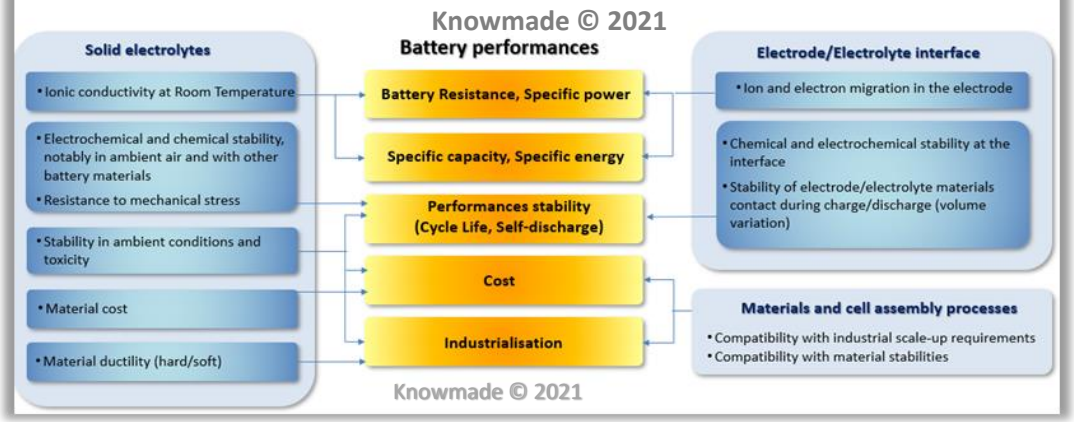
INTRODUCTION
Impact of main "bulk" solid-state battery technical issues on its performances

Three main developments axes have been envisioned to improve performances of "Bulk" Solid-state batteries: Solid electrolytes, electrode/electrolyte interface and materials/cell assembly processes. Impact of solid electrolyte properties, electrode/electrolyte interface properties and material/cell assembly processes on battery performances are represented on the scheme below.



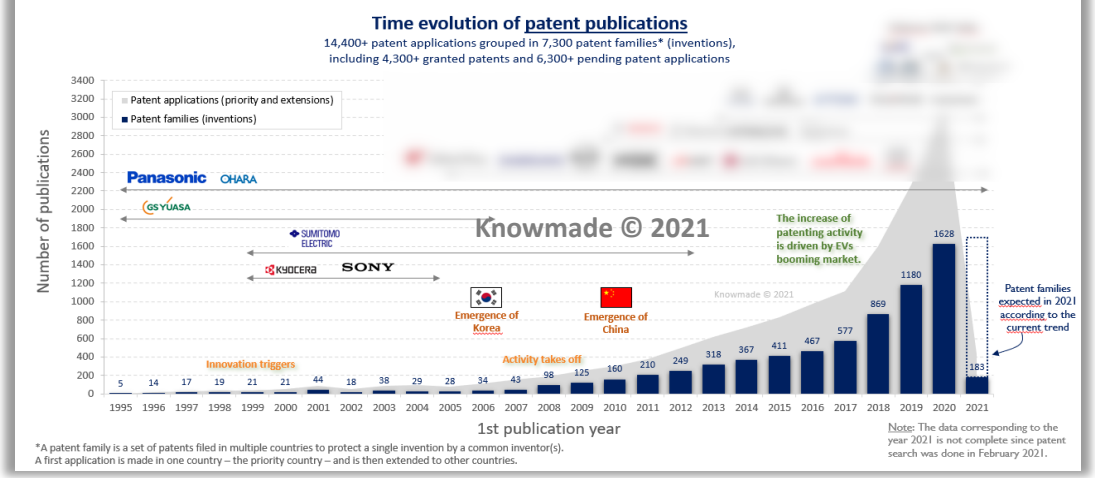
PATENT LANDSCAPE OVERVIEW

IP dynamics

SAMPLE

PATENT LANDSCAPE OVERVIEW

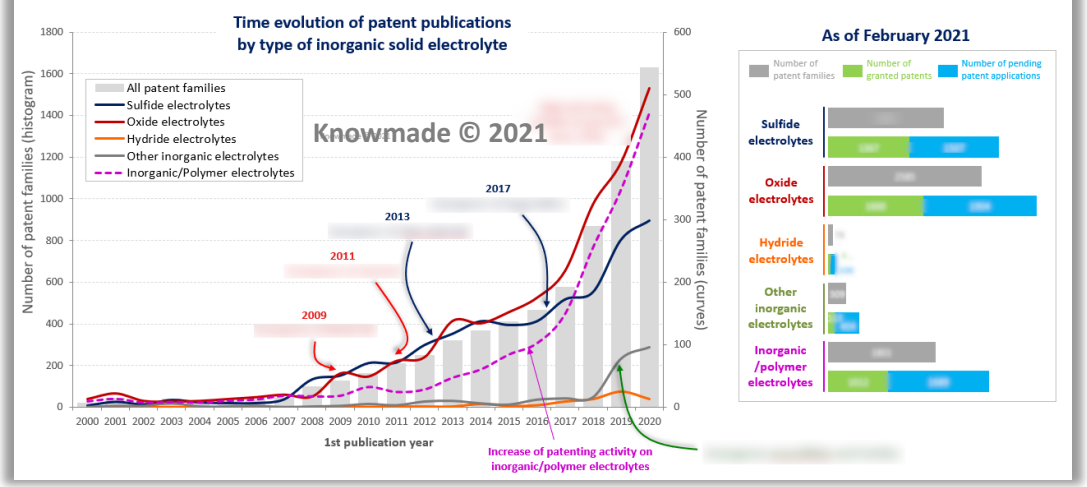
Time evolution of patent publications and main patent applicants



*A patent family is a set of patents filed in multiple countries to protect a single invention by a common inventor(s). A first application is made in one country – the priority country – and is then extended to other countries.

