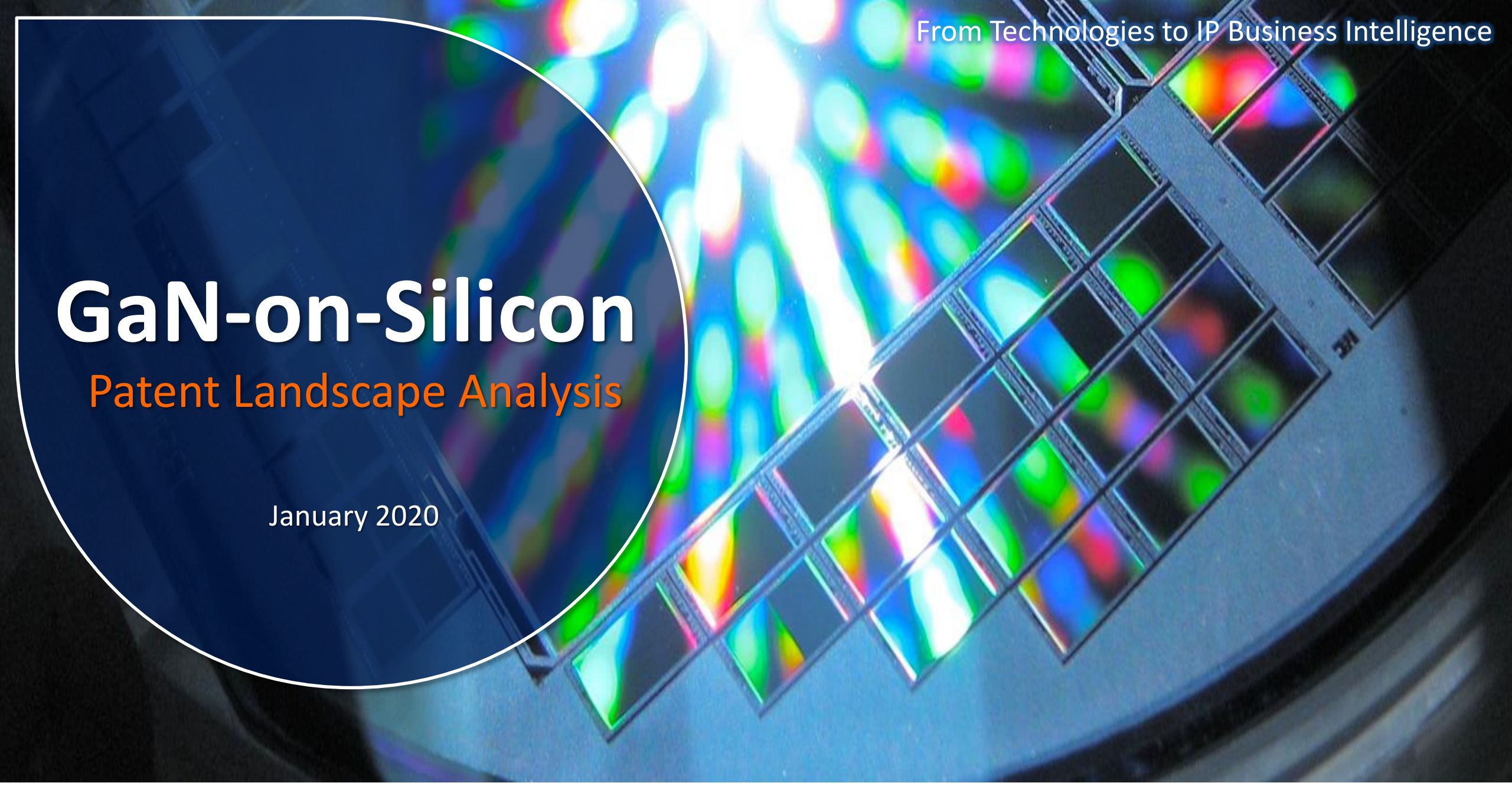
GaN-on-Silicon

Patent Landscape Analysis

January 2020



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SCOPE OF THE REPORT

- This report provides a detailed picture of the patent landscape for **GaN-on-Silicon technology** from **epitaxy** and **semiconductor devices** to **circuits**, **operating methods**, **packaging** and **modules**.
- This report covers **patents published worldwide up to July 2019**.
- We have selected and analyzed more than **2,800 patent families** (inventions) relevant to the scope of this report.

