

Hybrid Bonding

Patent Landscape Analysis – November 2019

Who has the ability to hamper the development of products using hybrid bonding processes?



A technology driven by CIS but on its way to conquer other industries.

The pace of Moore’s law is slowing, if it has not already stopped, as mentioned by Forbes and Nvidia. It’s reaching its limits because developing smaller technology nodes is doable technically, but is no longer cost efficient. The digital electronics market requires a higher density semiconductor memory chip to cater to recently released central processing unit (CPU) components. To answer the growing demand and overcome Moore’s law’s limits, multiple die stacking has been suggested as a solution. Advanced packaging technology development, specifically 2.5D technology, was first used in high performance applications. Today, scaling the Z axis is becoming more and more important in what is called 3D stacking.

Generally, 2.5D-3D stacking was achieved thanks to Through Silicon Via (TSV) technology. However, TSVs are large and using them limits efforts to reach very dense architectures. Furthermore, filling TSVs with metals is complex and requires significant know how. To overcome these limitations, players have started to look at other solutions. A first step toward a new way of 3D stacking is ZiBond, developed by Ziptronix, a company founded in 2000 as a spin-out of Research Triangle Institute. ZiBond is an enhanced version of direct oxide bonding that involves wafer-to-wafer processing at low temperatures, from 150-300°C, to initiate high bond strengths, rivaling silicon. The next step was to combine the dielectric bond with embedded metal to simultaneously bond wafers or bond dies to wafers and form the interconnects. ZiBond is the dielectric bond that forms the basis for direct bonding interconnect (DBI) technology developed in 2005. Tessera, now called Xperi, acquired Ziptronix in 2015 and ZiBond and DBI were integrated in the Invensas subsidiary’s portfolio. This hybrid bonding technology is quickly becoming recognized as the preferred permanent bonding path to form high-density interconnects in heterogeneous integration applications, from 2D enhanced, to 3D stacking with or without TSVs, as well as MEMS.

After entering the CMOS Image Sensor (CIS) market in 2016, hybrid bonding technology has started to be investigated by other industries, such as memory. However, the hybrid bonding market’s growth follows Xperi’s developments. The company has adopted an aggressive strategy to assert its patents. Yet in parallel with the market and Xperi’s growth, some other players, like YMTC, Sony, Samsung and TSMC, have developed their own patent portfolios and strategies and are on the edge of releasing their first products using hybrid bonding processes. Understanding the IP landscape is becoming key to evaluate the risks and opportunities that go with the development and use of hybrid bonding technology.

REPORT OUTLINE

- Hybrid Bonding
- Patent landscape analysis
- November 2019
- Ref.: KM19008
- PDF > 80 slides
- Excel file > 1,000 patents
- €6,490 for a multi-user license

REPORT’S KEY FEATURES:

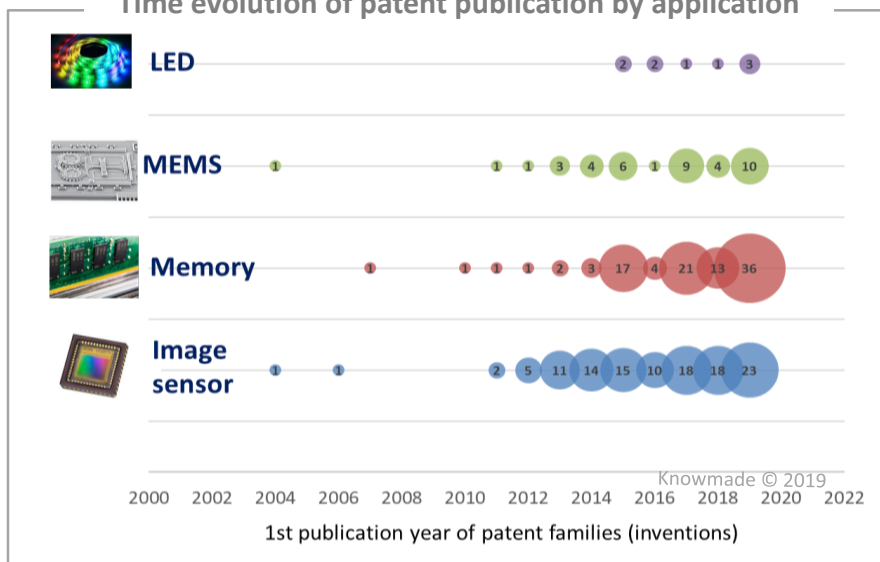
- **IP trends**, including time-evolution of published patents, countries of patent filings, etc.
- Ranking of **main patent assignees**
- **Key players’ IP position** and **relative strength** of their patent portfolios
- **Patent segmentation per application:**
 - CMOS image sensor (CIS)
 - Memory
 - MEMS
 - LED
- **Key patent** identification and details
- **IP profile of key players:** Xperi, TSMC, YMTC
- **Excel database** containing all patents analyzed in the report, including technology and application segmentations