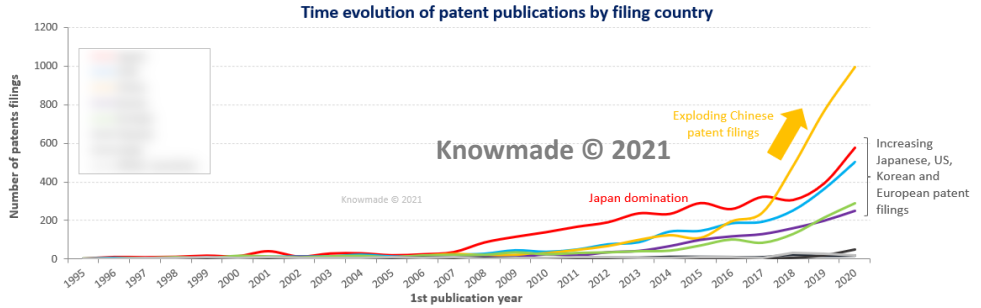
PATENT LANDSCAPE OVERVIEW

Time evolution of patent publications by type of solid electrolyte



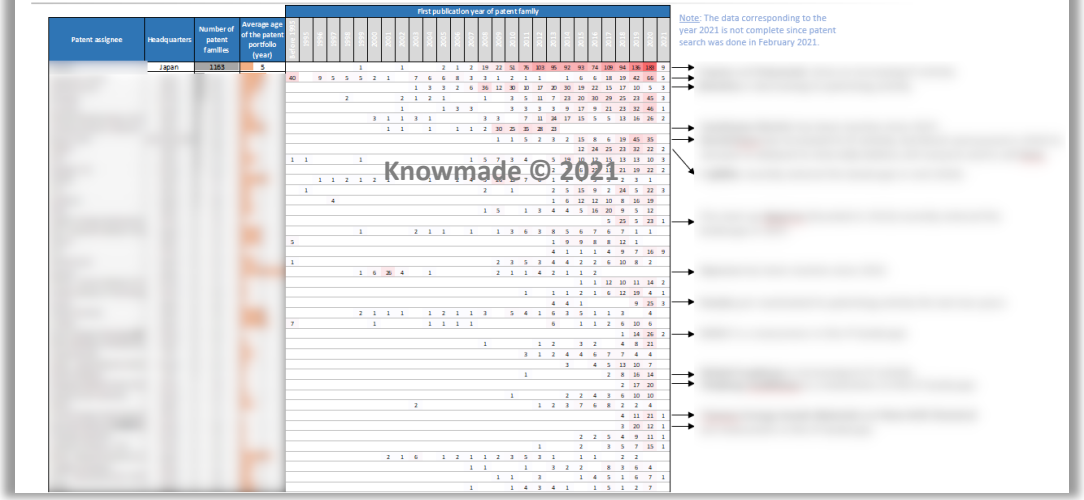
PATENT LANDSCAPE OVERVIEW

Time evolution of patent publications by filing country



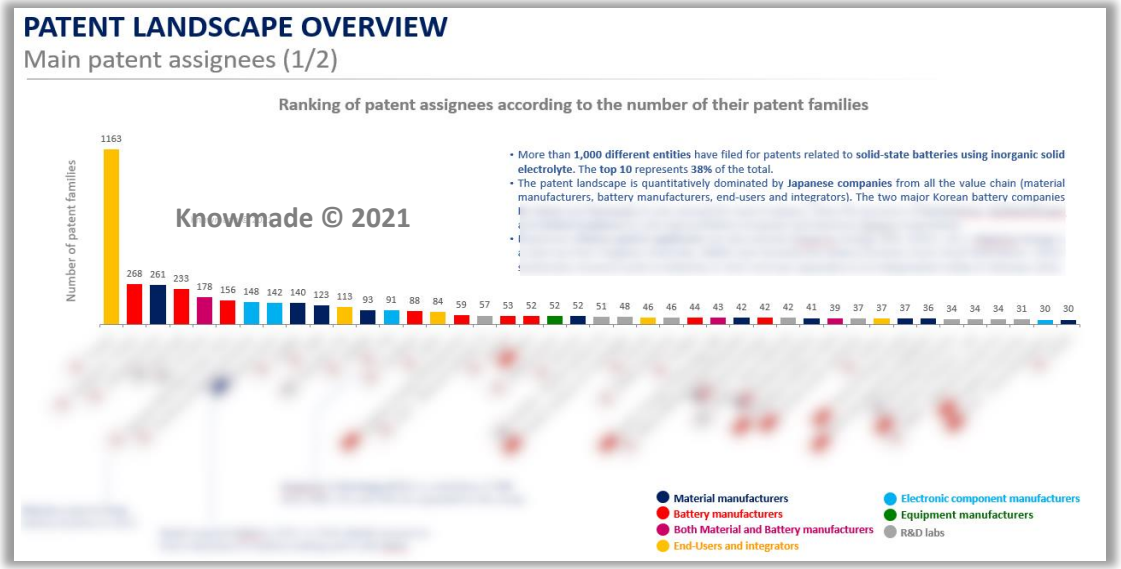
PATENT LANDSCAPE OVERVIEW

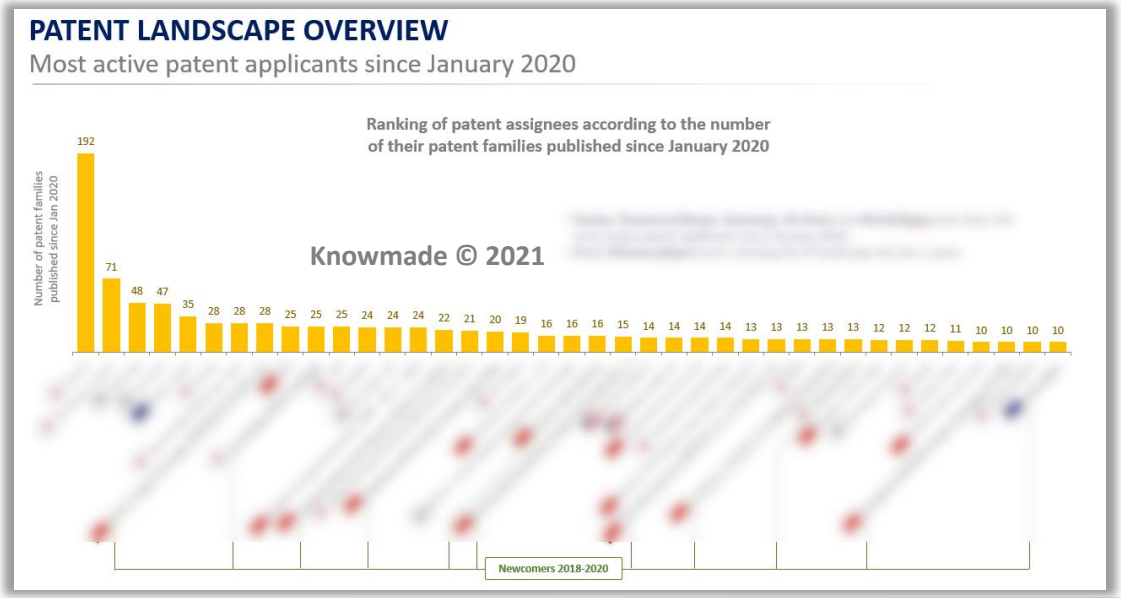
Main patent assignees - Time evolution of patent publications