	Selected	Excluded
Patents related to GaN-on-Silicon including epiwafers, devices, modules, packaging and circuits & operating methods.	X	
Patents claiming devices (transistors, diodes) or modules that specifically use GaN-on-Silicon technology.	X	
Patents describing GaN-on-Silicon as the preferred solution.	X	
Patents describing devices (transistors, diodes) or modules that can use GaN epiwafers selected from GaN-on-SiC, GaN-on-Sapphire, or GaN-on-Silicon, including an embodiment focused on GaN-on-Silicon.	X	
Patents describing devices (transistors, diodes) or modules that can use GaN epiwafers selected from GaN-on-SiC, GaN-on-Sapphire, or GaN-on-Silicon, without any embodiment or preferred solution based on GaN-on-Silicon.		X
Patent claiming systems using GaN-on-Silicon but without inventive aspect related to GaN-on-Silicon technology.		X

PATENT LANDSCAPE ANALYSIS

Benefits for customer

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

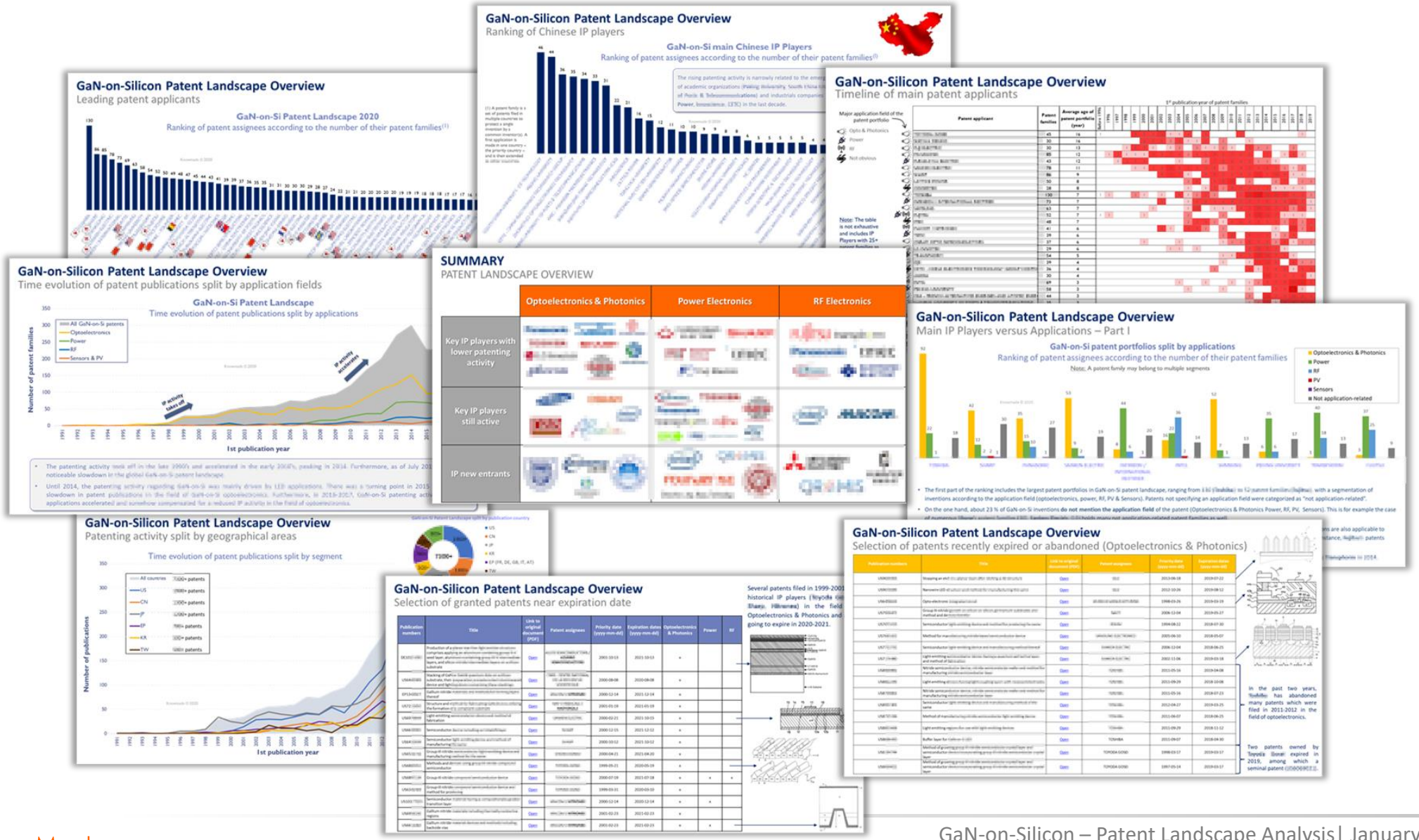
- Know the **key IP players**, their **key patents**, their IP/technology **strategy** and their **future intents**
- Identify **new entrants**, their **technology** and **market areas** of interest
- Follow the **technology trends** and identify **emerging technologies**
- **Benchmark** patent portfolios and know competitors' **strengths** and **weaknesses**
- Identify the **key patents** (seminal, blocking, valuable) and the **key technical solutions** that address hot technical issues
- Identify **free technologies** which can be used safely and mitigate the **risks of patent infringement**
- Identify **technologies to acquire** and potential **R&D partners**