RELATED REPORTS

[2.5D-3D TSV and Wafer-Level Stacking Technology and Market - Update 2019](#) - Yole Développement

[Wafer to Wafer Permanent Bonding Comparison 2018](#) - System Plus Consulting

Time evolution of patent publication by application

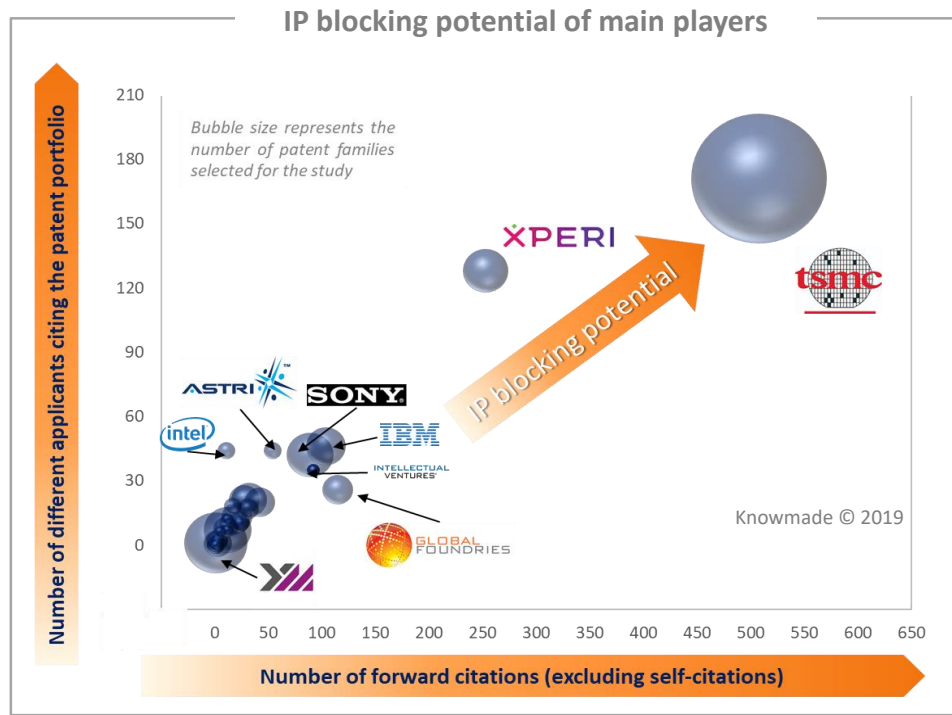


Main IP player ranking

In this report, Knowmade has manually selected more than 290 patent families and inventions related to **hybrid bonding** and provides a general overview of **today's IP landscape trends and dynamics**. Knowmade delivers an understanding and analysis of the **current IP positions of the main IP players using or developing hybrid bonding process**, as well as the links between them through licensing.

IP player current developments

This report reveals all players developing IP related to hybrid bonding per type of targeted applications and shows companies' current developments. Learn how they integrate hybrid bonding in their manufacturing process flow. Detect your future competitors or partners and evaluate their know how, IP strength, IP weaknesses and the risk of infringing their patents.