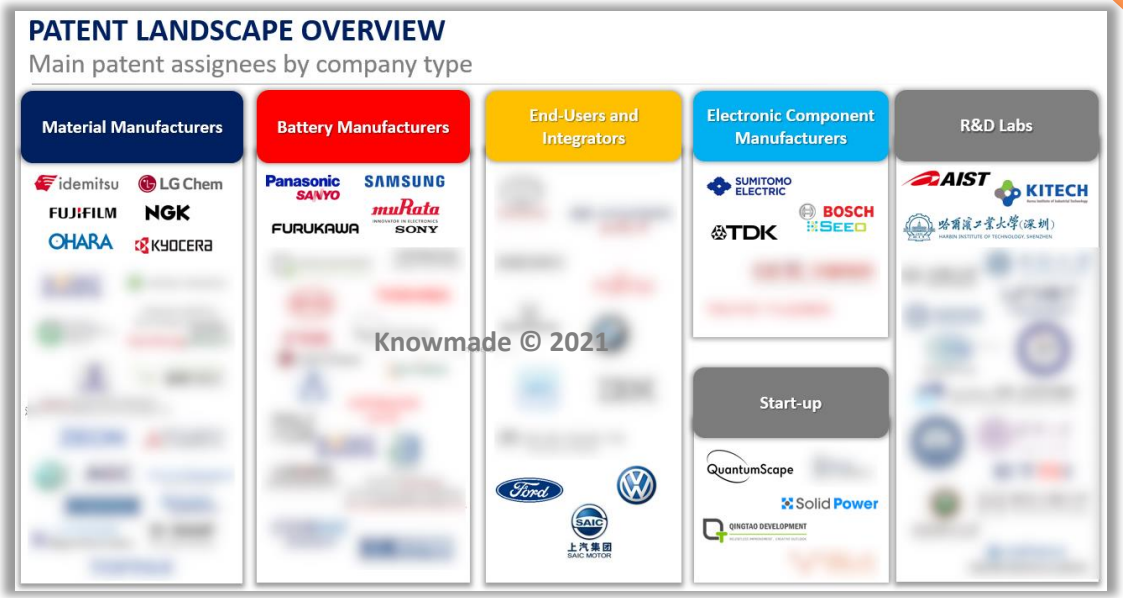


PATENT LANDSCAPE OVERVIEW

Main patent assignees





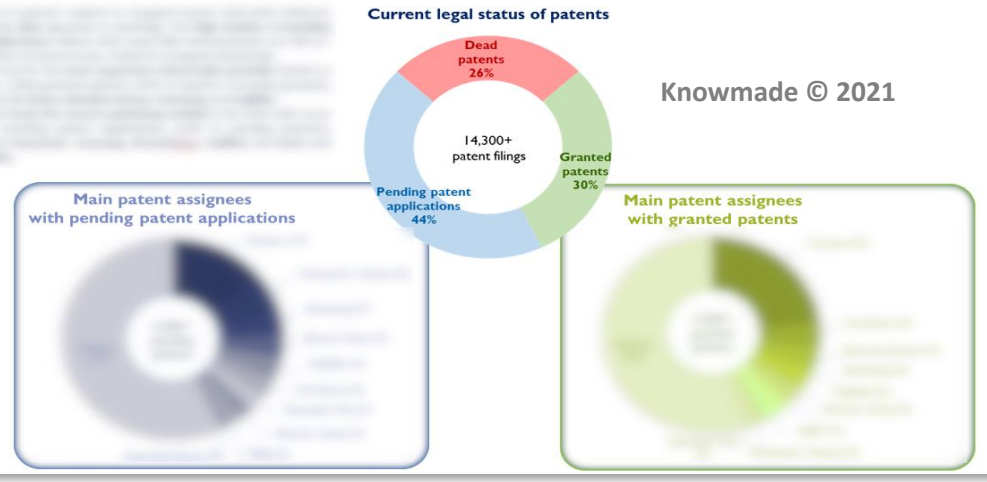


PATENT LANDSCAPE OVERVIEW

Legal status and countries of patent filings

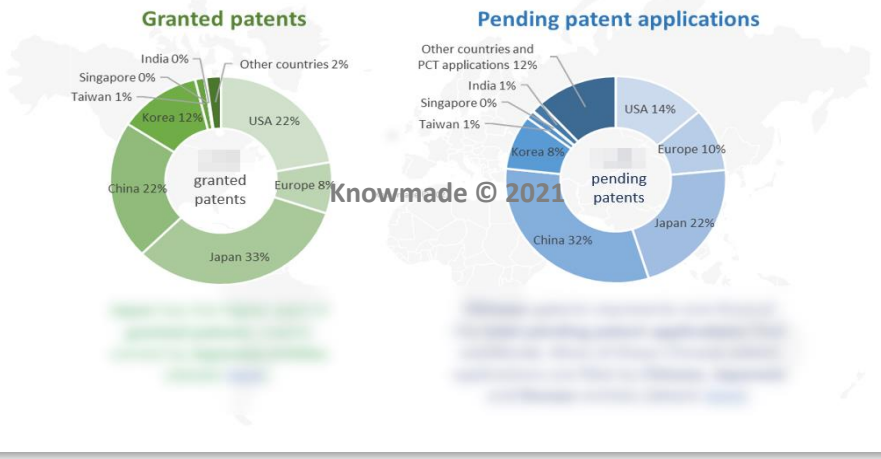
PATENT LANDSCAPE OVERVIEW

Current legal status of patents



PATENT LANDSCAPE OVERVIEW

Geographical distribution of granted patents and pending patent applications



PATENT LANDSCAPE OVERVIEW

Geographical coverage of granted patents and pending patent applications

PATENT LANDSCAPE OVERVIEW

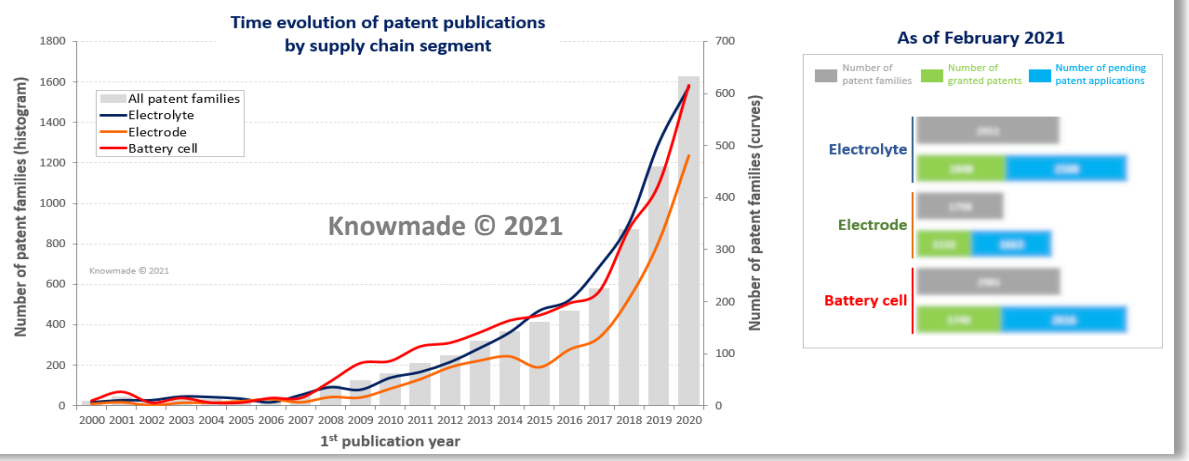
Main patent assignees – Geographical coverage of IP portfolios