Very complementary to market research

Give an other point of view of the competitors, technologies and markets

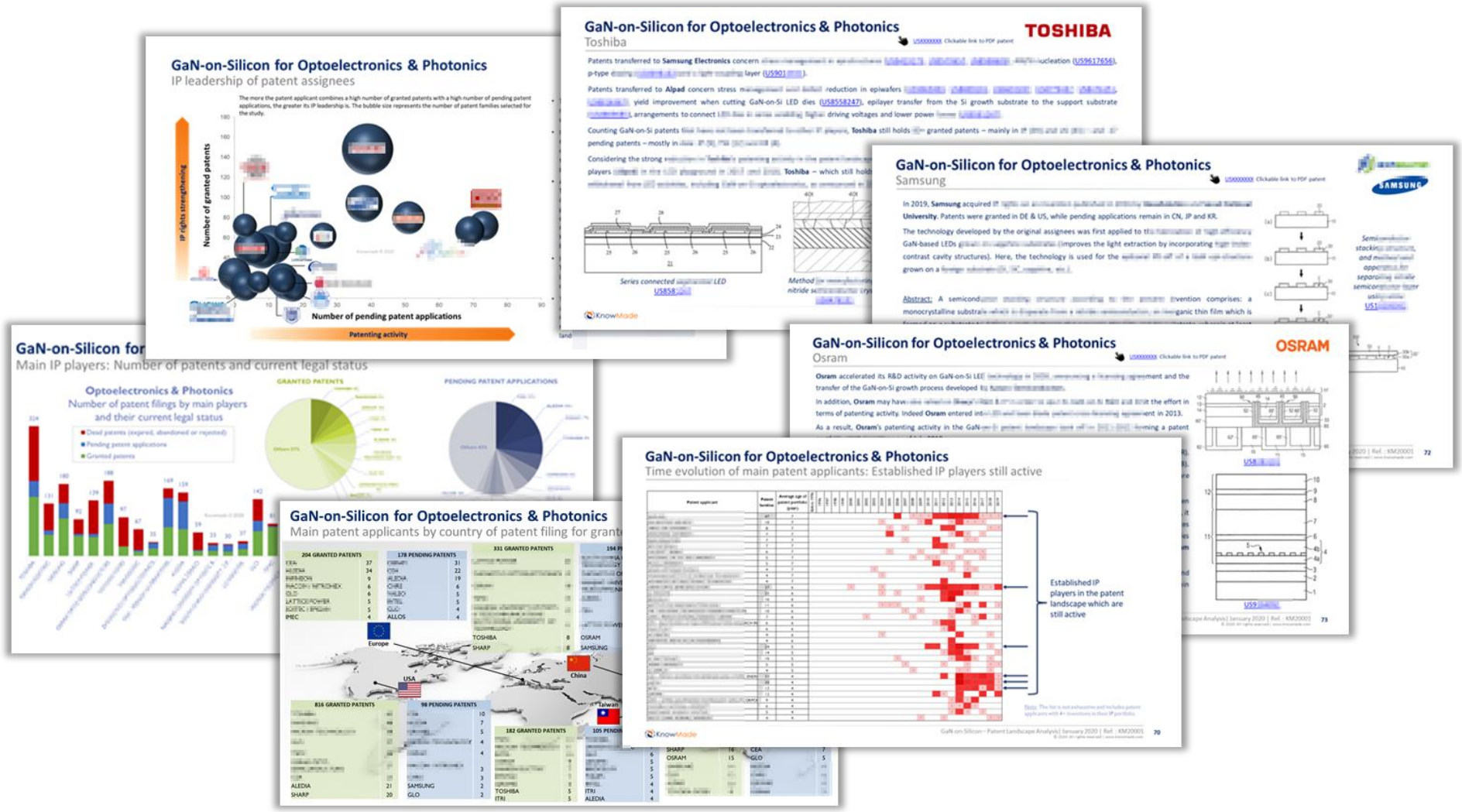
Patent Landscape Overview

Main patent assignees, New entrants, IP dynamics, Technologies/Applications, Patent legal status, Geo coverage



