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# MICROBATTERY

## Patent Landscape Analysis

*September 2016*



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Web: <http://www.knowmade.com>



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**PATENT LITIGATION** **58**

**IP PROFILE OF KEY PLAYERS** **60**

- Cymbet
- PolyPlus Battery
- Panasonic
- Infinite Power Solutions
- Front Edge Technology
- CEA
- Johnson Battery Technologies
- I-TEN
- Applied Materials
- ST Microelectronics

- For each player:
- Company presentation
  - Summary of the patent portfolio
  - Key patents

**PATENT SEGMENTATION**

- Mapping of Key Players for Battery Technologies and Applications
- Mapping of Key Players for Battery Components
- Mapping of Key Players for Types of claims and Process methods
- Matrix Main Patent Assignees v.s. Technical Segments

- Focus on key segments:**
- Type of claimed invention
  - Battery technologies
  - Battery designs
  - Battery components (electrodes, electrolytes, barrier layers, packaging, non-active parts)
  - Process methods (sputtering, evaporation, CVD, PVD, ALD, spraying, printing electrodeposition ...)
  - Apparatus*

- For each segment:
- Main patent assignees
  - Time evolution of patent applications
  - Technology evolution
  - Most cited patents

**CONCLUSION** **197**

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*We Know Technology, We Know Patents*

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# INTRODUCTION

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# INTRODUCTION

## Scope of the Report

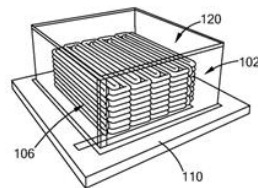
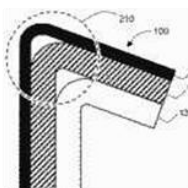
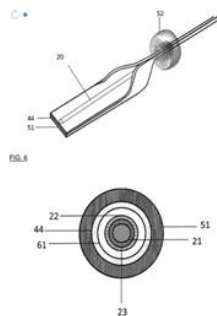
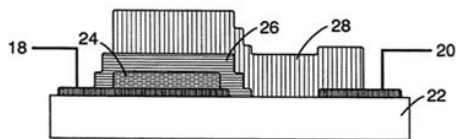
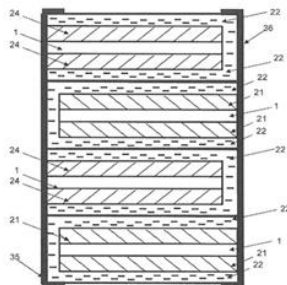
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- This report provides a detailed picture of the patent landscape for **Microbattery Technologies** (micro-batteries and solid thin film batteries).
- This report covers **patents published worldwide up to May 2016**.
- We have selected and analyzed more than **3,000 patents and patent applications** (900+ patent families) relevant to the scope of this report.

### Included in the report

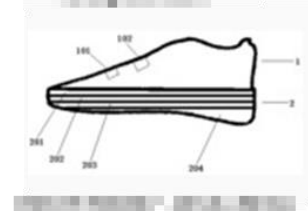
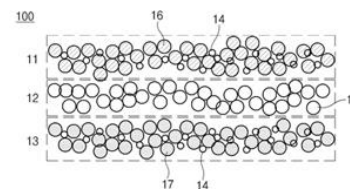
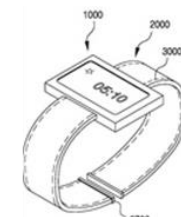
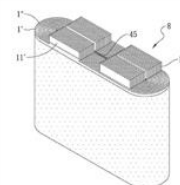
- Patents related to **micro-batteries** and **solid thin film batteries**.

Micro-scaled in at least one dimension



### Not included in the report

- Patents mentioning micro-battery or solid thin film battery **as a part of a device without describing its manufacture**.
- Patents on electrodes or electrolytes in which their **specific use in micro-batteries or solid thin film batteries is not described**.
- Patents related to thin film batteries with **liquid electrolytes** and solid batteries **without 3D** or thin film electrodes and a thin layer of electrolyte.





# INTRODUCTION

## Key Features of the Report (1/2)

- The report provides essential patent data for Micro-Batteries and Solid Thin Film Batteries.
- It identifies more than 20 major patent holders and it provides in-depth IP analysis of key technical segment and key players including:
  - Time evolution of patent publications and countries of patent filings.
  - Current legal status of patents.
  - Ranking of main patent applicants.
  - Joint developments and IP collaboration network of main patent applicants.
  - Key patents.
  - Granted patents near expiration.
  - Relative strength of main companies IP portfolio.
  - Matrix applicants/technology issues for more than 20 companies.
- The Micro-batteries IP profile of 10 major companies is presented, including key patents, recent patented technologies, technological issues, partnerships, last market news.

# INTRODUCTION

## Key Features of the Report (2/2)



- The report provides an extensive Excel database with all patents analyzed in the report.

This useful patent database allows multi-criteria searches:

- Patent publication number
  - Hyperlinks to the original documents
  - Priority date
  - Title
  - Abstract
  - Patent Assignees
  - Segmentation
  - Legal status for each member of the patent family
- 
- 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.

# INTRODUCTION

## Objectives of the Report

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### Objectives of this patent landscape is to:

- ✓ Understand the IP landscape for Micro-batteries.
- ✓ Identify key patents.
- ✓ Understand trends in Micro-batteries IP and future technological choices.
- ✓ Identify the major IP players in Micro-batteries and the relative strength of their patent portfolio.
- ✓ Identify newcomers in Micro-batteries.
- ✓ Identify IP collaboration networks between key players.
- ✓ Identify main patent litigations.



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# METHODOLOGY

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# METHODOLOGY

## Patent Search, Patent Selection, Patent Analysis (1/2)



- The data were extracted from the **FamPat worldwide database** (Questel-ORBIT) which provides 80+ million patent documents from 95 offices.
- The search for patent was performed in **May 2016** hence patents published after this date will not be available in this report.
- The patents were grouped by **patent family**. 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.
- The selection of the patents has been done both automatically and manually (all details in next slides).

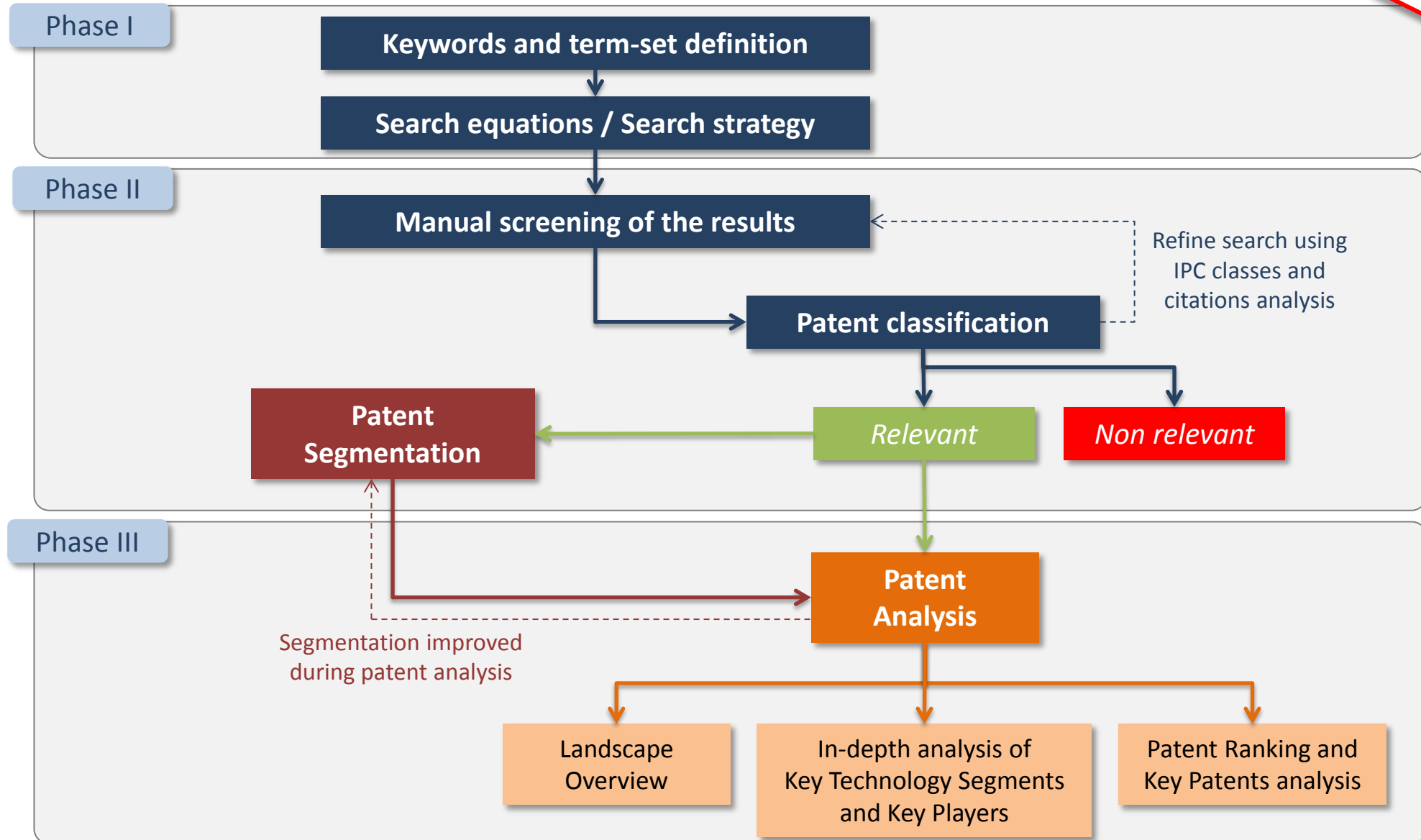
Number of selected patent families for the Micro-batteries IP Investigation:  
912 over a number of returned results > 6,600

- The statistical analysis was performed with **Orbit IP Business Intelligence web based patent analysis software from Questel**.
- The patents were **manually categorized in technical segments** using keyword analysis of patent title, abstract and claims, in conjunction with expert review of the subject-matter of inventions (all details in next slides).
- For legal status of European (EP) and PCT (WO) patent applications, EPO Register Plus has been used. For legal status of US patents, USPTO PAIR has been used. For legal status of other patents, information have been gotten from their respective national registers.