PATENT SEGMENTATION BY SOLID ELECTROLYTE MATERIALS

Segmentation by supply chain segments

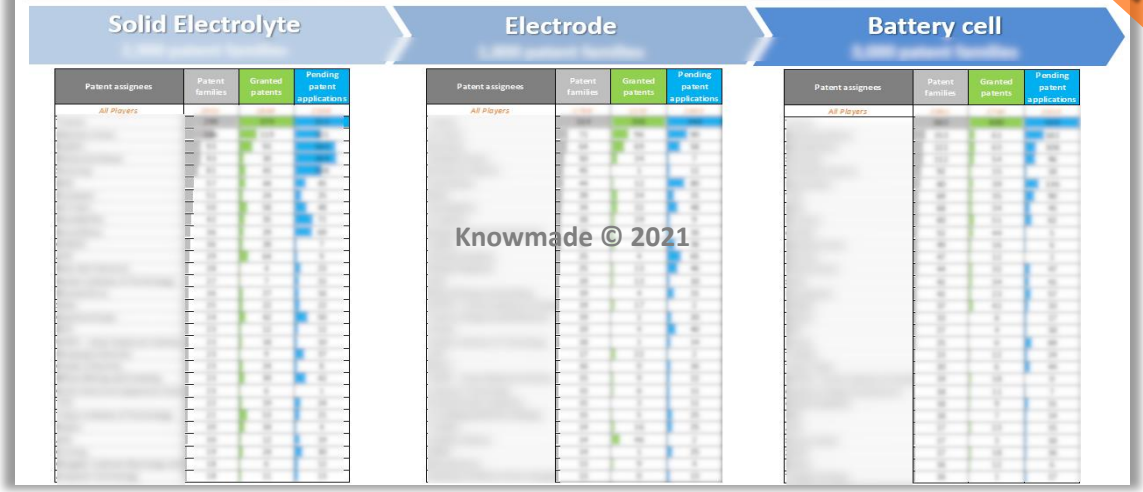
PATENT LANDSCAPE OVERVIEW

Time evolution of patent publications by supply chain segment



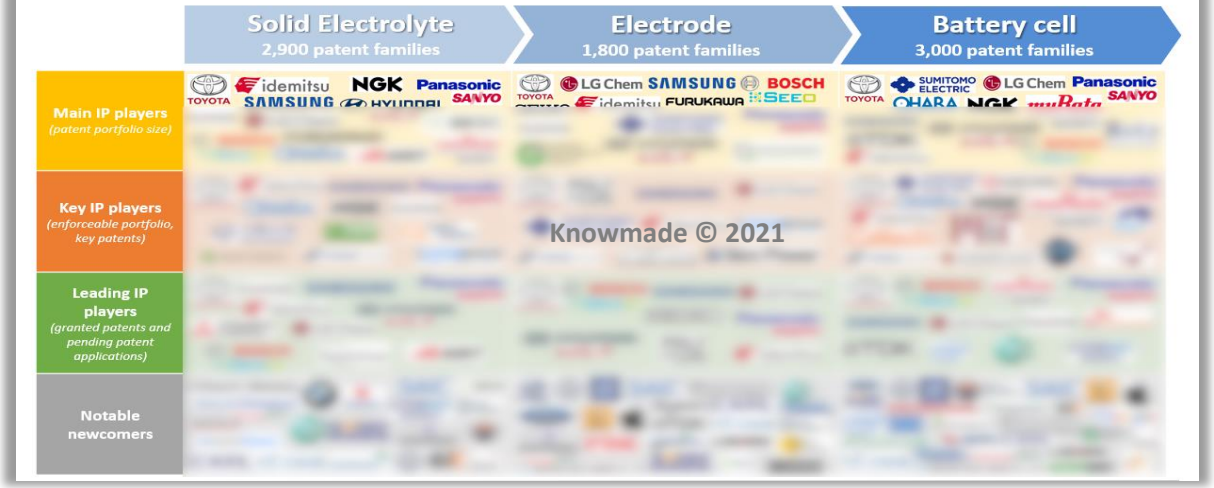
PATENT LANDSCAPE OVERVIEW

Ranking of main patent assignees by supply chain segment



PATENT LANDSCAPE OVERVIEW

Noteworthy IP players by supply chain segment



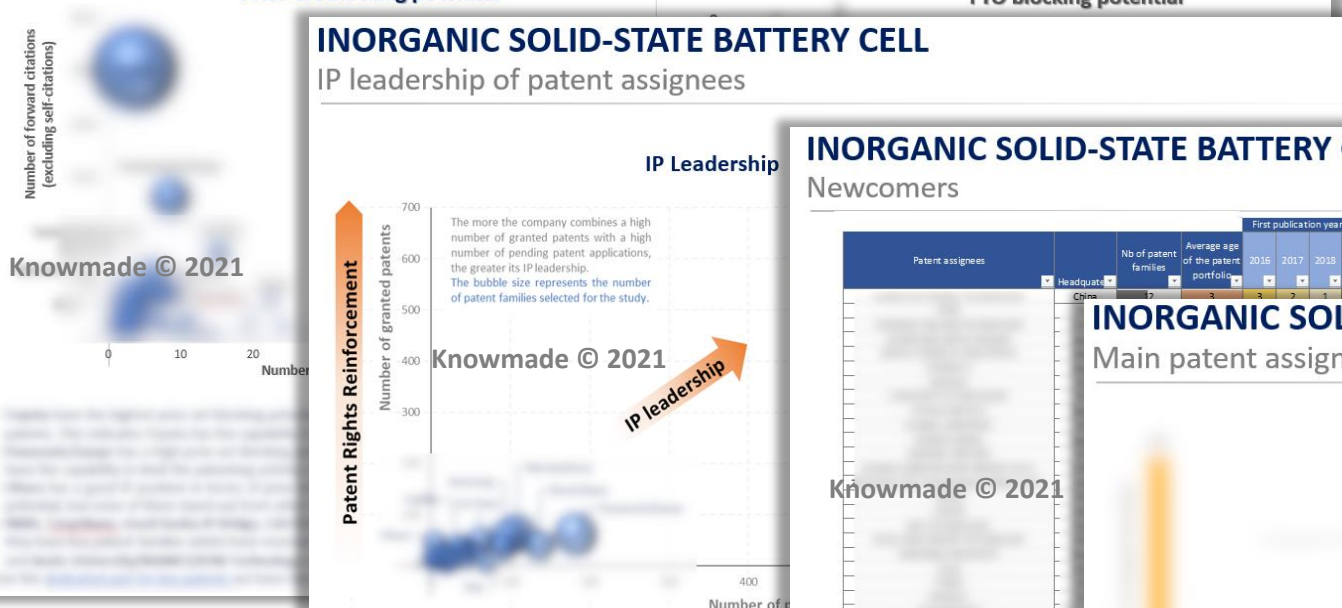
PATENT SEGMENTATION BY SOLID ELECTROLYTE MATERIALS

Detailed analysis of competitive landscape for supply chain segments

SAMPLE

INORGANIC SOLID-STATE BATTERY CELL

Key IP players