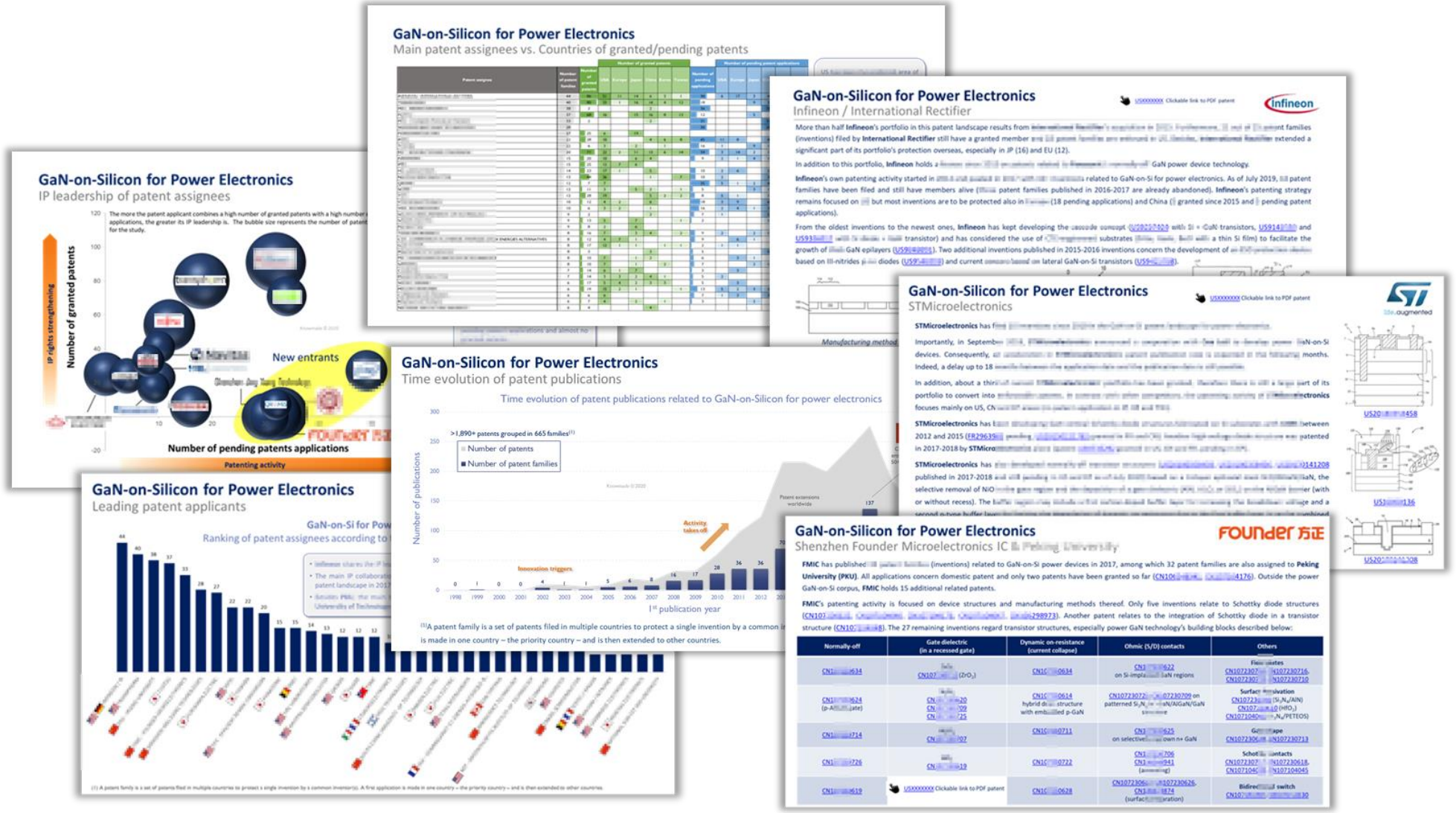
Focus on Optoelectronics & Photonics

IP Leadership & Dynamics, Focus on the IP activity & portfolio of new entrants and main historical players