# METHODOLOGY

## Patent Search, Patent Selection, Patent Analysis (1/2)

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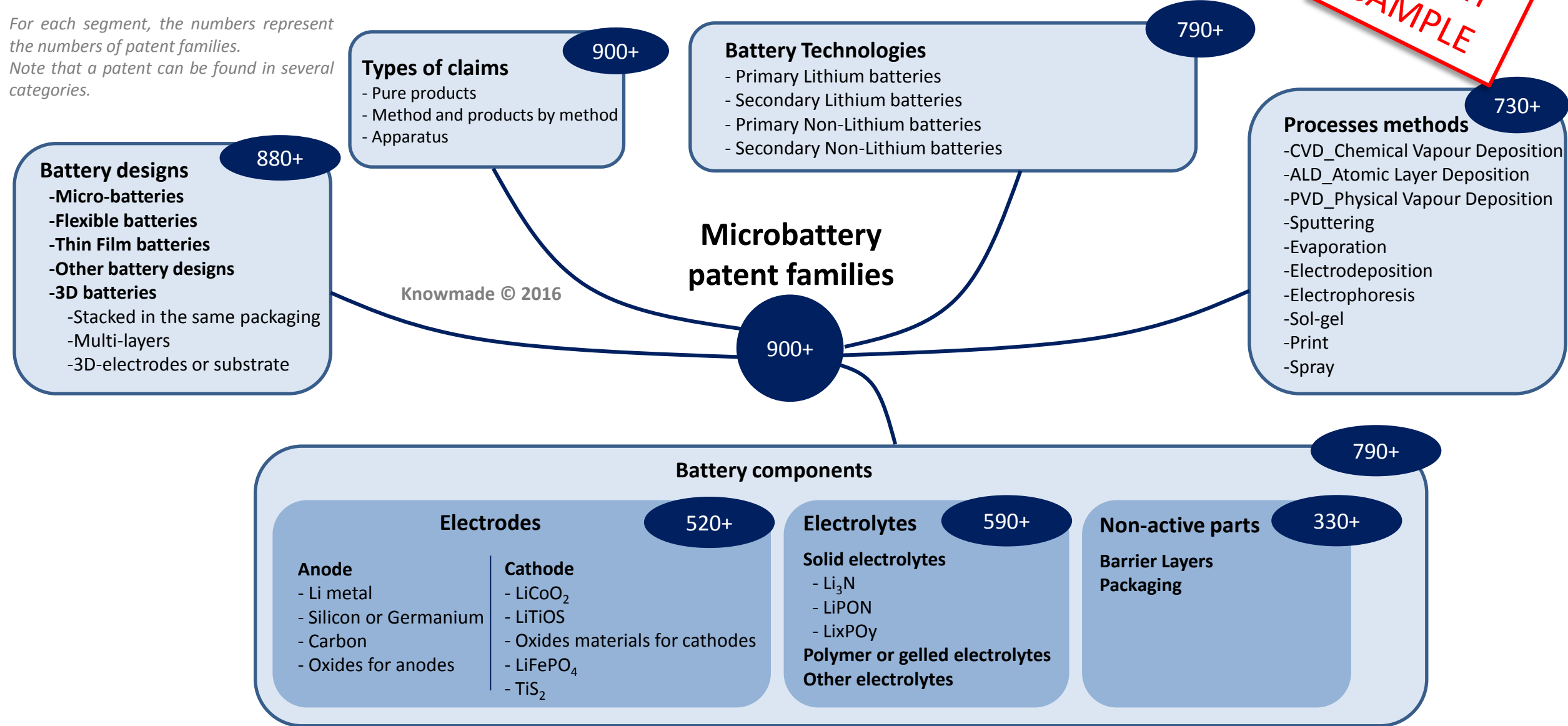


# METHODOLOGY

## Patent Segmentation

For each segment, the numbers represent the numbers of patent families.

Note that a patent can be found in several categories.



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# NOTEWORTHY NEWS

- ❖ **2016, I-TEN** raised 10M€ from **Innovacom Gestion** , **Demeter Partners** and **Rhone-Alpes Creation Viveris Venture**. The company raised 3.2M€ in 2014.
- ❖ **2016, Cymbet Corporation** announced that it has completed a recapitalization and restructuring of the company in connection with a \$10 million-plus equity investment led by Dallas, TX-based **Island Shore Investments (ISI)**. This significant investment and restructuring will fund the production and introduction of new products and provide additional working capital to expand Cymbet’s business in key markets. The announced financing is the first part of a two-part funding round, the second portion totalling \$5-7 million, which is to be completed in the first half of 2016.
- ❖ **2016, CEA-LETI** joined the **Stanford System X Alliance** and signed a new agreement with **Intel** to develop microelectronic components.
- ❖ **2016, Philips** announced that it will commercialise 5 connected devices for health applications.
- ❖ **2016, STMicroelectronics** acquired assets on RFID and NFC from **AMS** group.
- ❖ **2016, Fraunhofer IZM** opens a new microbattery prototype fabrication line based on precision screen-printing. Current developments at the Fraunhofer IZM reach a minimum size of 2 x 2 mm<sup>2</sup> with a diameter of only 2 mm and a thickness of 200 µm.
- ❖ **2015, Dyson** acquired **SAKTI3**, an American start-up incorporated in 2007 as a spin-off from **University of Michigan**.
- ❖ **2015**, a patent on “Contact lenses with hybrid power sources” filed by **Google** was published (WO2015137937).

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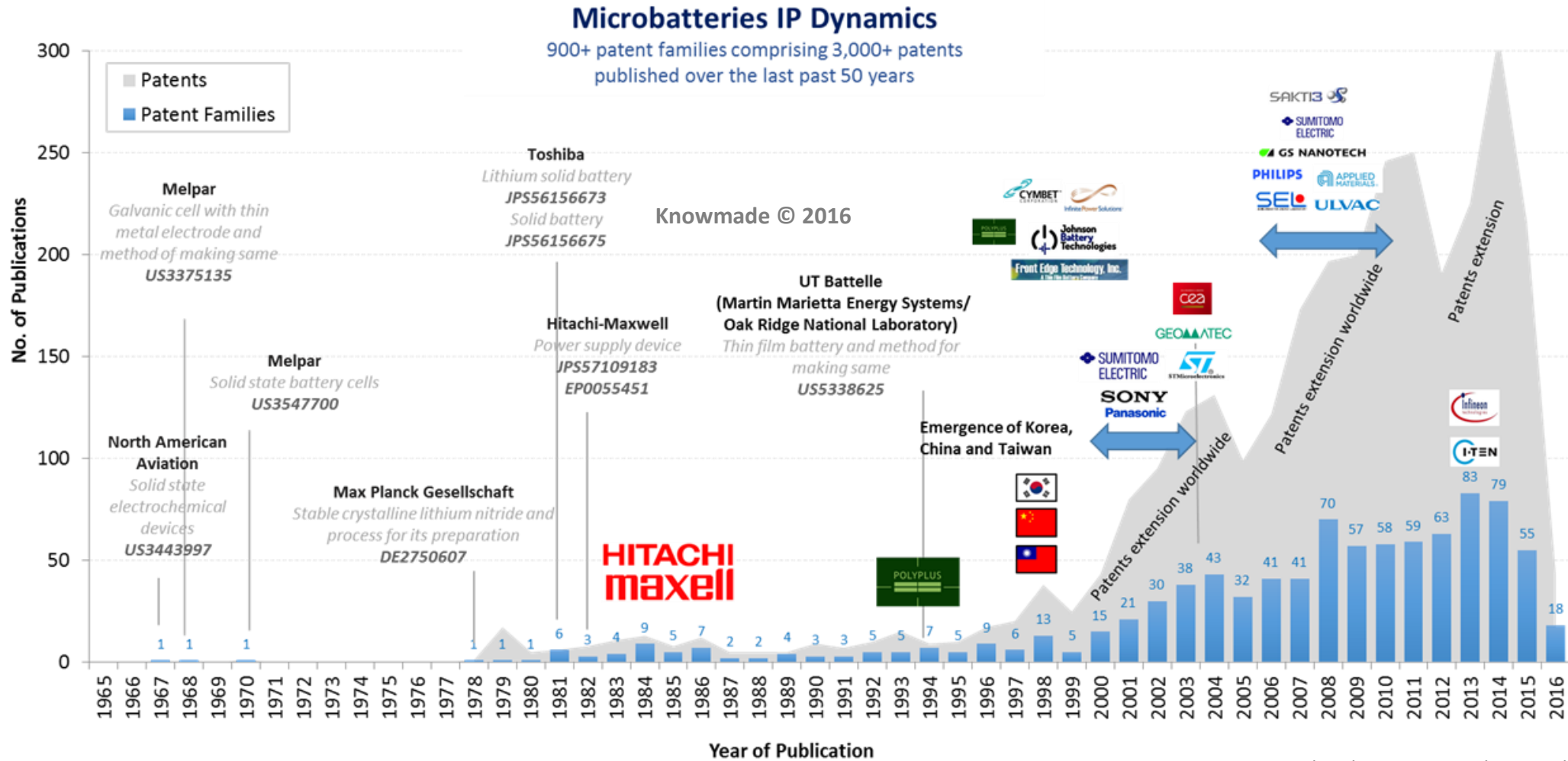
# PATENT LANDSCAPE OVERVIEW

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# PATENT LANDSCAPE OVERVIEW

## Time Evolution of Patent Publications

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Note: The data corresponding to the year 2016 is not complete since the patent search was done in May 2016.

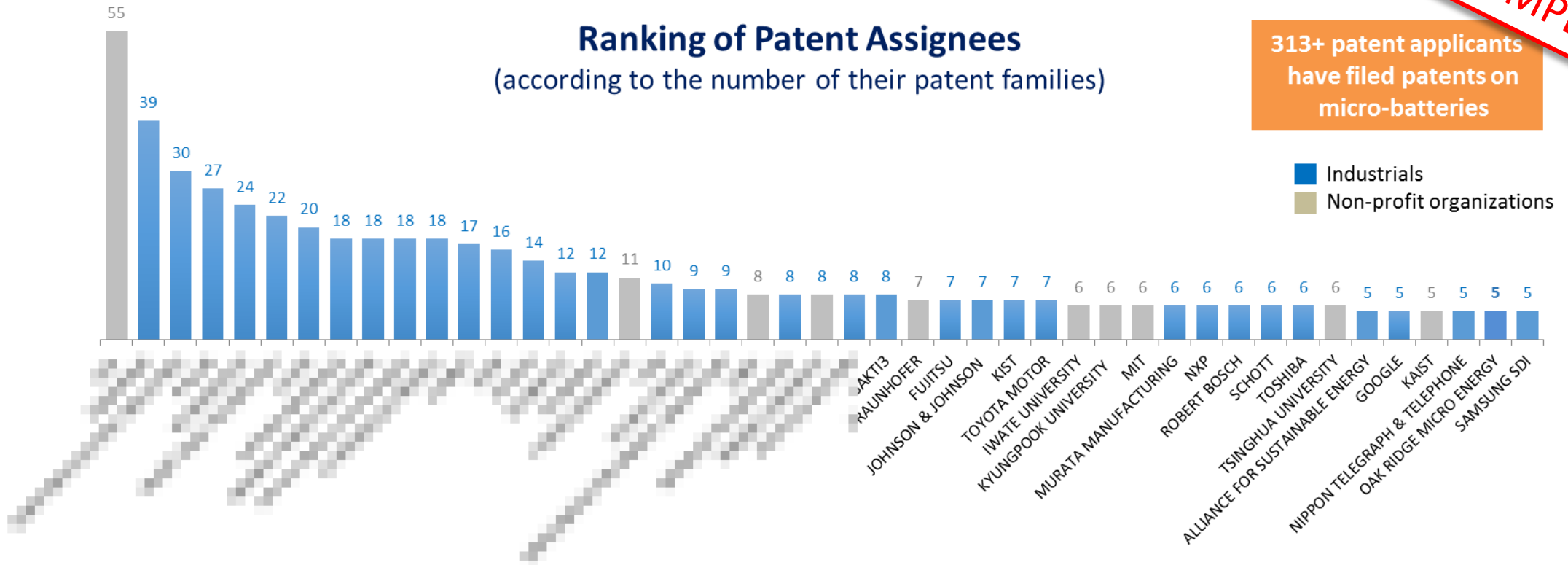
# PATENT LANDSCAPE OVERVIEW

## Main Patent Assignees

**REPORT SAMPLE**

**Ranking of Patent Assignees**  
(according to the number of their patent families)

313+ patent applicants have filed patents on micro-batteries



- GS Nanotech is part of GS Energy since 2012. GS Energy Corporation is a Korea-based company founded in 2012 to gather technological subsidiaries of GS Holding.
- Johnson Battery Technologies was spun-off from Excellatron Solid State in 2011. Excellatron Solid State, Johnson R&D and Johnson Battery Technologies, all belonging to Dr Lonnie Johnson have been gathered under the name "Johnson Battery Technologies".
- Oak Ridge National Laboratories (ORNL) on the electrolyte Lithium Phosphorus Oxynitride (LiPON).
- [Redacted] red and absorbed by Apple in 2013.
- [Redacted] 2007 and acquired by Dyson in 2015.
- [Redacted] ivision.