INORGANIC SOLID-STATE BATTERY CELL

IP leadership of patent assignees

INORGANIC SOLID-STATE BATTERY CELL

Newcomers

INORGANIC SOLID-STATE BATTERY CELL

Main patent assignees

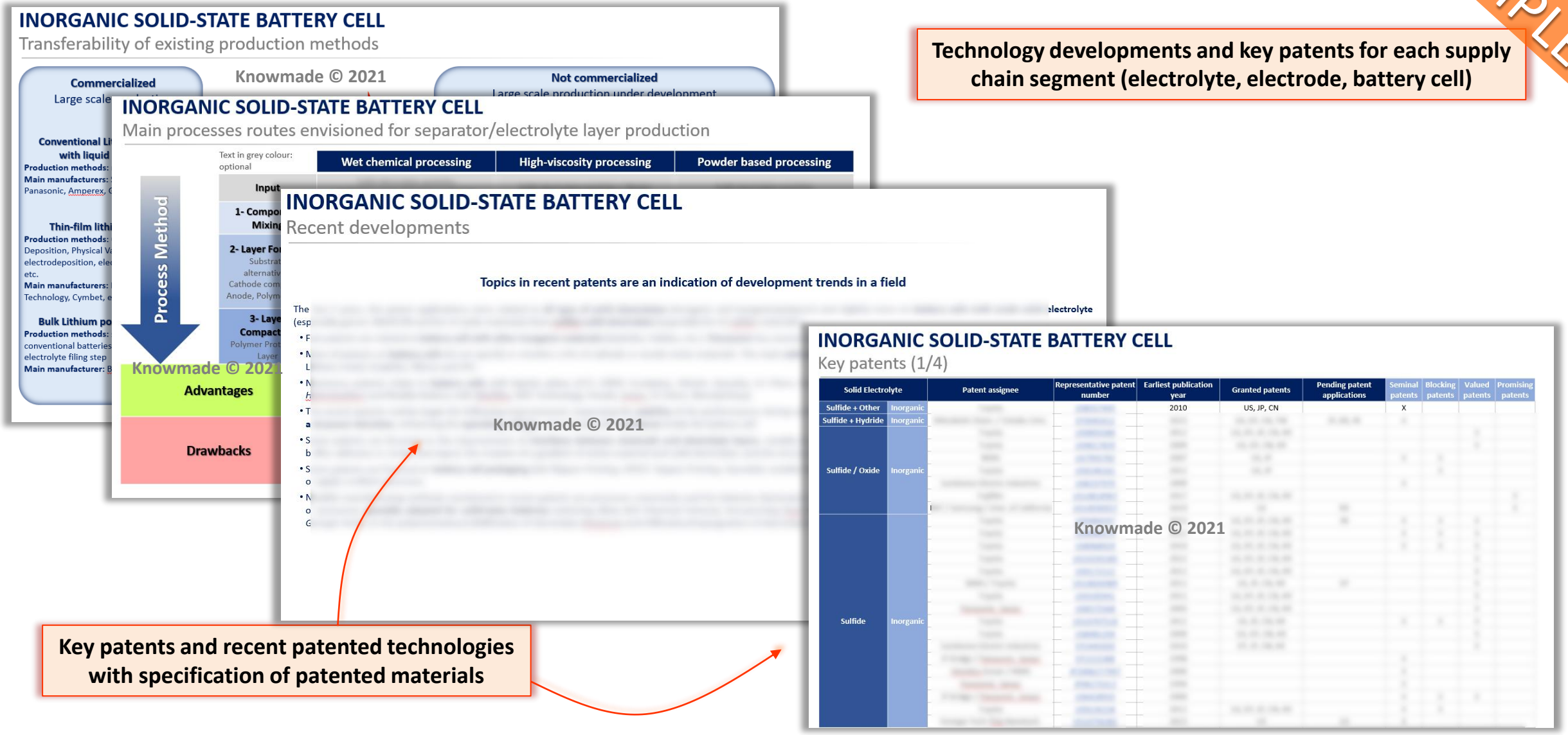
Competitive landscape: main patent assignees, key IP players and IP newcomers for each supply chain segment (electrolyte materials, electrode, eattery cell)

PATENT SEGMENTATION BY SOLID ELECTROLYTE MATERIALS

Detailed analysis of technology landscape for supply chain segments

SAMPLE

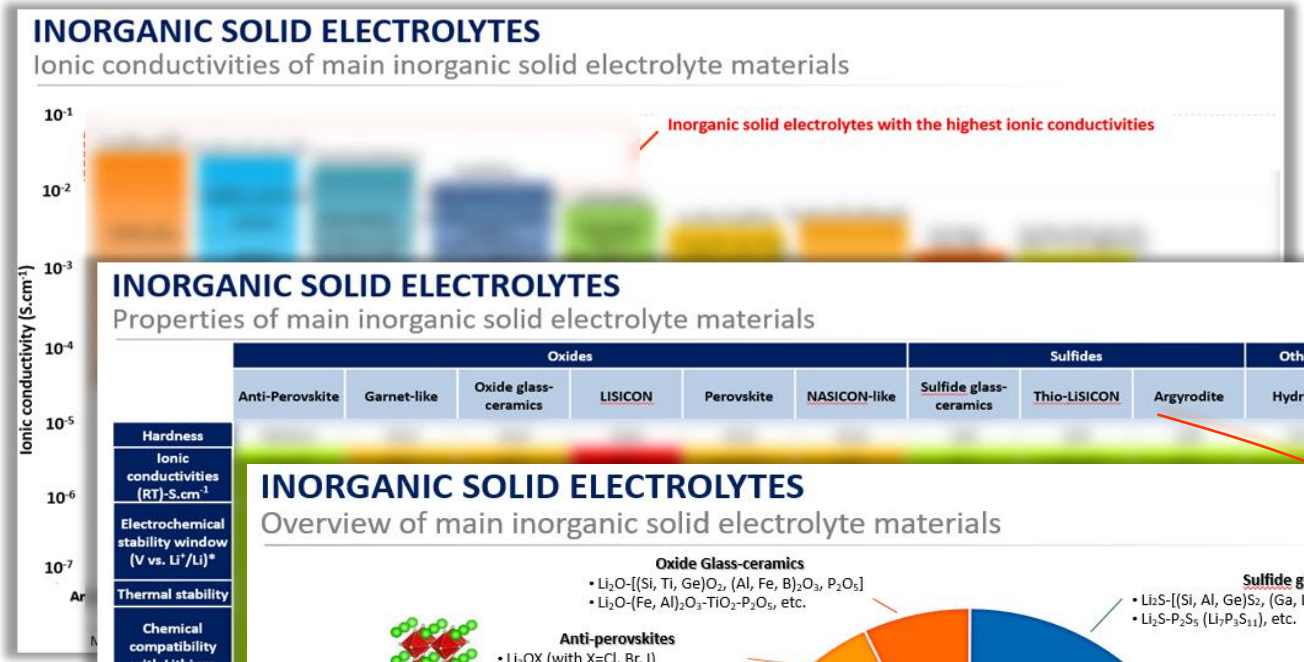
Technology developments and key patents for each supply chain segment (electrolyte, electrode, battery cell)