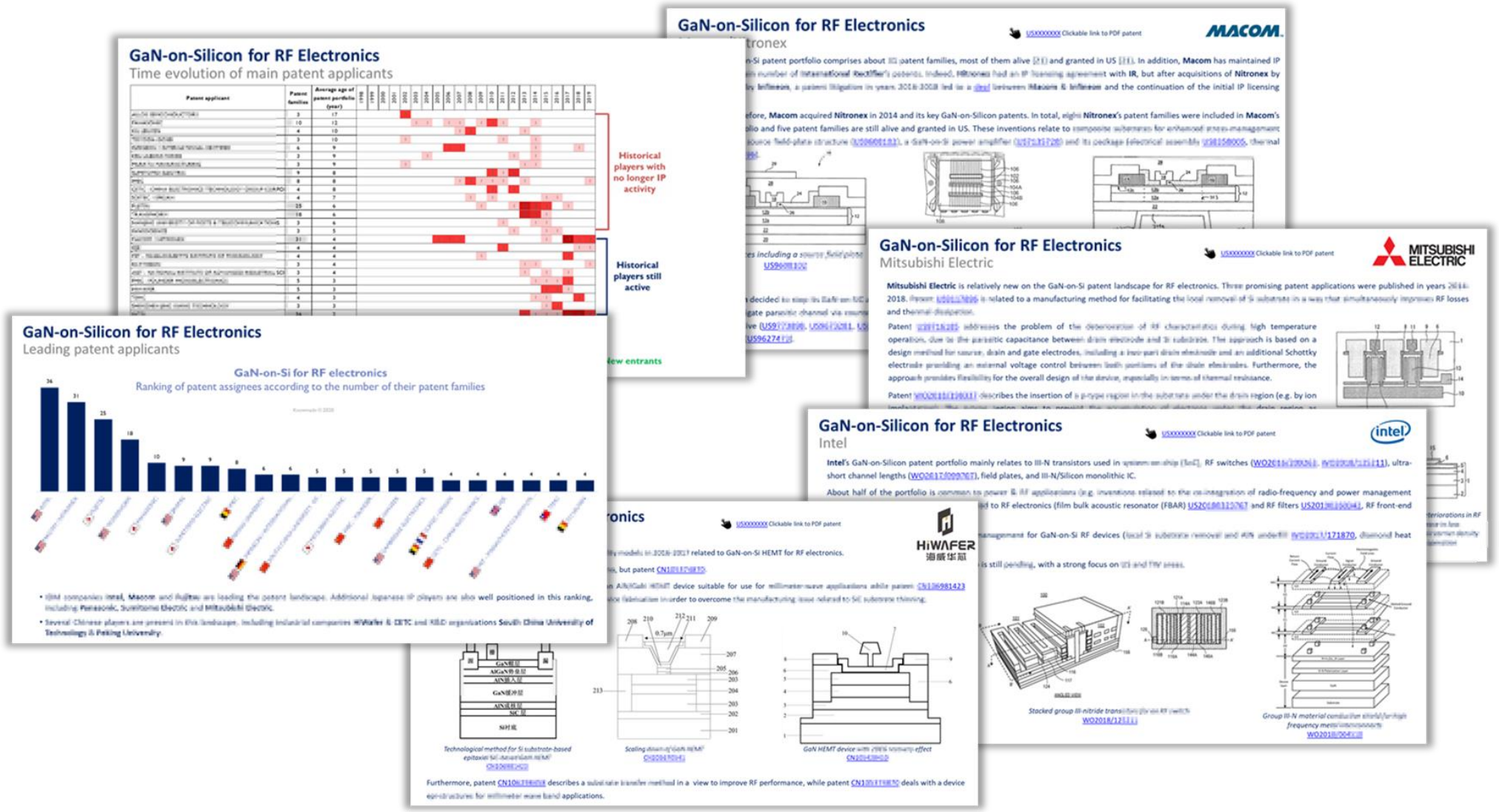
Focus on Power electronics

IP Leadership & Dynamics, Focus on the IP activity & portfolio of new entrants and main historical players