# PATENT LANDSCAPE OVERVIEW

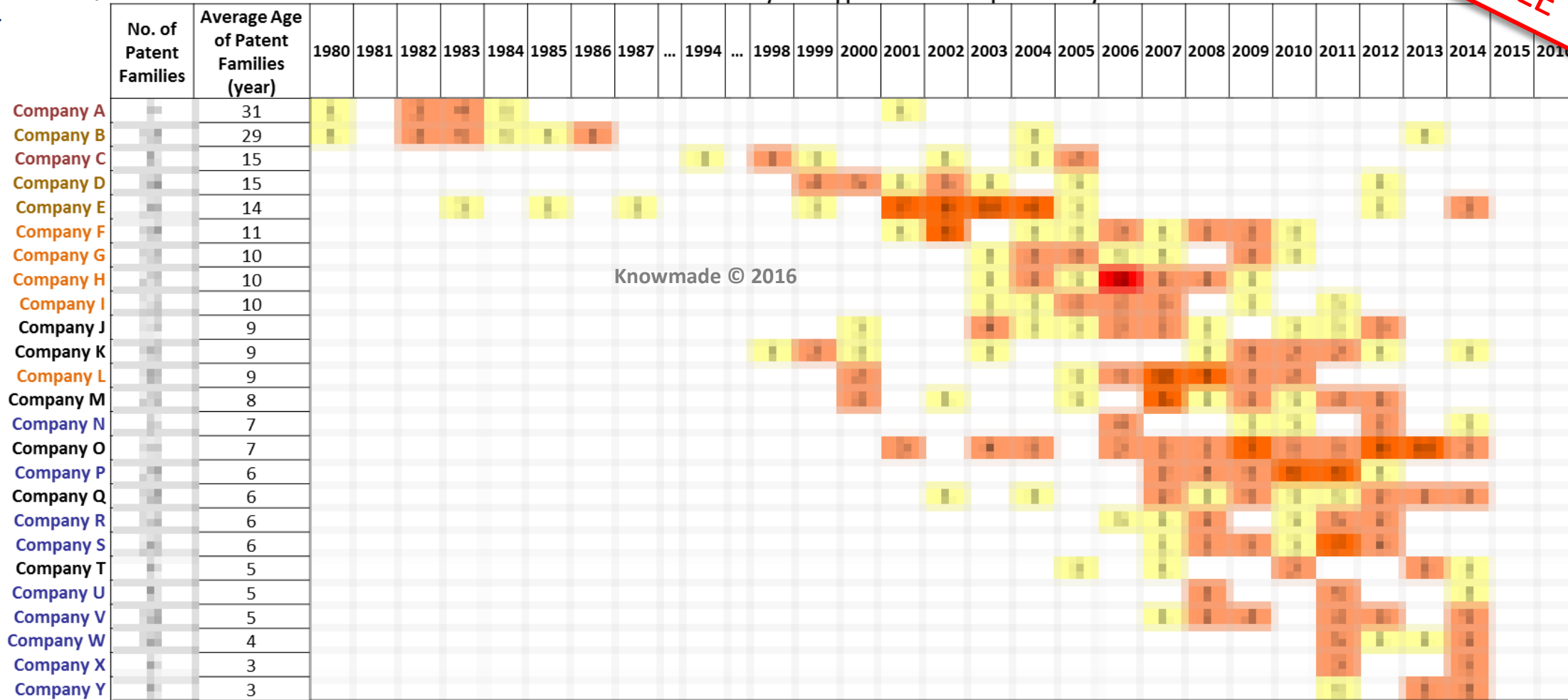
## Time Evolution of Patent Assignees

REPORT SAMPLE

For each year, the numbers represent the numbers of patent families.

Ranking ↘

Earliest year of application for each patent family



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Last patent applications before 2005  
Slowing patent applications since 2005  
No patent application since 2010  
First patent application after 2005

Note: The data corresponding to the year 2014, 2015 and 2016 may not be complete since most patents filed during these years are not published yet.

# PATENT LANDSCAPE OVERVIEW

## Countries of Patent Filing for Main Patent Assignees

Countries are defined by the country code from the patent numbers. The number represents the number of published patent families. Note that PCT (Wo) and EP applications may hide other countries that are not visible.

**REPORT SAMPLE**

	N° Patent families	USA	Japan	China	Korea	Taiwan	European applications (EP)	Germany	France	PCT applications (WO)
		50	35						53	35
		4							6	4
NINGBO UNIVERSITY	8									
		18	38							11
		19	17							27
		12	16							8
HITACHI	14	4	13							1
		1	9							
		5	29							3
ULVAC	20	1	20							3
		1	11							2
		3	2							2
		9	8							11
		8	9							2
		15	4						9	
INFINEON TECHNOLOGIES	8	8	1							1
		11	10							16
		21	2							15
		15	3							17
		14	10							12
		17	12							14
		7	7						10	10
		8	6							7
SAKTIS	8	7	2							3

### Non-profit organizations

CEA has a... contrary to... and CNRS... their original...

... microbattery IP players, Infinite Power Solutions. ... plan to outsource the...

### Equipment suppliers and component makers

They mainly file patents... have production factories... which files its patents... become one of the battery factories equ...

### Pure play microbattery companies

... applications, Front Edge Battery Technology seem... Cymbet, Infinite Power lyplus Battery adopted a...

# PATENT LANDSCAPE OVERVIEW

## Mapping of Main Current Patent Holders


REPORT SAMPLE


Number of patent families\* containing **granted patents** in the corresponding country.

\* A patent family is a set of patents filed in multiple countries by a common inventor(s) to protect a single invention.


PANASONIC		6

SAMSUNG		4

SONY		8

CYMBET		7

CEA		9

HONGFUJIN PRECISION INDUSTRY		4

USA  
484 patent families

Europe  
260 patent families

269 patent families

Korea

Japan  
442 patent families

China  
307 patent families

Taiwan  
62 patent families

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# PATENT LANDSCAPE OVERVIEW

## Patent Portfolio Summary of Main Patent Assignees

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Patent Applicants	No. of patent families	Oldest priority year of the patent portfolio	Earliest publication year	No. of patent families filed / year (average)	No. of granted patents	No. of pending patents	No. of dead patent families	Average age of patent families (Year)	Number of patent families containing granted patents in the corresponding country					Number of patent families containing pending patents in the corresponding country						
									USA	Europe	Japan	Korea	China	USA	Europe	Japan	Korea	China	PCT (WO)	
Company A	15	2008	2010	1.5	12	18	1	10.5	2	1	1	1	1	3	2	1	1	1	1	1
Company B	12	2005	2006	1.2	8	15	2	9.5	1	1	1	1	1	2	1	1	1	1	1	1
Company C	18	2009	2011	1.8	15	22	3	11.0	3	2	2	2	2	4	3	2	2	2	2	2
Company D	14	2007	2008	1.4	10	17	2	10.0	2	1	1	1	1	3	2	1	1	1	1	1
Company E	16	2006	2007	1.6	13	20	3	10.5	2	2	2	2	2	4	3	2	2	2	2	2
Company F	11	2008	2009	1.1	7	14	1	10.0	1	1	1	1	1	2	1	1	1	1	1	1
Company G	13	2007	2008	1.3	9	16	2	10.0	2	1	1	1	1	3	2	1	1	1	1	1
Company H	17	2009	2010	1.7	14	21	3	11.0	3	2	2	2	2	5	4	3	3	3	3	3
Company I	10	2006	2007	1.0	6	13	1	9.5	1	1	1	1	1	2	1	1	1	1	1	1
Company J	14	2008	2009	1.4	11	18	2	10.5	2	1	1	1	1	3	2	1	1	1	1	1
Company K	12	2007	2008	1.2	8	15	2	10.0	1	1	1	1	1	2	1	1	1	1	1	1
Company L	15	2009	2010	1.5	12	19	3	10.5	2	2	2	2	2	4	3	2	2	2	2	2
Company M	11	2006	2007	1.1	7	14	1	9.5	1	1	1	1	1	2	1	1	1	1	1	1
Company N	13	2008	2009	1.3	10	17	2	10.0	2	1	1	1	1	3	2	1	1	1	1	1
Company O	16	2007	2008	1.6	13	20	3	10.5	3	2	2	2	2	5	4	3	3	3	3	3
Company P	14	2009	2010	1.4	11	18	2	10.5	2	2	2	2	2	4	3	2	2	2	2	2
Company Q	12	2006	2007	1.2	8	15	2	10.0	1	1	1	1	1	2	1	1	1	1	1	1
Company R	10	2011	2013	2.5	9	54	0	3.8	0	6	0	0	0	7	10	7	7	7	7	3
Company S	9	1980	1982	0.3	0	0	9	31.4	0	0	0	0	0	0	0	0	0	0	0	0
Company T	9	2006	2007	1.0	20	14	0	7.0	5	0	3	3	2	4	2	5	1	1	1	1
Company U	8	2005	2007	0.8	4	9	2	5.4	1	3	0	0	0	2	3	0	0	0	0	0
Company V	11	2008	2009	1.1	7	14	1	9.5	1	1	1	1	1	2	1	1	1	1	1	1
Company W	13	2007	2008	1.3	10	17	2	10.0	2	1	1	1	1	3	2	1	1	1	1	1
Company X	15	2009	2010	1.5	12	19	3	10.5	3	2	2	2	2	5	4	3	3	3	3	3
Company Y	12	2006	2007	1.2	8	15	2	10.0	1	1	1	1	1	2	1	1	1	1	1	1
Company Z	14	2008	2009	1.4	11	18	2	10.5	2	2	2	2	2	4	3	2	2	2	2	2