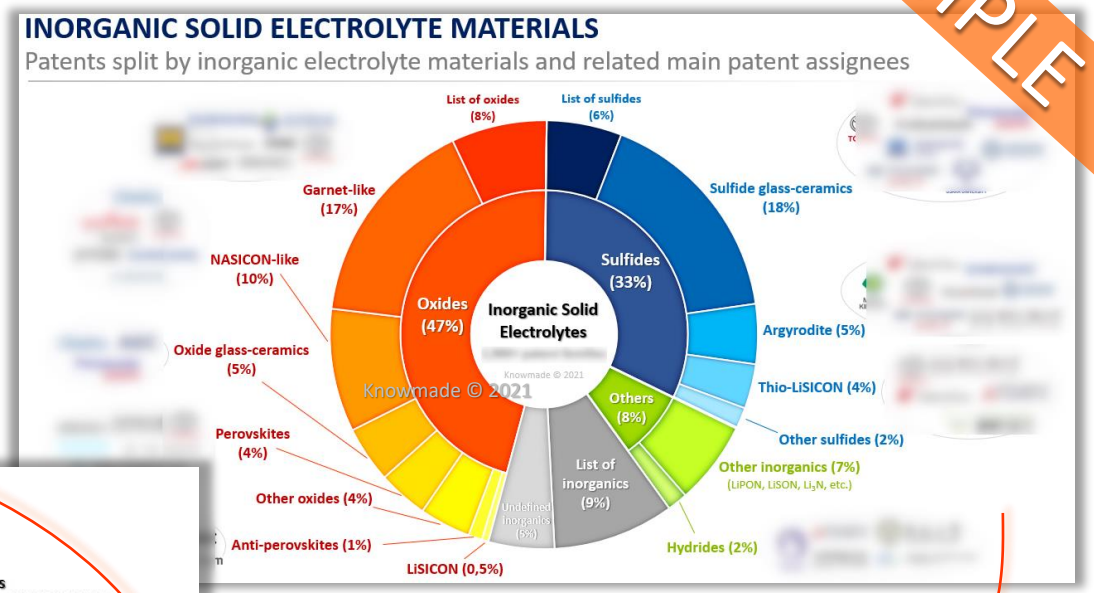


Key patents and recent patented technologies with specification of patented materials

PATENT SEGMENTATION BY SOLID ELECTROLYTE MATERIALS

Segmentation by inorganic solid electrolyte materials





Patenting activity

Categories of inorganic solid electrolytes
Properties of materials
Ionic conductivities

FOCUS ON KEY IP PLAYERS

IP profiles of key IP players

Key patents and recent technology developments

IP dynamics, patenting activity, and IP position for main patent assignees and key IP players (focus on 10+ players' IP portfolio)

Overview of players' IP strategies and IP position by supply chain segments (electrolyte materials, electrode, battery cell)

COMPANY A
Main Recent developments

COMPANY A
Key patented technologies

COMPANY A
Patent portfolio segmentation and time evolution of patent publications

Earliest year of patent family publication

Segments		Number of patent families	Number of granted patents	Number of pending patent applications	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Supply Chain	Electrolyte																							
	Electrode																							
	Battery cell																							
Type of electrolytes	Inorganic																							
	Inorganic/ Polymer																							
	List of materials																							
	Undefined solid electrolyte																							
Inorganic solid electrolyte materials	Sulfides (All)																							
	Argyrodites																							
	Sulfide glasses																							
	Thio-LISICON																							
	Other sulfides																							
	List of sulfides																							
	Oxide (all)																							
	Oxide glass ceramics																							
	Anti-perovskites																							
	Perovskites																							
	Garnet																							
	NASICON																							
	Other oxides																							
	List of oxides																							
	Hydrides																							
	Other inorganics																							
	List of inorganics																							
	Undefined inorganics																							

Note: The data corresponding to the year 2021 is not complete since the patent search was done in February 2021.

The numbers represent the numbers of p

COMPANY A
Matrix Electrolytes vs. Supply Chain

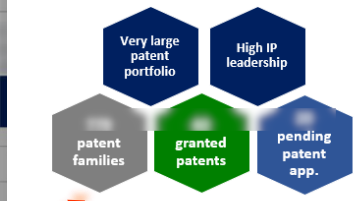
The numbers represent the numbers of patent families. A patent family can belong to multiple segments.

	All segments	Supply Chain		
		Electrolyte	Electrode	Battery cell
All patent portfolio				
Type of electrolytes: Inorganic				
Type of electrolytes: Inorganic/ Polymer				
Type of electrolytes: List of materials				
Type of electrolytes: Undefined solid electrolytes				
Inorganic solid electrolyte materials: Sulfides (All)				
Inorganic solid electrolyte materials: Argyrodites				
Inorganic solid electrolyte materials: Sulfide glasses				
Inorganic solid electrolyte materials: Thio-LISICON				
Inorganic solid electrolyte materials: Other sulfides				
Inorganic solid electrolyte materials: List of sulfides				
Inorganic solid electrolyte materials: Oxide (all)				
Inorganic solid electrolyte materials: Oxide glass ceramics				
Inorganic solid electrolyte materials: Anti-perovskites				
Inorganic solid electrolyte materials: Perovskites				
Inorganic solid electrolyte materials: Garnet				
Inorganic solid electrolyte materials: NASICON				
Inorganic solid electrolyte materials: Other oxides				
Inorganic solid electrolyte materials: List of oxides				
Inorganic solid electrolyte materials: Hydrides				
Inorganic solid electrolyte materials: Other inorganics				
Inorganic solid electrolyte materials: List of inorganics				
Inorganic solid electrolyte materials: Undefined inorganics				

COMPANY A
Main IP collaborations and transfer

Co-assignees	Number of common patent families	Representative members of patent families	Earliest publication years

COMPANY A
Patent portfolio overview

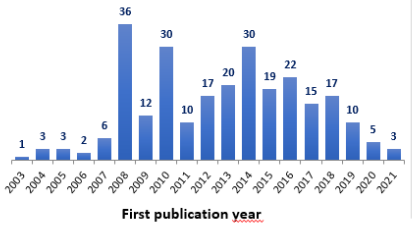


IP position by supply chain segments
(compared to other patent assignees)

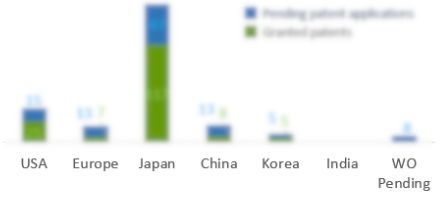
	SUPPLY CHAIN SEGMENTS		
	Electrolyte	Electrode	Battery Cell
Size of patent portfolio			
IP leadership			
Prior-art blocking potential			
FTO blocking potential			
Number of key patents			

See the methodology.