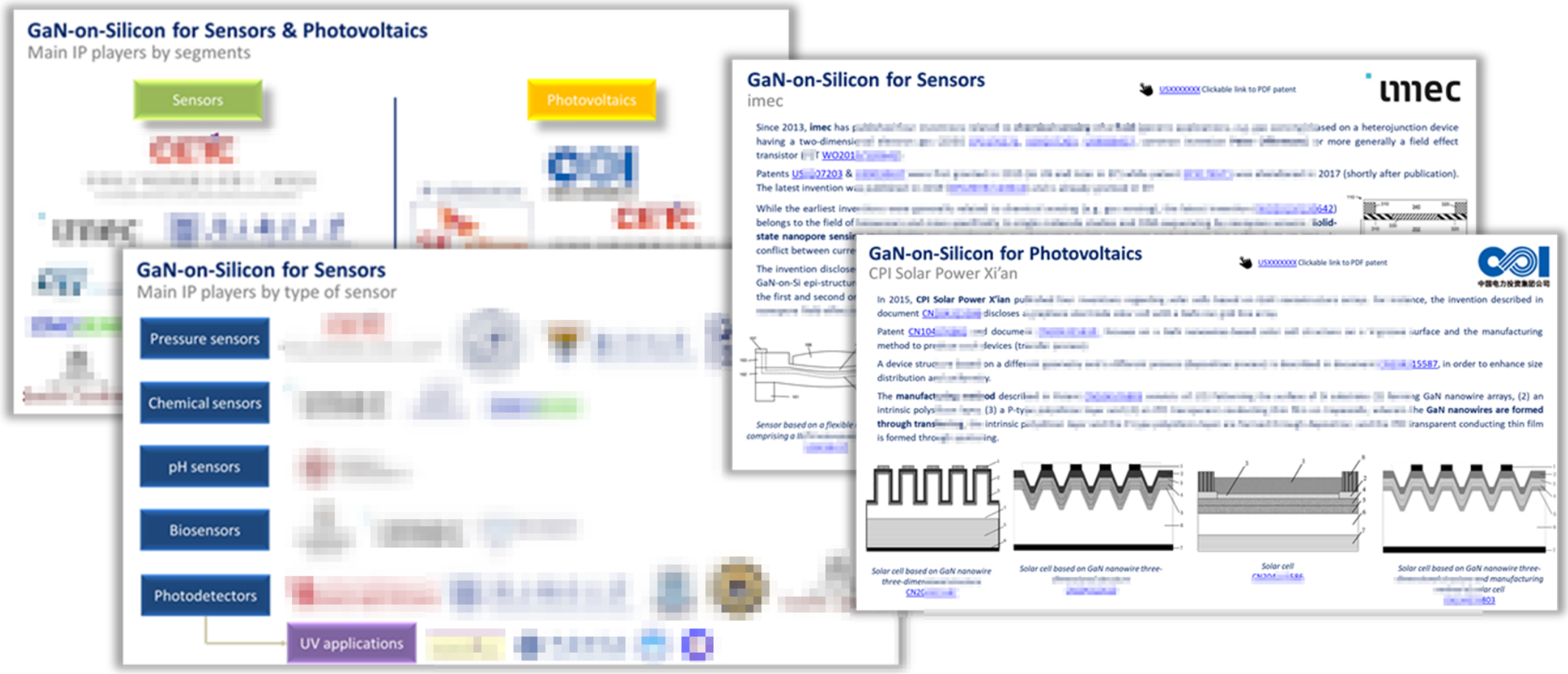
Focus on RF electronics

IP Leadership & Dynamics, Focus on the IP activity & portfolio of new entrants and main historical players



Focus on PV & Sensors

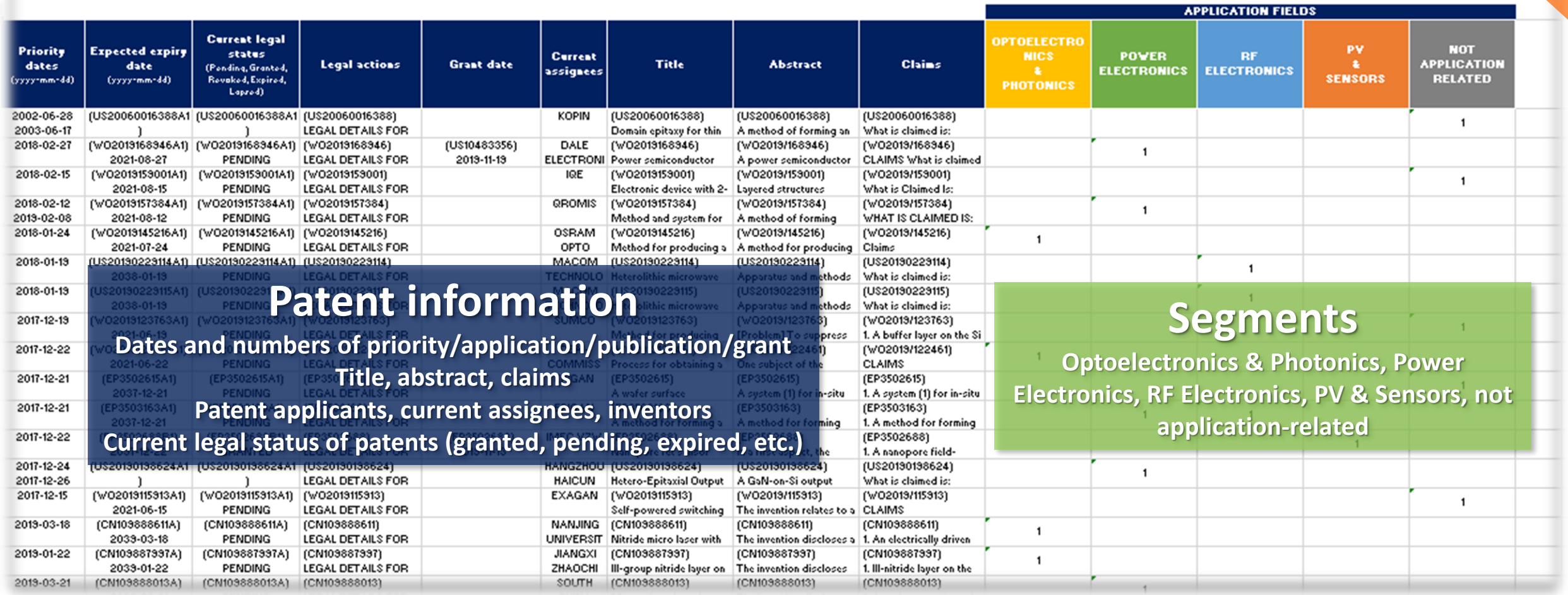
IP patent assignees, Technologies & Applications, Review of main IP portfolios