# PATENT LANDSCAPE OVERVIEW

## Most Cited Granted Patents

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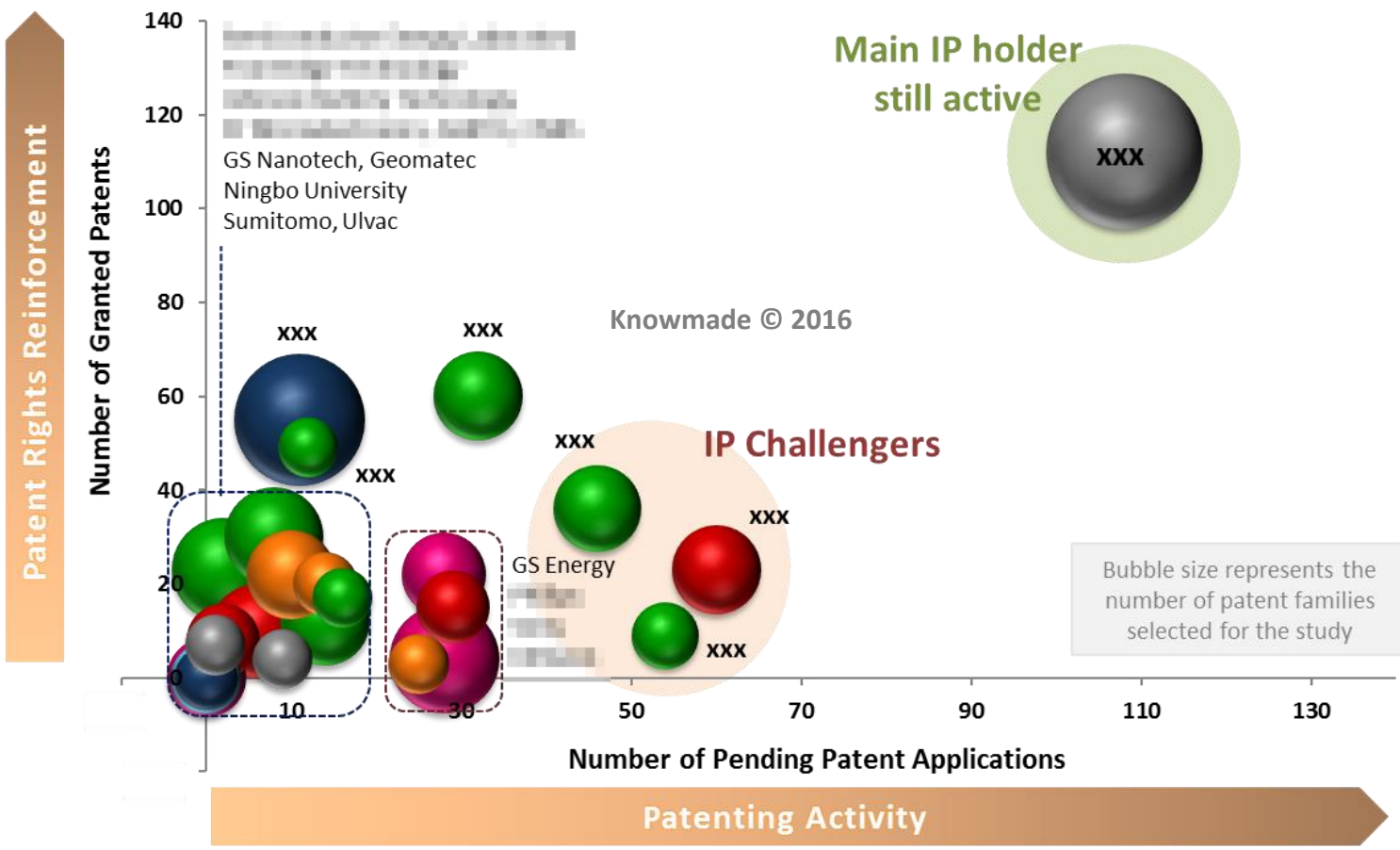
Patent Number	Assignee	English title	Current Legal Status	Application Date	Expected Expiration Date *	Number of Forward Citations	Age of Publication Date (Year)	Average Number of Forward Citations / Year
[US 2012]		Energy storage devices and manufacturing methods	GRANTED					
[US 2013]		Manufacturing methods for metal anodes	GRANTED					
[US 2015]		Manufacturing methods for metal anodes with non-aqueous electrolyte	GRANTED					
[US 2014]		Manufacturing methods for metal anode	GRANTED					
[US 2015]		Manufacturing methods for metal anode coatings	GRANTED					
[US 2018]		Manufacturing methods for metal anode lens	GRANTED	2009-09-10	2029-11-02	64	6.2	10.2
[US 2015]		Manufacturing methods for metal anode coatings	GRANTED	2000-08-16	2019-11-01	133	14.0	9.5
[US 2010]		Manufacturing methods for metal anode coatings	GRANTED	2001-07-09	2018-08-25	136	14.6	9.3
[US 2014]	POLYPLUS BATTERY	Manufacturing methods for metal anode layers	GRANTED					
[US 2011]		Manufacturing methods for metal anodes and electrolyte	GRANTED					
[US 2013]		Manufacturing methods for metal alloy anode	GRANTED					
[JP 2013]		Laminated metal anode layer, and all solid electrolyte	GRANTED					
[US 2017]		Manufacturing methods for metal anode substrate	GRANTED					
[US 2018]	CYMBET	Manufacturing methods for metal anode devices	GRANTED					
[US 2017]		Manufacturing methods for metal anode layers	GRANTED					

\* Expected Expiration Date is dependent on the accuracy and timeliness of the information provided by the patent offices. This indicator may change at any time without notice based on new information received from the patent offices. No decision should be made based solely on this indicators.

# PATENT LANDSCAPE OVERVIEW

## Main Assignees IP Leadership

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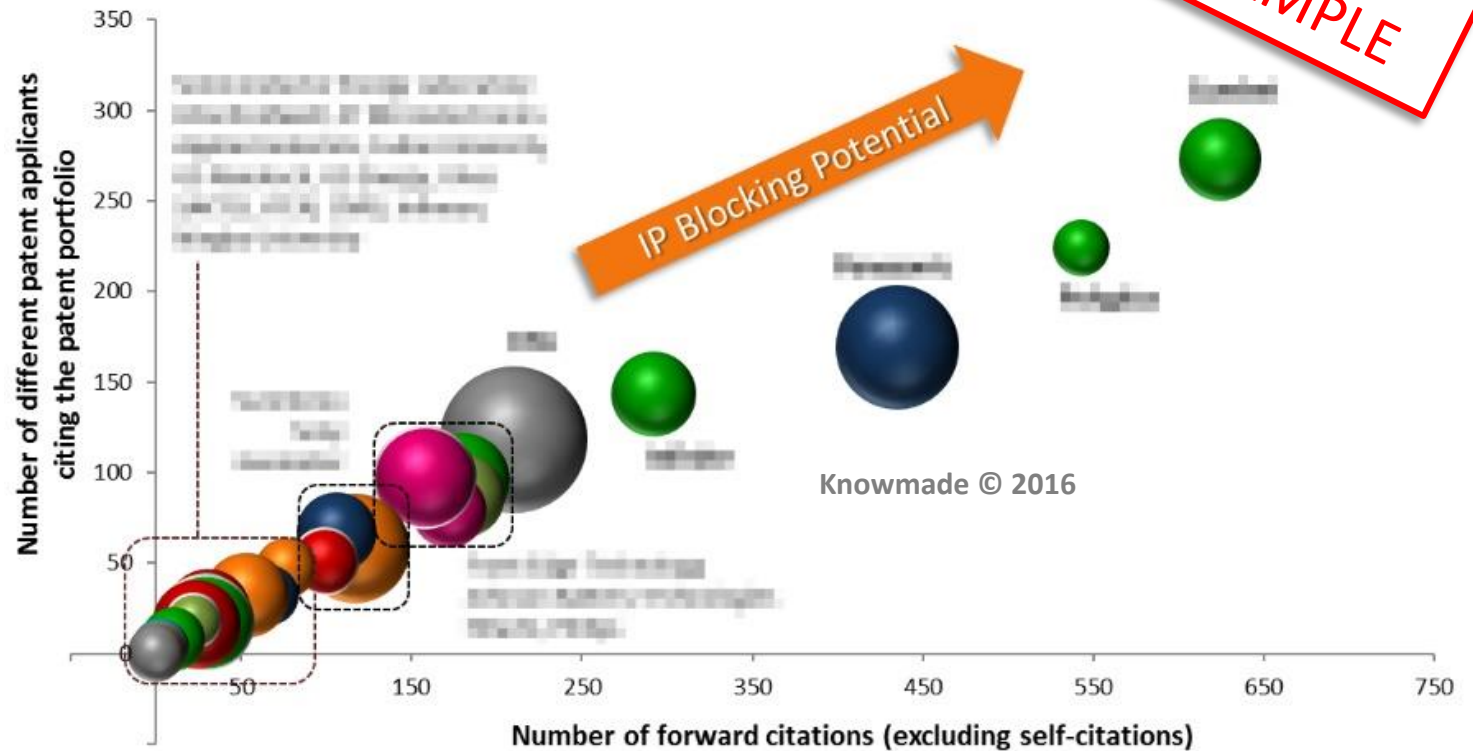
- **Company A** is leading the IP landscape with 100+ granted patents and 100+ pending patent applications, all over the world. Its patents are mainly related to new materials for micro-batteries and process methods for manufacturing devices.
- **Company D, Company B** and **Company C** are IP challengers with numerous pending patent applications all over the world. **Company D** filed patents on thin film multi-layered batteries made by atmospheric sputtering. **Company B** has patents on micro-batteries, manufacturing methods and apparatus and related communication devices integrating them. **Company C** patents are mainly focused on process methods and apparatus for manufacturing micro-batteries.
- **Company E, Company F** and **Company G** have noticeable number of enforceable patents but they have currently a lower amount of patents in pre-grant stage compared to **Company D, Company B** and **Company C**. **Company E** has key patents XXX. Some of them will expired in 2018. The company moves their R&D activities in lithium-ion and lithium-sulfur batteries.



# PATENT LANDSCAPE OVERVIEW

## Main Assignees IP Blocking potential

- **Company A** and **Company B**, whose patent portfolios have the strongest strength index for prior art contribution, distinguish themselves with the **highest IP blocking potential**. Their patents relating to Microbattery received a lot of forward citations from a lot of different patent applicants. That means they have the **capacity to hamper** the other firms' attempts to patent related inventions. Note that **Company A** and **Company B** hold respectively at least **XXX granted patents** (USA, Europe, China) and **XXX granted patents** (USA, Europe, China).
- Even if the **Company C** has a large Microbattery patent portfolio (XXX+ other patents worldwide), it **does not show a high IP blocking potential**.
- **Company D**, one of the current IP challengers, has a **weak IP blocking potential**, since the company started to file patents in XXXX.
- **Company E**, a pure play microbattery company, started its patenting activity in XXXX. Its patents are related to micro-batteries made by **electrochemical deposition, a deposition method only patented by few companies in this field**. This explains that its patents are not cited as often.

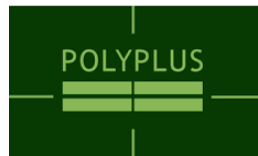


The more the number of forward citations from different patent applicants is high, the more the capacity to hamper the other firms' attempts to patent a related invention is important.

*Note:* This graph is at patent family level. The identification of a "blocking patent" requires an in-depth specific analysis of each patent documents composing the patent families.