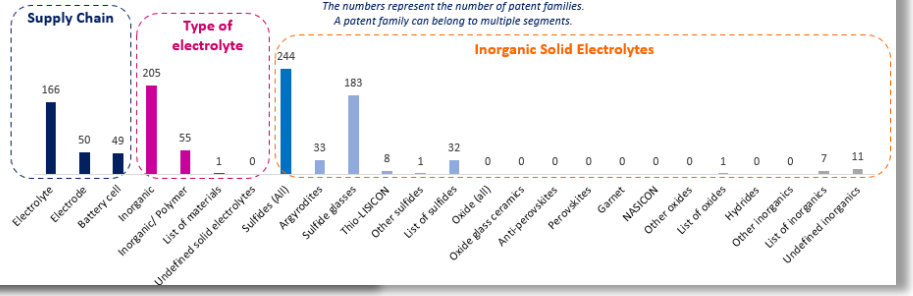
Time evolution of patent publications
The numbers represent the number of patent families



Geographic coverage of the portfolio
The numbers represent the number of patent filings



Segmentation of the patent portfolio
The numbers represent the number of patent families. A patent family can belong to multiple segments.

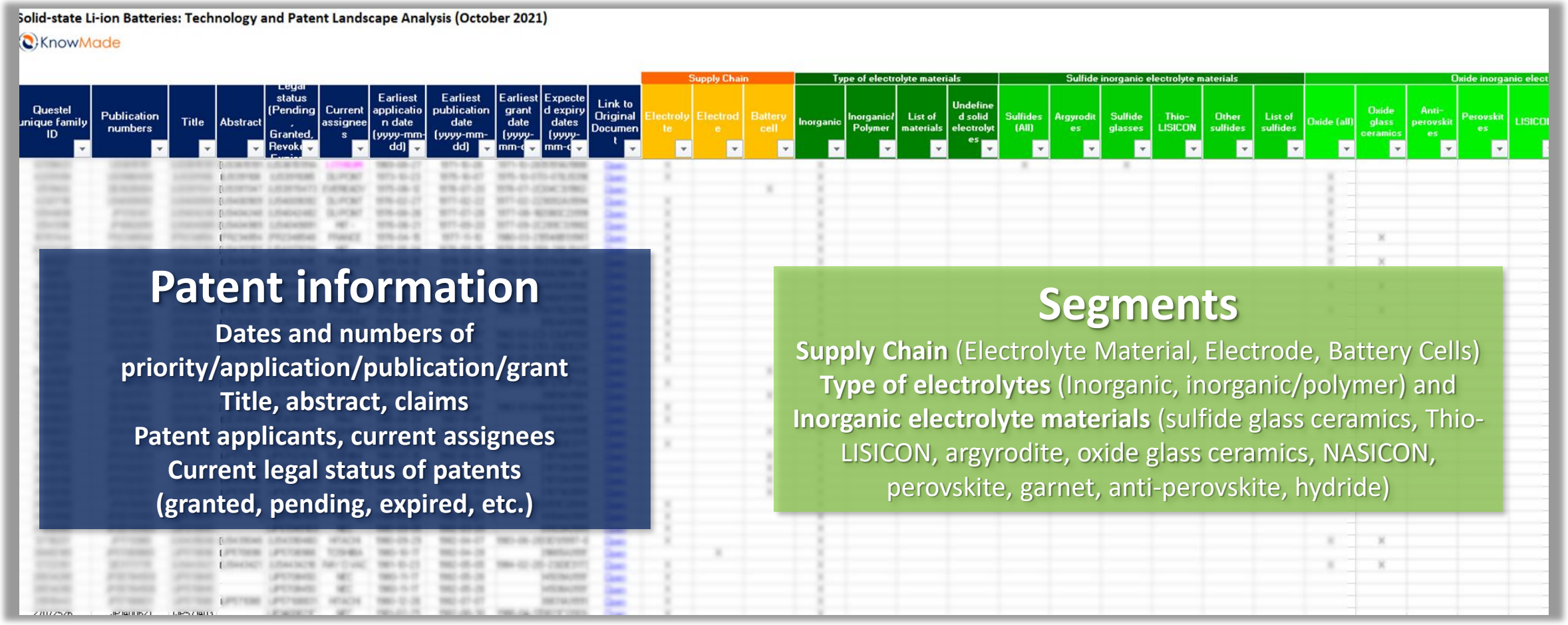


EXCEL PATENT DATABASE

Useful Excel file containing all the patents analyzed in this report with corpus segmentation

SAMPLE

This report also includes an **Excel database with the 7,300+ patent families** (inventions) analyzed in this study. This useful patent database **allows for multi-criteria searches** and includes patent publication numbers, **hyperlinks to updated online database** (original documents, legal status, etc.), priority date, title, abstract, patent assignees, patent's current legal status, and **segments** (electrolyte materials, electrodes, battery cells, inorganic, inorganic/polymer, sulfide glass ceramics, Thio-LISICON, argyrodite, oxide glass ceramics, NASICON, perovskite, garnet, anti-perovskite, hydride, etc.)



ORDER FORM

Solid-State Li-ion Batteries with Inorganic Solid Electrolyte

Patent Landscape Analysis – October 2021

Ref.:KM21005

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

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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

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RETURN ORDER BY

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

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- 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.

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Patent & Technology Intelligence

KNOWMADE PURPOSE

Turning **patents** and **scientific information** into **business-oriented report** for **decision makers** working in **R&D**, **Innovation Strategy**, **Intellectual Property**, and **Marketing**

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

KnowMade

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Patent your inventions

Assert your patents and defend your position in case of licensing/litigation

Evaluate the risks to infringe patents

Prior art search, Freedom-to-operate analysis, Patent invalidation, Evidence of use, Patent valuation

Understand, anticipate and evaluate the competitive landscape and current technology developments

Patent landscape, Monitoring service, IP due diligence

Improve your R&D and IP strategy

Identify and get access to external innovation

Technology scouting, Scientific literature analysis

KNOWMADE OFFER

Patent Landscape Analysis
to give an overview on IP dynamics, IP trends and IP players

Tailor-made analyses

Meet customer's business needs and budgetary constraints

Off-the-shelf Reports

Monitors

Patent Monitoring Service
to track current R&D activity and early detect weak signals, opportunities and risks

Monthly IP database | Quarterly report
Access to IP analysts

MAIN FIELDS OF EXPERTISE

Communication

- RF, Microwaves, mm-Waves
- RF Front End Module
- Antenna & Networks
- Digital Optic Communication (datacom, telecom, photonics)