Main IP players' packaging-related IP activity

	Image sensor	Stacked Memory	Memory on logic	LED	MEMS
Hybrid bonding process	47 inventions XPERI, tsmc, SAMSUNG ELECTRONICS, Micron, ON	69 inventions tsmc, YMC, XPERI, IBM, GLOBAL FOUNDRIES	51 inventions YMC, tsmc, WILAN, intel, IBM	3 inventions XPERI, tsmc, 北京大学 PEKING UNIVERSITY	33 inventions tsmc, XPERI, GLOBAL FOUNDRIES, ETH zürich, XMC
Devices using hybrid bonding technology	78 inventions tsmc, SONY, Canon, Omnitron Vision, ON, CEA, SAMSUNG ELECTRONICS, Monolithic 3D	40 inventions YMC, tsmc, Monolithic 3D, 三星电子 SAMSUNG ELECTRONICS, TOSHIBA	21 inventions YMC, tsmc, facebook, XMC, Micron	6 inventions CEA, tsmc, ON, facebook, IBM	11 inventions tsmc, IBM, XPERI, Monolithic 3D

Main IP players' portfolio analysis

This report provides a **detailed comparison** of the three main IP players' portfolios: **TSMC, Xperi and YMC**. For each player, Knowmade highlights their **strengths and weaknesses**, and provides information regarding their **IP strategies, blocking potential, current and potential licensees**. Knowmade also gives an understanding of how these players' IP could impact the business of companies using or developing hybrid bonding. In addition, a detailed description and analysis of their **key patents** is provided.

This report's main assets

- Understanding the key players' patented technologies and current IP strategies

More than **50 patent applicants** are involved in the **hybrid bonding** patent landscape. This report reveals the **IP position of key players** through a detailed analysis of their patent portfolios. We also describe their **patented technologies**, their **IP strategy**, and their **ability to limit other firms' patenting activity and freedom-to-operate**.

- Analyzing IP players' position, key patents and targeted market

This report furnishes an understanding of **IP players' positions**. The **main IP players and key patents** are presented, along with an **understanding of the current applications aimed by players and position in the supply chain**.

- Understanding the impact of players IP on the market

This report offers a detailed **analysis the blocking potential of each players**. Learn about **IP players' capability to limit your freedom to operate and possible ways to by-pass their patents**.

- Useful Excel patent database

This report also includes an **Excel database with the >1,000 patents and patent applications** 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 application segments.

COMPANIES MENTIONED IN THIS REPORT (NON-EXHAUSTIVE LIST)

XPERI, TSMC, YMTC, SAMSUNG ELECTRONICS, SONY, CEA, CANON, RENESAS ELECTRONICS, RAYTHEON, APPLE, STMICROELECTRONICS, SMIC, INTEL, SEOUL NATIONAL UNIVERSITY INDUSTRY FOUNDATION, SHANGHAI IC R&D CENTER, XMC, OMNIVISION TECHNOLOGIES, IMEC, MONOLITHIC 3D, NANYA TECHNOLOGY, KATHOLIEKE UNIVERSITEIT LEUVEN, GLOBALFOUNDRIES, AMERICAN BUSINESS GRID IC TECHNOLOGY, ON SEMICONDUCTOR, QUALCOMM, NCAP, LEXVU OPTO MICROELECTRONICS TECHNOLOGY, INTELLECTUAL VENTURES, MAGNACHIP SEMICONDUCTOR, IBM, ATRI, INSTITUTE OF MICROELECTRONICS CHINESE ACADEMY OF SCIENCES, and more...

TABLE OF CONTENTS

INTRODUCTION	4	CORPUS SEGMENTATION	31
Context and market		Position on the supply chain	
Manufacturing process		Hybrid bonding process	
		Devices using hybrid bonding technology	
SCOPE AND METHODOLOGY	7	Applications:	
Scope of the report		CMOS image sensor (CIS)	
Key feature of the report		Memory	
Main assignees citing in the report		MEMS	
Objectives of the report		LED	
Methodology for patent search and selection			
Terminologies for patent analysis		KEY PATENTS	40
Definition for key patents			
		LITIGATION	57
IP LANDSCAPE OVERVIEW	20	IP PROFILE OF KEY PLAYERS	60
Time evolution of patent publications		Main IP players	
Main IP players		TSMC	
Legal status of patents		Xperi	
Geographic coverage of IP portfolios		IP Newcomers	
Time evolution of patent publications per assignee		YMTC	
IP position of main IP players			
IP leadership		CONCLUSION	77
IP blocking potential			
Strength index		KNOWMADE PRESENTATION	80