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# IP PROFILE OF KEY PLAYERS



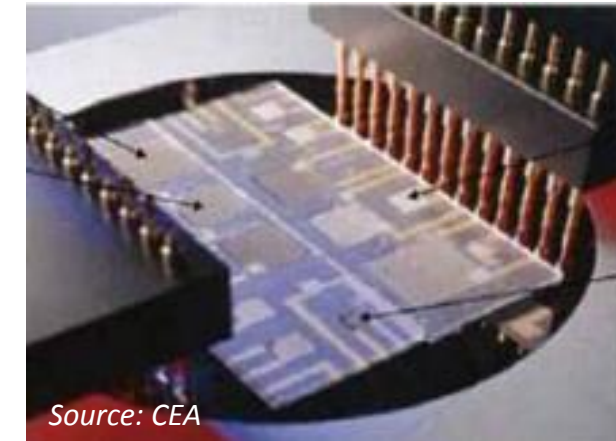
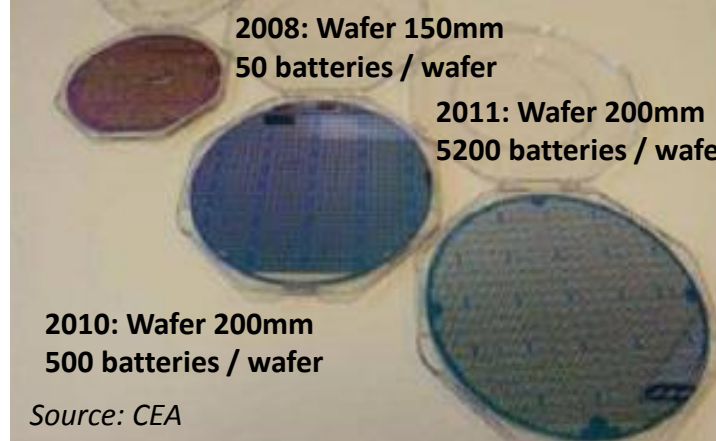


# CEA (French Alternative Energies and Atomic Energy Commission)

## Company Profile

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- The **French Alternative Energies and Atomic Energy Commission** or **CEA**, is a French public government-funded research organization in the areas of defense and security, information technologies and health technologies. It maintains a cross-disciplinary culture of engineers and researchers, building synergies between fundamental and technological research. It is divided into 5 divisions: Nuclear energy (DEN), Technological research (DRT), Life sciences (DSV), Sciences of matter (DSM) and Military applications (DAM). Research on micro-batteries in CEA is now performed in LETI, the CEA institute specialized in micro-electronic devices. CEA has created more than 150 start-ups in about 20 years, such as **SOITEC**, **Alchimer** (renamed **Aveni**), **Crocus Technology**, **Tronics**, **ISORG**, **Microoled**, **Movea**, **Enerbee**, **EnWires** ...
- **CEA** doesn't commercialize products but it produces prototypes. It focuses on R&D for micro-batteries (materials, process methods...). It has a special process platform to product prototypes in condition near from the one of production. This platform is composed of about 30 manufacturing devices, including PVD-CVD apparatus. CEA-LETI has a partnership with **ST Microelectronics** to develop their micro-batteries pilot line in Tours. In 2016, CEA-LETI joined the **Stanford System X Alliance** and signed a new agreement with **Intel** to develop microelectronic components.
- Large scale and miniaturized fuel cells, scale Li-ion batteries and new batteries technologies, such as Na-ion battery, all organic battery, Li-Air battery or Li-S battery, printed electronic, photovoltaic devices ... are also developed in CEA in **LITEN**, CEA's institute specialized in energy storage and collecting devices.

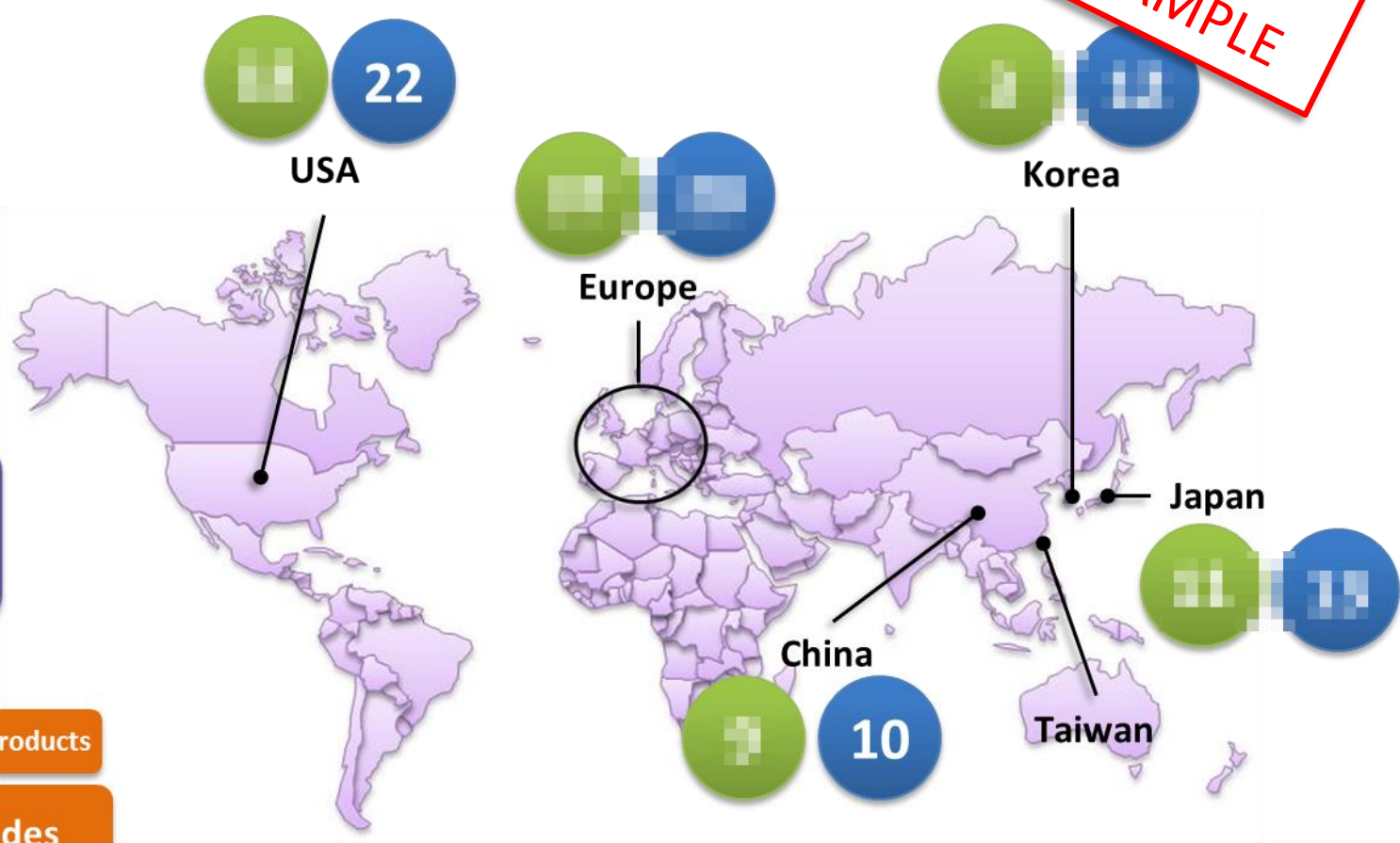
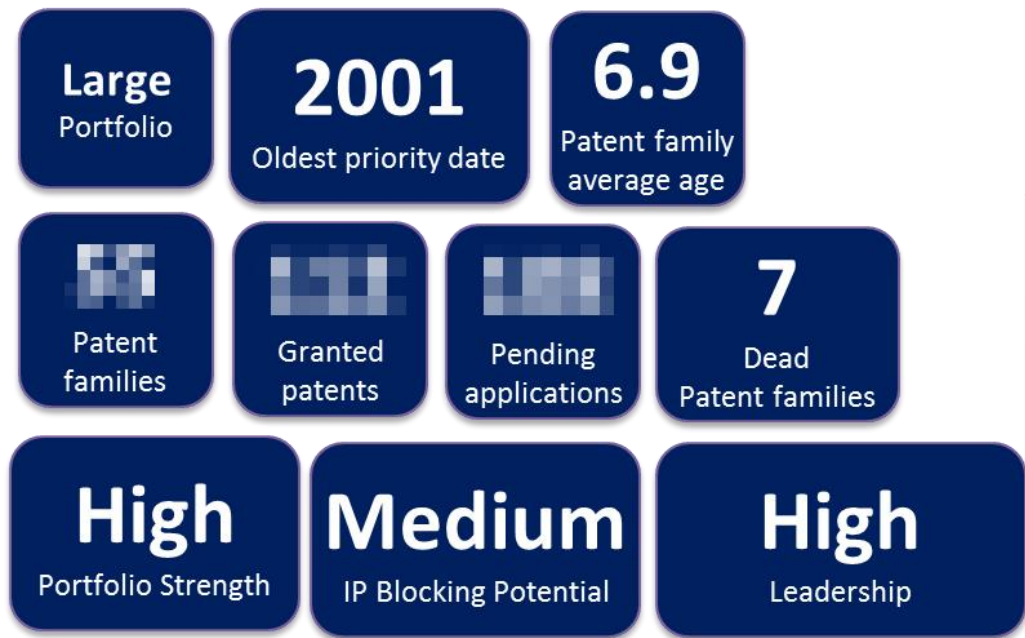


# CEA (French Alternative Energies and Atomic Energy Commission)

## Patent Portfolio Summary



**REPORT SAMPLE**



● Patent families comprising granted patents  
● Patent families comprising pending patents

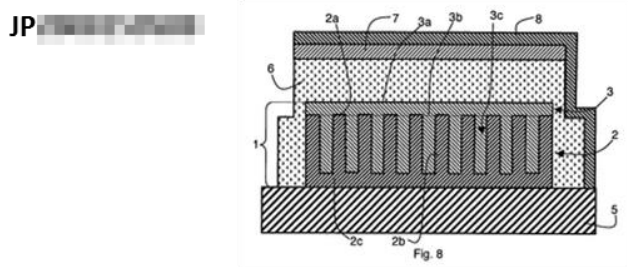
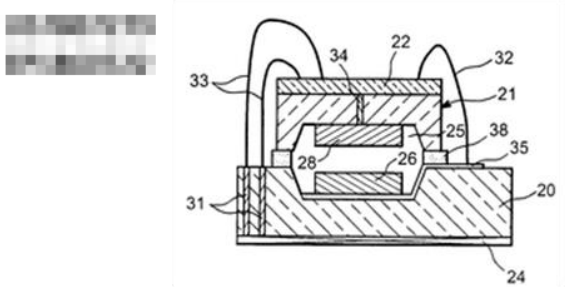
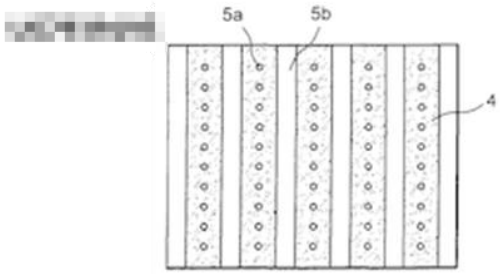
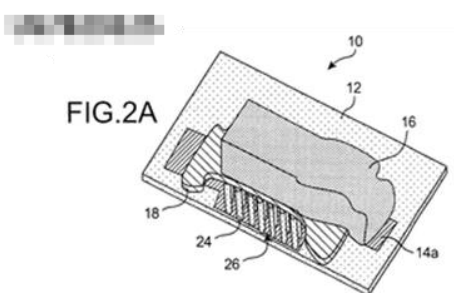