Advanced Packaging
Innovative Materials
AI & Computing

Energy Mgt & Storage

- Power electronics
- Batteries & Fuel-cell
- Power management
- PV

MEMS, Sensors & Optoelectronics

- Micro-systems
- Sensors & Imaging
- Lighting & Display

Life Sciences & Healthcare

- MedTech
- Microfluidics
- Biotech & Pharmaceutics
- Agrifood

BATTERY

Knowmade expertise

Whole Battery Supply Chain

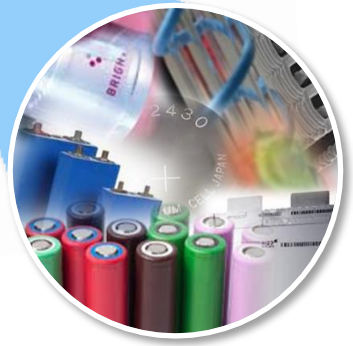
- Materials
- Components
- Battery cell
- Battery Packs (BMS, thermal management, etc)
- Recycling
- Manufacturing

Key Battery Technologies

- Lithium battery
- Ni-MH battery
- Zn-Air battery
- Lead-Acid battery
- Na-S battery
- Redox flow battery
- Li-Air battery
- Li-S battery
- Na-ion battery
- Mg-ion battery

All Battery applications

- Automotive
- Consumer
- Stationary
- Medical



All Battery Cell Designs

- Cylindrical
- Prismatic
- Flexible
- Thin film / Microbattery

BATTERY
Off-the-shelf reports

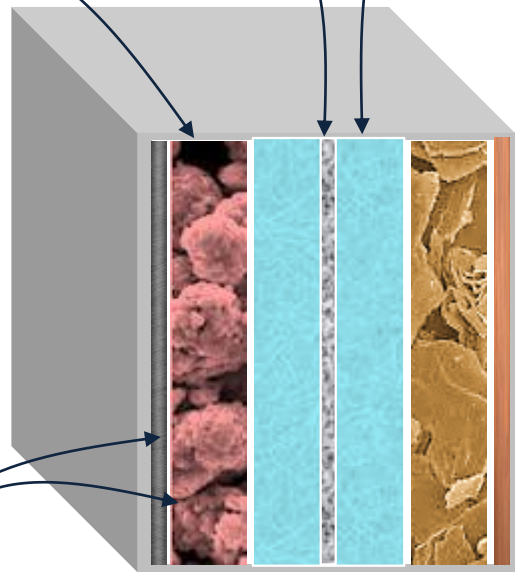
Click on the picture to access to the flyer and sample

SEPARATOR

CATHODE
NMC, NCA, LFP, LMO, etc.

REPORT

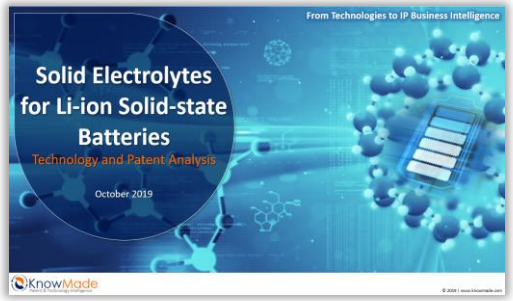
NMC Li-ion Battery (2017)



ELECTROLYTES
Liquid, gelled, solid, ionic liquids, solvents, salts, additives, etc.

REPORT

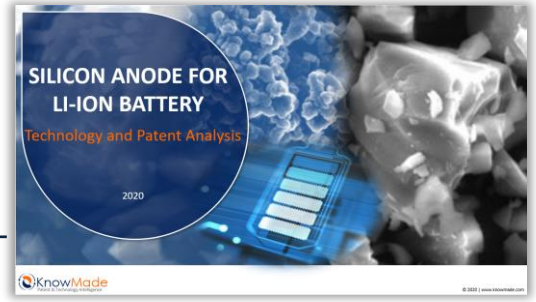
Solid Electrolytes for Li-ion Solid-State Batteries (2019)



ANODE
Graphite, Silicon, LTO, Lithium, etc.

REPORT

Silicon Anode for Li-ion Battery (2021)



Other materials:
Current collector, binder, additives, etc.

REPORT

Status of Battery Patents (2018)

Microbattery (2016)

BATTERY

Solid-State Batteries Patent Monitor (annual subscription)

CONTENTS

Quarterly IP database (up-to-date Excel file)

- New patent applications
- Patents newly granted
- Expired or abandoned patents
- Transfer of IP rights (re-assignment, licensing)
- Patent litigation & opposition
- Patent categorization by:
  - Supply Chain: Electrolyte, Electrode, Battery, Pack
  - Type of electrolyte materials: Inorganic, Inorganic/polymer, Polymer
  - Inorganic electrolyte materials: Sulfide Glass Ceramic, Thio-LISICON, Argyrodite, Oxide Glass Ceramic, NASICON, Garnet, Perovskite, Anti-Perovskite, LISICON, Hydride, etc.

Quarterly IP report (PDF slide deck)

On a quarterly basis, this report will provide the IP trends over the three last months, with a close look to key IP players and key patented technologies.

Access to an IP analysts (100 hours per year)

Q&A session and discussion with our IP analysts regarding trends, analyses, specific patented technologies or company's IP portfolio in the field Solid-State Batteries.

Flyer and samples: www.knowmade.com/downloads/solid-state-batteries-patent-monitor/

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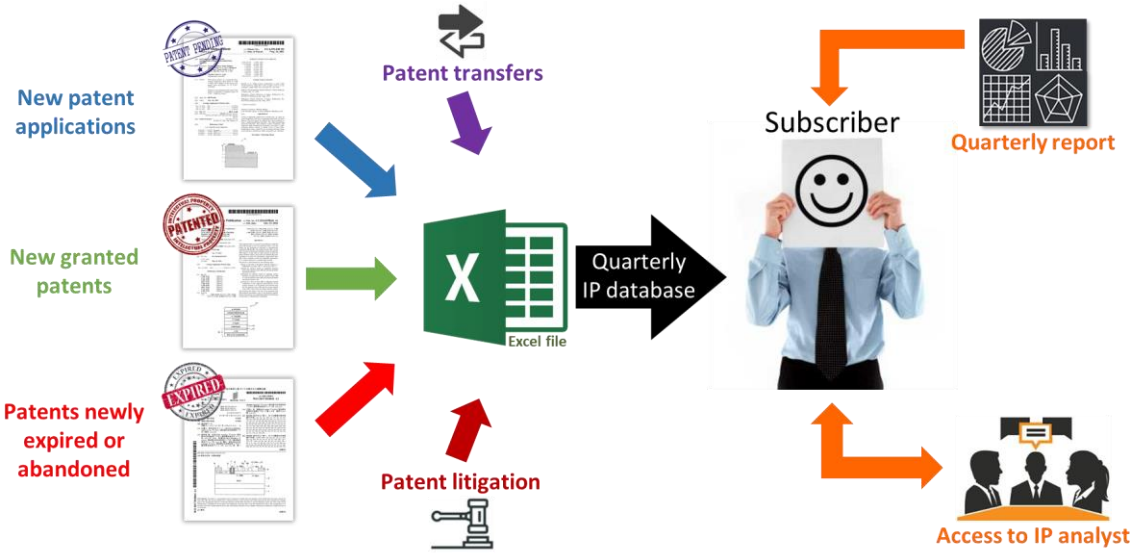

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