Excel file with all patents analyzed in the report

Useful patent database allows multi-criteria searches

SAMPLE



Priority dates (yyyy-mm-dd)	Expected expiry date (yyyy-mm-dd)	Current legal status (Pending, Granted, Revoked, Expired, Lapsed)	Legal actions	Grant date	Current assignees	Title	Abstract	Claims	APPLICATION FIELDS: OPTOELECTRONICS & PHOTONICS	POWER ELECTRONICS	RF ELECTRONICS	PV & SENSORS	NOT APPLICATION RELATED
2002-06-28 2003-06-17	(US20060016388A1)	(US20060016388A1)	(US20060016388) LEGAL DETAILS FOR		KOPIN	(US20060016388) Domain epitaxy for thin	(US20060016388) A method of forming an	(US20060016388) What is claimed is:					1
2018-02-27	(WO2019168946A1) 2021-08-27	(WO2019168946A1) PENDING	(WO2019168946) LEGAL DETAILS FOR	(US10483356) 2019-11-19	DALE ELECTRONI	(WO2019168946) Power semiconductor	(WO2019/168946) A power semiconductor	(WO2019/168946) CLAIMS What is claimed		1			
2018-02-15	(WO2019159001A1) 2021-08-15	(WO2019159001A1) PENDING	(WO2019159001) LEGAL DETAILS FOR		IQE	(WO2019159001) Electronic device with 2-	(WO2019/159001) Layered structures	(WO2019/159001) What is Claimed Is:					1
2018-02-12 2019-02-08	(WO2019157384A1) 2021-08-12	(WO2019157384A1) PENDING	(WO2019157384) LEGAL DETAILS FOR		QROMIS	(WO2019157384) Method and system for	(WO2019/157384) A method of forming	(WO2019/157384) WHAT IS CLAIMED IS:		1			
2018-01-24	(WO2019145216A1) 2021-07-24	(WO2019145216A1) PENDING	(WO2019145216) LEGAL DETAILS FOR		OSRAM OPTO	(WO2019145216) Method for producing a	(WO2019/145216) A method for producing	(WO2019/145216) Claims	1				
2018-01-19	(US20190229114A1) 2038-01-19	(US20190229114A1) PENDING	(US20190229114) LEGAL DETAILS FOR		MACOM TECHNOLO	(US20190229114) Heterolithic microwave	(US20190229114) Apparatus and methods	(US20190229114) What is claimed is:			1		
2018-01-19	(US20190229115A1) 2038-01-19	(US20190229115A1) PENDING	(US20190229115) LEGAL DETAILS FOR		MACOM TECHNOLO	(US20190229115) Heterolithic microwave	(US20190229115) Apparatus and methods	(US20190229115) What is claimed is:			1		
2017-12-19	(WO2019123763A1) 2021-06-19	(WO2019123763A1) PENDING	(WO2019123763) LEGAL DETAILS FOR		SUMCO	(WO2019123763) Method for producing	(WO2019/123763) [Problem] To suppress	(WO2019/123763) 1. A buffer layer on the Si					1
2017-12-22	(WO2019122461A1) 2021-06-22	(WO2019122461A1) PENDING	(WO2019122461) LEGAL DETAILS FOR		COMMISS	Process for obtaining a	One subject of the	(WO2019/122461) CLAIMS	1				
2017-12-21	(EP3502615A1) 2037-12-21	(EP3502615A1) PENDING	(EP3502615) LEGAL DETAILS FOR		SAN	(EP3502615) A wafer surface	(EP3502615) A system (1) for in-situ	(EP3502615) 1. A system (1) for in-situ					1
2017-12-21	(EP3503163A1) 2037-12-21						(EP3503163) A method for forming	(EP3503163) 1. A method for forming			1		
2017-12-22								(EP3502688) 1. A nanopore field-					
2017-12-24 2017-12-26	(US20190198624A1)	(US20190198624A1)	(US20190198624) LEGAL DETAILS FOR		HANGZHOU HAICUN	(US20190198624) Hetero-Epitaxial Output	(US20190198624) A GaN-on-Si output	(US20190198624) What is claimed is:		1			
2017-12-15	(WO2019115913A1) 2021-06-15	(WO2019115913A1) PENDING	(WO2019115913) LEGAL DETAILS FOR		EXAGAN	(WO2019115913) Self-powered switching	(WO2019/115913) The invention relates to a	(WO2019/115913) CLAIMS					1
2019-03-18	(CN109888611A) 2039-03-18	(CN109888611A) PENDING	(CN109888611) LEGAL DETAILS FOR		NANJING UNIVERSIT	(CN109888611) Nitride micro laser with	(CN109888611) The invention discloses a	(CN109888611) 1. An electrically driven	1				
2019-01-22	(CN109887937A) 2039-01-22	(CN109887937A) PENDING	(CN109887937) LEGAL DETAILS FOR		JIANGXI ZHAOCHI	(CN109887937) III-group nitride layer on	(CN109887937) The invention discloses	(CN109887937) 1. III-nitride layer on the	1				
2019-03-21	(CN109888013A)	(CN109888013A)	(CN109888013)		SOUTH	(CN109888013)	(CN109888013)	(CN109888013)					