# CEA (French Alternative Energies and Atomic Energy Commission)

## Key Patents

REPORT  
SAMPLE

Patent number	Patent Title	Application date	Current Legal Status	Expiration Date	PDF	Average Number of Forward Citations / Year	Number of Backward Citations	Forward Citations
US20080120121	Microstructured electrode for microbatteries	2006-12-12	GRANTED	2017-12-12	<a href="#">Open</a>	1.3	11	11
US20080120120	Structured electrode for microbatteries	2006-12-14	GRANTED	2018-08-01	<a href="#">Open</a>	1.3	11	11
US20080120120	Integrated microcomponent combining energy storage and charge functions	2006-08-07	GRANTED	2018-08-07	<a href="#">Open</a>	2.8	4	11
US20080120121	Integrated microcomponent combining functions of energy storage and charge	2006-08-07	GRANTED	2017-08-07	<a href="#">Open</a>	2.8	4	11
US20080120120	Method of producing a microbattery	2006-07-28	GRANTED	2016-08-28	<a href="#">Open</a>	1.1	4	11
US20080120120	Microbattery with porous electrode substrate assembly with expansion cavity and its manufacturing method	2006-08-07	PENDING	2017-11-07	<a href="#">Open</a>	1.8	4	11
US20080120120	Method for manufacturing polymer type microbattery for microbattery	2006-08-07	GRANTED	2016-08-07	<a href="#">Open</a>	1.1	1	4
JP5101011	Micro-battery having structured electrolyte	2005-12-22	GRANTED	2025-12-22	<a href="#">Open</a>	1.3	5	13



REPORT  
SAMPLE

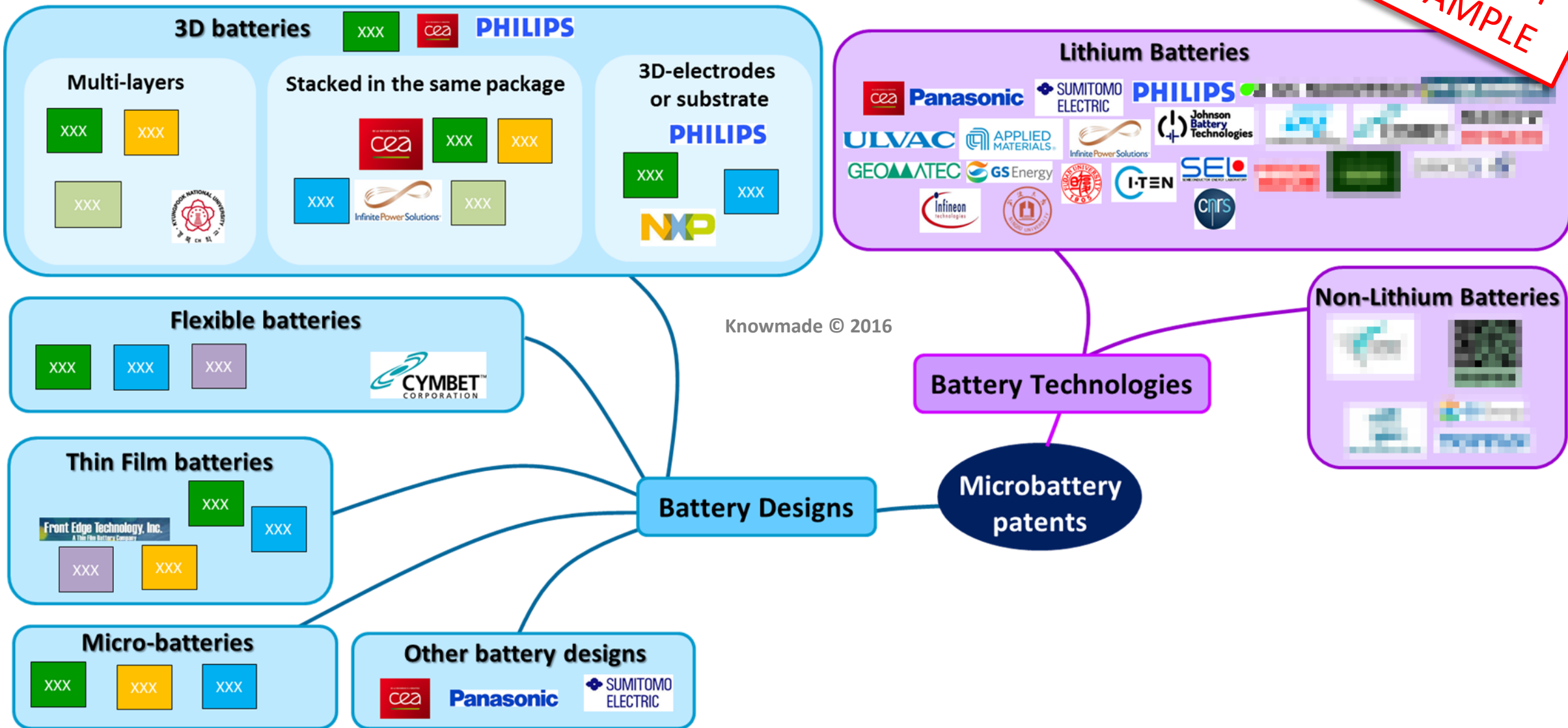
# PATENT SEGMENTATION

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# PATENT SEGMENTATION

## Mapping of Key Players for Battery Technologies and Designs

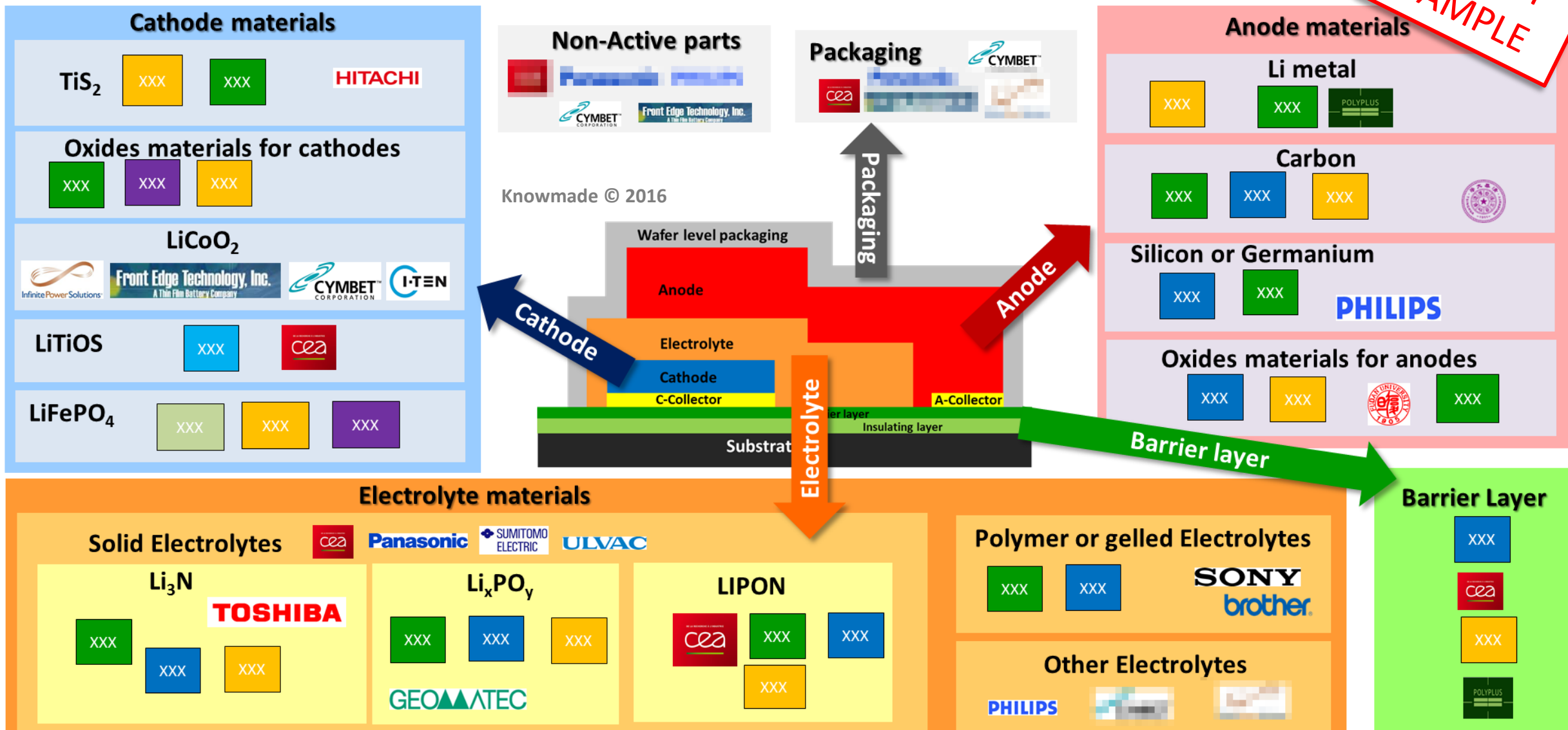
REPORT  
SAMPLE



# PATENT SEGMENTATION

## Mapping of Key Players for Battery Components

REPORT SAMPLE



# PATENT SEGMENTATION

## Matrix Main Patent Assignees v.s. Technical Segments

REPORT  
SAMPLE

Ranking ↘

For each segment, the numbers represent the numbers of patent families

Patent assignees	No of patent families	Battery technologies				Battery components					Types of claims		
		Primary Lithium batteries	Secondary Lithium batteries	Primary Non-Lithium batteries	Secondary Non-Lithium batteries	Electrodes	Electrolytes	Barrier Layer	Packaging	Non-active parts	Pure products	Method and products by method	Apparatus
TOTAL	912	345	664	57	47	529	595	99	234	338	40	734	40
Company A													
Company B													
Company C													
Company D													
Company E													
Company F													
Company G													
Company H													
Company I													
Company J													
Company K													
Company L													
Company M													
Company N		8	8			9	14		2	1			
Company O		3	6	2	3	12	12	1	3	8			
Company P		1	12			3	7		5	6			
Company Q		3	5			6	3	1	1	2			
Company R		1	10			8	10	1	3	3			
Company S		4	5	1		7	9	1	2	2			
Company T			6			4	5		2	3			
Company U		7	8			6	5		1	1			
Company V		5	8			5	5	1	5	5			
Company W		3	5				5						
Company X		1	8			8	6	6	3	6			
Company Y			8			7	5	1	2	6			
Company Z		1	4	2	1		4		4	5			
FUJITSU													
JOHNSON & JOHNSON													
KIST													
TOYOTA MOTOR													

REPORT  
SAMPLE

# Battery Technologies

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# BATTERY TECHNOLOGIES

## Principle of a Lithium Battery

REPORT  
SAMPLE

- **Lithium battery** is operating thanks to the electrochemical couple  $\text{Li}^+/\text{Li}$ .  
**Anode** material is either in Lithium metal or materials which can reversibly intercalate or form an alloy with Lithium.  
**Cathode** material can reversibly liberate Lithium ion.
- During the **charge**, cathode material is oxidized and liberates Lithium ions which move to the anode through the electrolyte and electrochemically react with the anode material via a reduction reaction. Depending on the anode material, Lithium ions are intercalated into the anode material or form an alloy with it.
- During the **discharge**, the opposite process occurs. Anode material, which contains Lithium, is oxidized. Lithium ions are liberated, move through the electrolyte and electrochemically react with the cathode material via a reduction reaction.
- Examples of reduction and oxidation reactions associated to the charge and discharge of a Lithium battery are presented below.