AUTHORS**Dr. Paul Leclaire**

Paul works for Knowmade in the fields of RF technologies, Wireless communications and MEMS sensors. He holds a PhD in Micro and Nanotechnology from the University of Lille (France), in partnership with IEMN in Villeneuve-d'Ascq and CRHEA-CNRS in Sophia-Antipolis (France). Paul previously worked for an innovation strategy consulting firm as a consultant.

Contact: paul.leclaire@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 Semiconductor department. He holds a PhD in Physics from the University of Nice Sophia-Antipolis (France) and a master's degree in Intellectual Property Strategies and Innovation from the IEEPI (Strasbourg, France).

Contact: nicolas.baron@knowmade.fr

ABOUT KNOWMADE

Knowmade is a technology intelligence and IP strategy consulting company specialized in the analysis of patents and scientific information. The company helps R&D organizations, investors, and innovative companies to understand their competitive landscape, follow technology trends, and discover 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 findings into business intelligence tools. 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 extensive expertise in Compound Semiconductors, Power Electronics, Batteries, RF Technologies & Wireless Communications, Solid-State Lighting & Display, Photonics, Memory, MEMS & Solid-State Sensors/Actuators, Semiconductor Manufacturing, Packaging & Assembly, Medical Devices, Medical Imaging, Microfluidics, Biotechnology, Pharmaceuticals, and Agri-Food.

ORDER FORM

Hybrid Bonding

Patent Landscape Analysis – November 2019

Ref.: KM19008

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

Order online: [Click here](#)

Check

To pay your invoice using a check, please mail your check to the following address:

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

Money Transfer

To pay your invoice using a bank money wire transfer, please contact your bank to complete the process. Here is the information 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
IBAN: FR76 1460 7003 6360 6214 5695 139
BIC/SWIFT: CCBPFRPPMAR

Paypal

To pay your invoice via PayPal, you must first register at www.paypal.com. You can then send money to KnowMade S.A.R.L. by entering our email address (contact@knowmade.fr) as the recipient, and entering the invoice amount.

RETURN ORDER BY:

Email: contact@knowmade.fr

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

PRODUCT ORDER

- €6,490 – Corporate license
 €5,990 – Single-user license*

For price in dollars, please use the current day's exchange rate. French customers, add 20% for VAT.
Upon receipt of payment, all reports are delivered electronically in PDF format and Excel format.

**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 report-sharing is prohibited.*

I hereby accept Knowmade's Terms and Conditions of Sale

Signature:

TERMS AND CONDITIONS OF SALES

Definitions

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

“Buyer”: Any business user (i.e. any person acting in the course of its business activities, for its business needs) entering into the following general conditions to the exclusion of consumers acting in their personal interests.

“Contracting Parties” or “Parties”: The Seller on the one hand and the Buyer on the other hand.

“Intellectual Property Rights” (“IPR”) means any rights held by the Seller in its Products, including any patents, trademarks, registered models, designs, copyrights, inventions, commercial secrets and know-how, technical information, company or trading names and any other intellectual property rights or similar in any part of the world, notwithstanding the fact that they have been registered or not and including any pending registration of one of the above mentioned rights.

“License”: For the reports and databases, 2 different licenses are proposed. The buyer has to choose one license:

1. Single-user license: a single individual at the company can use the report.
2. Corporate license: the report can be used by unlimited users within the company. Subsidiaries are not included.

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

“Seller”: Based in Sophia Antipolis (France headquarters), Knowmade is a technology intelligence company specialized in the research and analysis of scientific and technical information. We provide patent landscapes and scientific state of the art with high added value to businesses and research laboratories. Our intelligence digests play a key role to define your innovation and development strategy.

1. Scope

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

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

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

2. Mailing of 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

BIC or SWIFT code: CCBPFRPPMAR

IBAN: : FR76 1460 7003 6360 6214 5695 139

To ensure payment, 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.