Patent information

Dates and numbers of priority/application/publication/grant

Title, abstract, claims

Patent applicants, current assignees, inventors

Current legal status of patents (granted, pending, expired, etc.)

Segments

Optoelectronics & Photonics, Power Electronics, RF Electronics, PV & Sensors, not application-related

ORDER FORM

GaN-on-Silicon

Patent Landscape Analysis – January 2020

Ref.:KM20001

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
06560 Valbonne Sophia Antipolis
FRANCE

Money Transfer

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

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

Paypal

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

RETURN ORDER BY

E-mail: contact@knowmade.fr

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

PRODUCT ORDER

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☐ **€5,990 – Single user license***

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

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

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I hereby accept Knowmade's Terms and Conditions of Sale

Signature:

Terms and Conditions of Sales

DEFINITIONS

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

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"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.

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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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1. SCOPE

1.1 The Contracting Parties undertake to observe the following general conditions when agreed by the Buyer and the Seller. ANY ADDITIONAL, DIFFERENT, OR CONFLICTING TERMS AND CONDITIONS IN ANY OTHER DOCUMENTS ISSUED BY THE BUYER AT ANY TIME ARE HEREBY OBJECTED TO BY THE SELLER, SHALL BE WHOLLY INAPPLICABLE TO ANY SALE MADE HEREUNDER AND SHALL NOT BE BINDING IN ANY WAY ON THE SELLER.

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

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

2. MAILING OF THE PRODUCTS

2.1 Products are sent by email to the Buyer:

- within [1] month from the order for Products already released; or
- within a reasonable time for Products ordered prior to their effective release. In this case, the Seller shall use its best endeavours to inform the Buyer of an indicative release date and the evolution of the work in progress.

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

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

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

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

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

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

3. PRICE, INVOICING AND PAYMENT

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

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

Banque Populaire Méditerranée, CAP 3000 Quartier du lac, 06700 St Laurent du Var, France
BIC or SWIFT code: CCBPFRPPMAR
IBAN: : FR76 1460 7003 6360 6214 5695 139

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

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

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

4. LIABILITIES

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

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

4.3 In no event shall the Seller be liable for:

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

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

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

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

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

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

4.8 The Seller does not make any warranties, express or implied, including, without limitation, those of saleability and fitness for a particular purpose, with respect to the Products. Although the Seller shall take reasonable steps to screen Products for infection of viruses, worms, Trojan horses or other codes containing contaminating or destructive properties before making the Products available, the Seller cannot guarantee that any Product will be free from infection.

5. FORCE MAJEURE

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

6. PROTECTION OF THE SELLER'S IPR

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

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

- Information storage and retrieval systems;
- Recordings and re-transmittals over any network (including any local area network);
- use in any timesharing, service bureau, bulletin board or similar arrangement or public display;
- Posting any Product to any other online service (including bulletin boards or the Internet);
- Licensing, leasing, selling, offering for sale or assigning the Product.

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

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

7. TERMINATION

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

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

8. MISCELLANEOUS

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

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

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

9. GOVERNING LAW AND JURISDICTION

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

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

KnowMade
Patent & Technology Intelligence

KnowMade SARL
2405 route des Dolines
06902 Sophia Antipolis, France

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