### Example for Li/LiCoO<sub>2</sub>

#### Charge

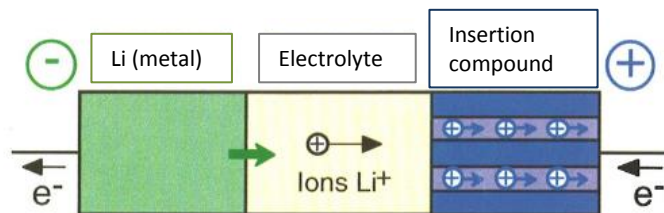
Anode:  $\text{Li}^+ + \text{e}^- \rightarrow \text{Li}$

Cathode:  $\text{LiCoO}_2 \rightarrow \text{CoO}_2 + \text{Li}^+ + \text{e}^-$

#### Discharge

Anode:  $\text{Li} \rightarrow \text{Li}^+ + \text{e}^-$

Cathode:  $\text{CoO}_2 + \text{Li}^+ + \text{e}^- \rightarrow \text{LiCoO}_2$



### Example for M/LiCoO<sub>2</sub>

M is a material which can insert or form an alloy with Li

#### Charge

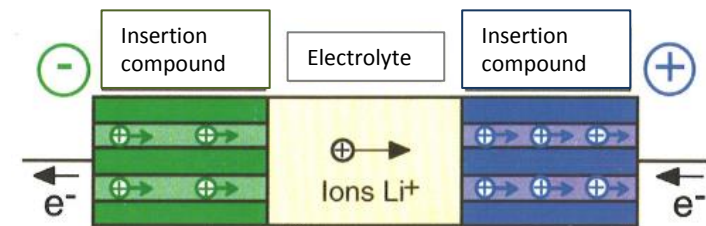
Anode:  $\text{Li}^+ + \text{e}^- \rightarrow \langle \text{LiM} \rangle$

Cathode:  $\text{LiCoO}_2 \rightarrow \text{CoO}_2 + \text{Li}^+ + \text{e}^-$

#### Discharge

Anode:  $\langle \text{LiM} \rangle \rightarrow \text{Li}^+ + \text{e}^- + \langle \text{M} \rangle$

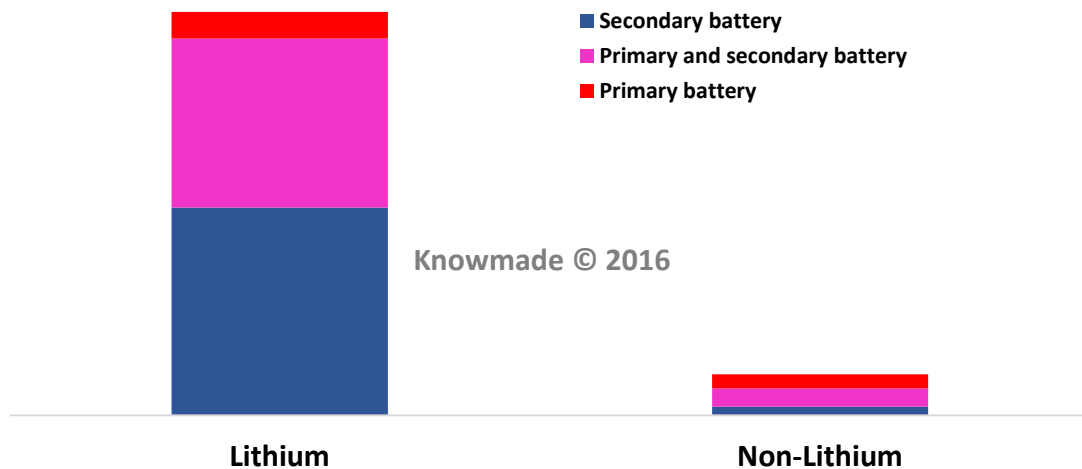
Cathode:  $\text{CoO}_2 + \text{Li}^+ + \text{e}^- \rightarrow \text{LiCoO}_2$



# BATTERY TECHNOLOGIES

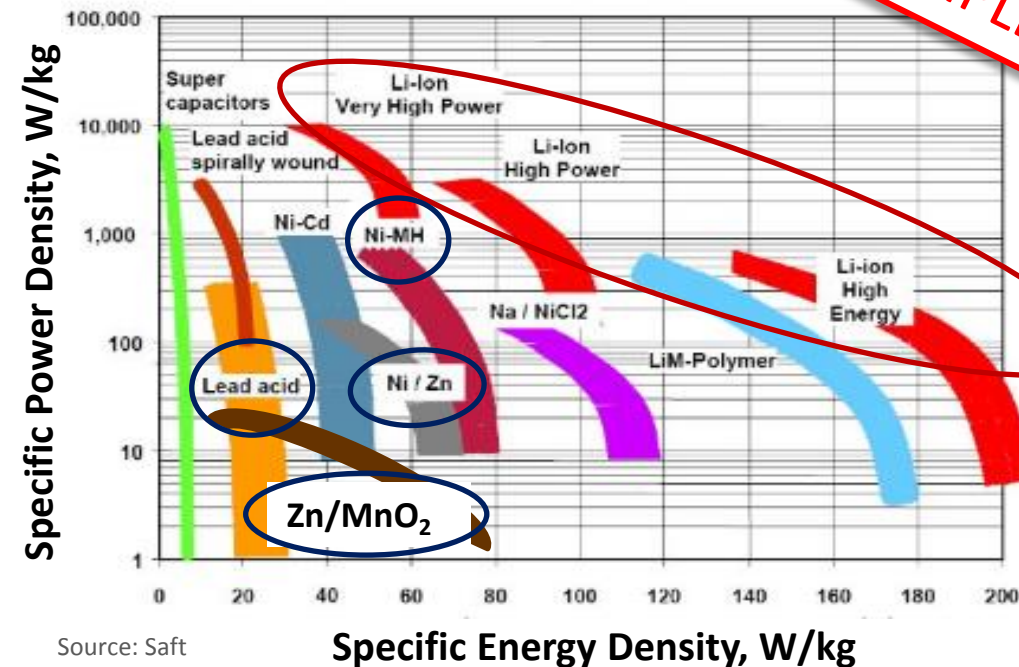
## Patents Split by Type of Technology

No of patent families by type of battery technologies



- The segment «**Primary and Secondary Battery**» stands for patent families referring to both primary and secondary batteries.
- In the segment «**Non-Lithium Battery**», there are XX patent families with unspecified battery technology (XX patent families for secondary battery, XX patent families for secondary and primary batteries and XX patent families for primary batteries).
- Primary non-Lithium batteries are mainly **XX batteries**. Primary and Secondary non-Lithium batteries are mainly XX batteries. Secondary non-Lithium batteries are mainly **XX Batteries**

Ragone plot for several battery technologies



- This Ragone plot represents the specific energy and power for several batteries technologies. It stands for all battery sizes. The specific energy is linked to the maximal duration of the discharge (.e. the autonomy) and the specific power to the amount of energy which can be delivered in a short time.
- It can be noticed that **Lithium batteries** covers the larger range of Specific Energy and Power density. For power density higher than 10W/kg, Lithium batteries have higher energy density than other battery technologies, i.e. the best theoretical autonomy. It explains why Lithium Batteries are the main battery technology patented in microbattery field.

REPORT  
SAMPLE

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SAMPLE

# Battery Designs

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# BATTERY DESIGNS

## Search Equations



Battery designs	Step	Search Equation	No of
Micro-batteries	#1	<i>[Faint search equation]</i>	<i>[Faint number]</i>
Flexible batteries	#2	<i>[Faint search equation]</i>	<i>[Faint number]</i>
Thin film batteries	#3	<i>[Faint search equation]</i>	<i>[Faint number]</i>
3D-batteries	#4	<i>[Faint search equation]</i>	<i>[Faint number]</i>
Multi-layers	#5	Manual selection of patents from #4	<i>[Faint number]</i>
Stacked in the same package	#6	Manual selection of patents from #4	<i>[Faint number]</i>
3D-Electrodes or substrates	#7	Manual selection of patents from #4	<i>[Faint number]</i>
Other battery designs	#8	NOT (#1 or #2 or #3 or #4)	<i>[Faint number]</i>

Note that a patent family can belong to several categories.

### Battery designs:

- **Micro-batteries:** Batteries have a micro-scale size. The term “micro-battery” or “microbattery” is clearly mentioned in the title, abstract or claims of the patent.
- **Flexible Batteries:** Batteries are flexible. The term “Flexible” is clearly mentioned in the title, abstract or claims.
- **Thin film Batteries:** Batteries electrodes and solid electrolyte layer are thin films. The term “Thin Film” is clearly mentioned in the title, abstract or claims.
- **3D-Batteries:** Batteries are built in three dimensions: Batteries stacked in the same package, multi-layers battery and battery built with 3D electrodes or substrates. Examples of 3D-batteries are shown on the next page. Terms associated to “three dimensions” are clearly mentioned in the title, abstract or claims.
- **Other battery designs:** It gathers patent families which don’t mention the battery design and those which are not in the segments « micro-batteries », « flexible batteries », « thin film batteries » and « 3D-batteries ».

# BATTERY DESIGNS

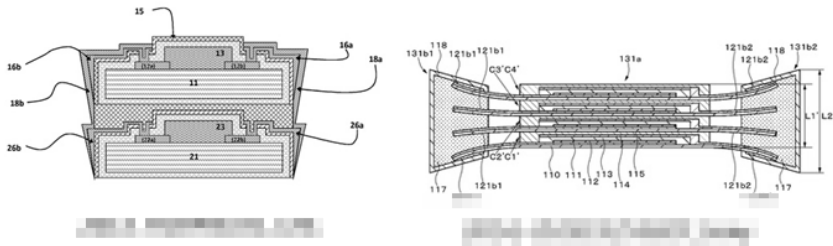
## Examples for 3D-batteries Sub-segments

REPORT  
SAMPLE

### Batteries stacked in the same packaging

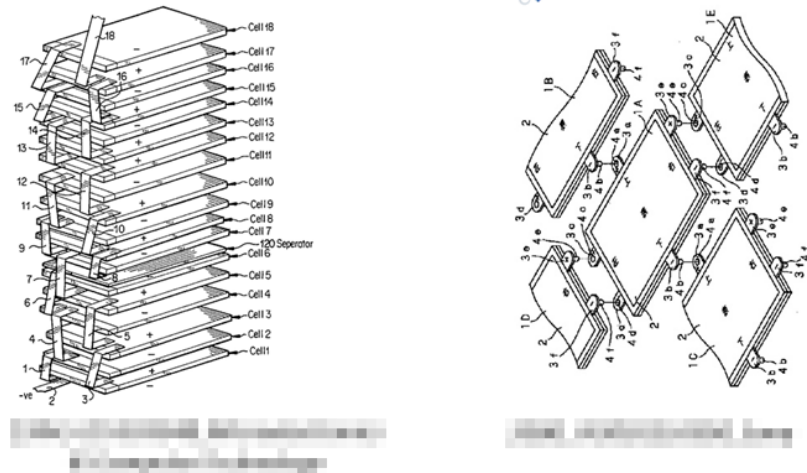
Included

Micro or thin film batteries are stacked and encapsulated in the same packaging.



Not included

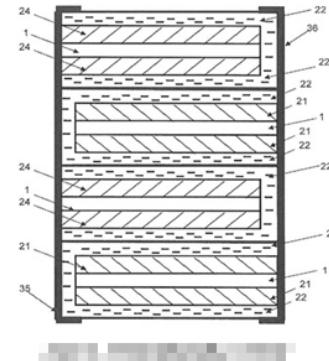
Micro or thin film batteries are encapsulated independently and stacked afterwards.



### Multi-layers batteries

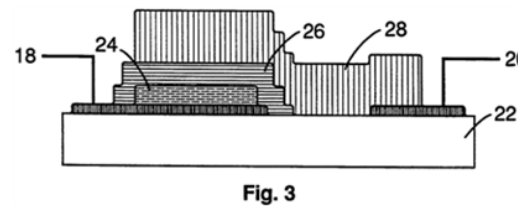
Included

Several layers of anodes/electrolytes/cathodes are pile-up.



Not included

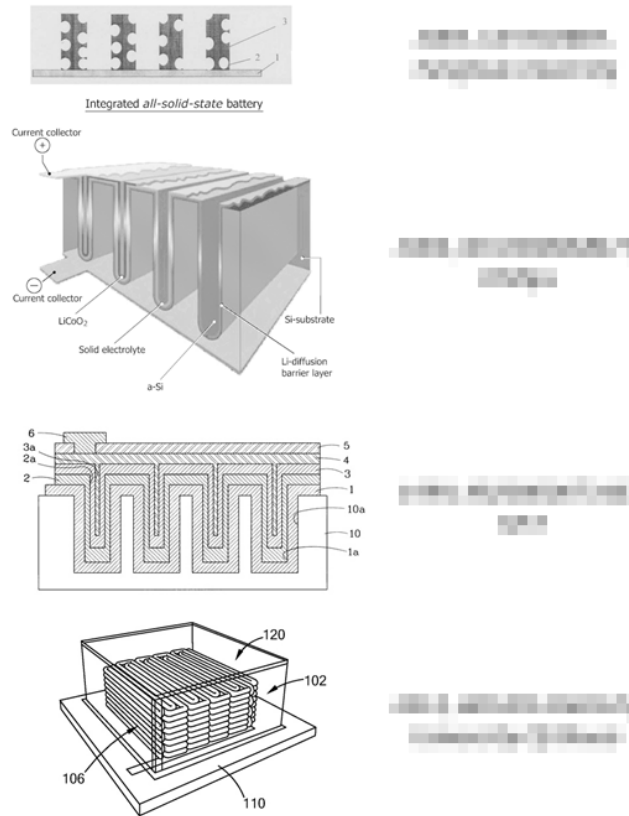
There is only one layer of anode, electrolyte and cathode materials.



### 3D electrodes or substrates

Included

Electrodes or substrates are structured in 3 Dimensions.

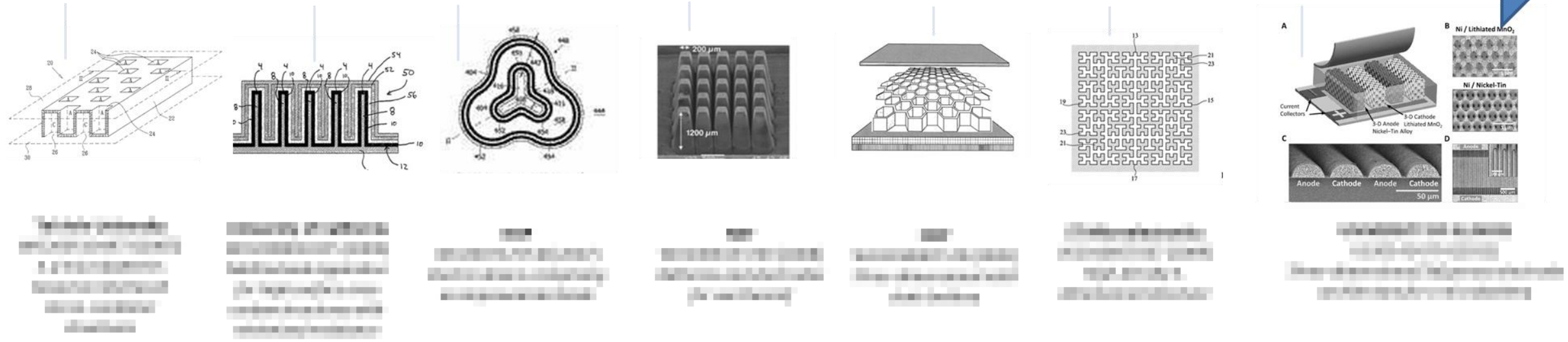
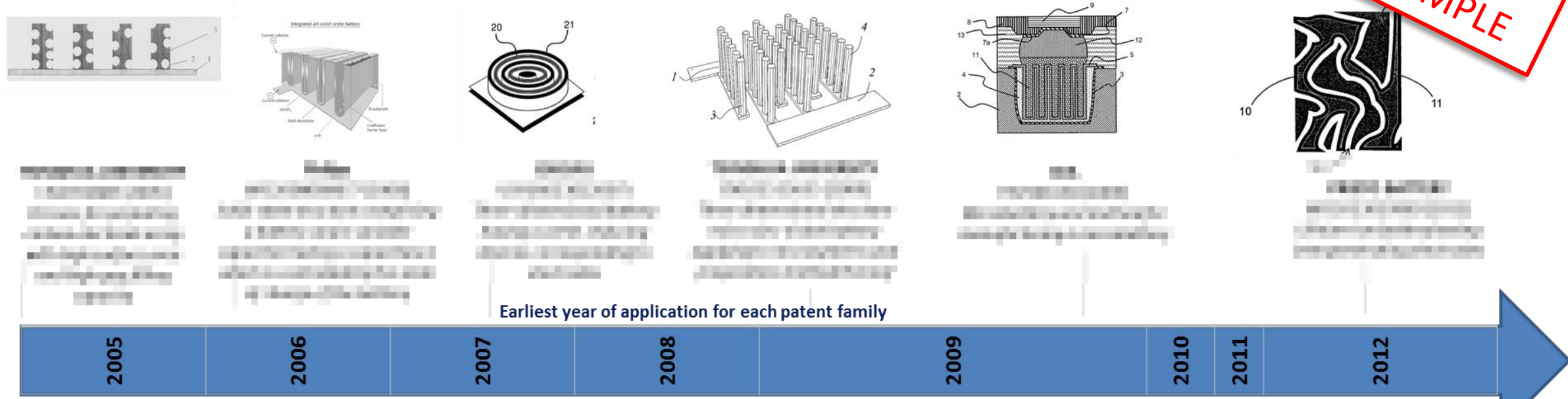




# BATTERY DESIGNS

## Evolution of the Design for 3D-Electrodes/Substrates (2/3)

REPORT SAMPLE



# Excel Database

with all patents analyzed in the report with technology segmentation

**REPORT  
SAMPLE**



This database allows multi-criteria searches and includes patent publication number, hyperlinks to the original documents, priority date, title, abstract, patent assignees, technological segments and legal status for each member of the patent family.



## Microbattery Patent Landscape – July 2016

Family Number (FamPat Databas)	Normalized PN	Publication data & Hyperlink to patent	Publication Date	Application Date	Application Data	English title	Earliest Priority Date	English Abstract	Family Normalized Assignee name	Current Legal Status & Action Taken	Segmentation												
											Types of claims			Battery technologies				Battery designs					
											Pure products	Method and products by meth	Apparatus	Primary Lithium Batteries	Secondary Lithium Batteries	Primary Non-Lithium Batteries	Secondary Non-Lithium Batteries	Micro-batteries	Flexible batteries	Thin film batteries	3D-batteries	Multi-layers	Stacked in the same packaging
63112	US200...	US200...	2002-08-	2002-02-06	US10/0...	Method of	1997-	A		LEGAL DETAILS		X		X	X								
2815972	US53...	US533...	1994-08-	1992-07-29	US07/9...	Thin film	1992-	Describe		LEGAL DETAILS		X				X	X	X					
0621764	US60...	US602...	2000-02-	1998-05-29	US09/0...	Protectiv	1994-	Disclose	POLYPLUS BATTERY	LEGAL DETAILS		X	X										
8292108	US20...	US200...	2003-04-	2002-11-08	US10/2...	Method of	1997-	A	PATTERNING TECHNOLOGIES	LEGAL DETAILS		X	X										
05640	US20...	US200...	2003-05-	2002-07-26	US10/2...	Battery	2000-	An		LEGAL DETAILS		X	X							X			
8848461	US20...	US200...	2007-07-	2006-12-19	US11/6...	Composit	2005-	A	POLYPLUS BATTERY	LEGAL DETAILS		X	X										
2901970	WO20...	WO200...	2007-01-	2006-06-30	WOJP20...	All-solid	2005-	All-solid	NATIONAL INSTITUTE FOR	LEGAL DETAILS		X	X										
780460	US20...	US200...	2005-08-	2004-04-14	US10/8...	Protected	2004-	Active	POLYPLUS BATTERY	LEGAL DETAILS		X	X							X	X		
2928363	US56...	US561...	1997-03-	1996-04-17	US08/6...	Recharge	1994-	Recharg		LEGAL DETAILS	X		X	X						X			
2928363	US55...	US556...	1996-10-	1995-06-07	US08/4...	Recharge	1994-	Recharg		LEGAL DETAILS	X		X	X						X			
2815972	US55...	US559...	1997-01-	1994-05-25	US08/2...	Electrolyt	1992-	Describe	UT BATTELLE	LEGAL DETAILS		X				X				X			
034010	US20...	US201...	2011-07-	2011-01-26	US13/0...	Battery	2010-	Disclose		LEGAL DETAILS		X	X						X	X	X	X	X
8292108	US20...	US200...	2004-08-	2004-01-20	US10/7...	Method of	1997-	A	PATTERNING TECHNOLOGIES	LEGAL DETAILS		X	X										
2815972	US55...	US556...	1996-10-	1994-07-12	US08/2...	Method	1992-	Describe	UT BATTELLE	LEGAL DETAILS		X				X				X			
889467	US61...	US616...	2001-01-	1999-04-02	US09/2...	Battery	1999-	A thin-	UT BATTELLE	LEGAL DETAILS		X	X							X			
2815972	US55...	US551...	1996-04-	1994-05-25	US08/2...	Method of	1992-	Describe	UT BATTELLE	LEGAL DETAILS		X				X				X			
233193	US64...	US640...	2002-06-	1998-08-25	US09/1...	Plating	1998-	A	POLYPLUS BATTERY	LEGAL DETAILS		X	X										
889371	US20...	US201...	2010-03-	2009-09-10	US12/5...	Binder of	2008-	This	JOHNSON & JOHNSON VISION	LEGAL DETAILS		X							X				

# ORDER FORM

## Microbattery Patent Landscape Analysis

September 2016

### 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, BP 65  
06902 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 St Laurent du Var CAP 3000 - Quartier du lac- 06700 St Laurent du Var  
IBAN: FR76 1560 7000 6360 6214 5695 126  
BIC/SWIFT: CCBPFRPPNCE

#### Paypal

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

### RETURN ORDER BY

**E-mail:** [contact@knowmade.fr](mailto:contact@knowmade.fr)

**Mail:** KnowMade S.A.R.L. 2405 route des Dolines, 06902 Sophia Antipolis, FRANCE

### PRODUCT ORDER

€4,990 – Single user license\*

€5,990 – Corporate 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.

*\*Single user license means only one person at the company can use the report. Please be aware that our publication will be watermarked on each page with the name of the recipient and of the organization (the name mentioned on the PO). This watermark will also mention that the report sharing is not allowed.*

*I hereby accept Knowmade's Terms and Conditions of Sale*

**Signature:**



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“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”.

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“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. Multi user license: the report can be used by unlimited users within the company. Subsidiaries are not included.

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

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## 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-ambiguous 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 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 St Laurent du Var CAP 3000 - Quartier du lac- 06700 St Laurent du Var

BIC or SWIFT code: CCBPFRPPNCE

IBAN : FR76 1560 7000 6360 6214 5695 126

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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