VCSEL
Patent Landscape Analysis
November 2018
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ABOUT KNOWMADE

Specialized in analysis of patents and scientific information, Knowmade provides Technology Intelligence and IP strategy consulting services. The company supports R&D organizations, industrial companies and investors in their business development by offering them a deep understanding of their IP environment and the technology trends.

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Knowmade’s 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’s analysts combine their technical and patent expertise by using powerful analytics tools and proprietary methodologies to deliver relevant patent analyses and scientific reviews.
**SCOPE OF THE REPORT**

Examples of patents included in the report

<table>
<thead>
<tr>
<th>Example</th>
<th>VCSEL devices and systems</th>
<th>VCSEL applications</th>
<th>Excluded</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface mounting packaging for high-speed vertical cavity surface-emitting lasers</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Method of fabricating a membrane using selective area deposition</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Visual with improved optical and electro-mechanical properties</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Optical source and detector using vertical cavity surface-emitting laser diode</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Examples of patents excluded from the report

<table>
<thead>
<tr>
<th>Example</th>
<th>Not included in the report</th>
</tr>
</thead>
<tbody>
<tr>
<td>VCSEL-Optical diode and laser diode</td>
<td></td>
</tr>
<tr>
<td>Display device having integrated piezoelectric material</td>
<td></td>
</tr>
<tr>
<td>Double diode structure using two laser diodes</td>
<td></td>
</tr>
<tr>
<td>Horizontal cavity surface-emitting laser assembly for fast assisted magnetic recording</td>
<td></td>
</tr>
<tr>
<td>Edge emitting semiconductor laser</td>
<td></td>
</tr>
</tbody>
</table>

**VCSEL – Patent Landscape Analysis | November 2018 | Ref. : KM18007**

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Understanding the main trends

Who, When and where?

IP LANDSCAPE OVERVIEW
Main patent applicants

IP LANDSCAPE OVERVIEW
Geographic map of patent applications

IP LANDSCAPE OVERVIEW
Time evolution of patent publications: Main IP players

IP LANDSCAPE OVERVIEW
Time evolution of patent publications of main application segments

Datacom and laser printing applications are the two oldest and most mentioned applications in patents related to VCSEL. Their related IP activities have decreased before 2010 because of the development of alternative solutions (inkjet printing, wireless technologies, etc.). However, IP activities related to those two applications are now well settled and constant (around 50 new inventions per year since 2010).

Since 2013, we have witnessed a strong increase of the patenting activity related to new applications: LiDAR, consumer applications (facial recognition and 3D imaging), medical imaging (OCT) and atomic clocks are today the main applications that drive the IP activity related to VCSEL.

It is interesting to notice that VCSEL have been mentioned for more than 10 years in every segment. However, the development thereof applications have only known a fast growing IP activity since 2013.
Understanding the main technological approach

Corpus segmentation by material, valued chain position and patented technologies

IP POSITION OF MAIN PATENT APPLICANTS

Patent corpus segmentation

Value chain: from VCSEL to their applications

VCSELs: Inherently high speed optical sources for high-speed remote sensing, optical computing, free space communication and high-speed data networking.

VCSEL array: High power VCSELs used in high-density, high-speed optical interconnects. VCSELs for high-speed optical computing and communication systems.

VCSEL packaging: Packaging solutions for VCSELs to enable high-performance and reliability in various applications.

Corporat segmentation by material, valued chain position and patented technologies

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Comparison of IP players
Portfolios analysis and ranking: who has the strongest IP position and why?

[Diagrams showing IP leadership, blocking potential, and reinforcement potential]
Understanding the key players IP strategies

Key player portfolio analysis

From portfolio to IP strategy
Key patents identification
What are the strongest, most blocking, promising ... patents?

**GRANTED PATENTS NEAR EXPIRATION**

Most relevant patents

In the following part, KnowMade has identified the most relevant patents that will expire in the first trimester of 2019. Among these patents a manual selection of the most relevant blocking patents (granted patents), seminal patents (most cited patents) and promising patents has been done.

**Patents involved in litigations**

Optical Communication Products vs Finisar Corporation

**Key patents related to manufacturing issues**

Key patents related to eyes safety

The development of new markets and applications have boost the development and R&D activity related to their manufacturing. Because the laser is can now be indirect contact with an human eye, VCSELs for consumer and B2B applications have to be safe and harmless for eyes as defined by each government policies.

40 patents families directly mentioned eyes safety concern in their description.

**Key patents related to yield improvement**

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A vertical-cavity surface-emitting laser (VCSEL) array (901) is provided with: a base substrate (11); VCSEL element columns (101-105) from each other. The insulation grooves (92) electrically insulate the VCSEL elements from each other. (From US9692211 B2)

A VCSEL array includes a base substrate, VCSEL element columns arranged in a row direction (y direction) on a plane, the VCSEL elements are located immediately above the columns, and the columns and VCSEL elements are electrically insulated from each other. The insulating grooves electrically insulate the VCSEL elements from each other. (From US9692211 B2)

A pick-up unit, an optical drive comprising such a pick-up unit, and a method of generating error-signals are disclosed. Relative timing for the switching of individual lasers of an array of VCSELs is used for the detection of error signals. (From US9692211 B2)

A vertical extended cavity surface emitting laser (VECSEL) includes intra-cavity frequency doubling. Conventional frequency control elements, such as etalons, are replaced with thin film interference filters or volume Bragg gratings. (From WO2006105249 A2)

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ORDER FORM

VCSEL – Vertical Cavity Surface Emitting Laser
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  - Assess patent & technology risks
  - Define your IP and R&D strategy
  - Monetize your technologies and know-how
  - Defend your business
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  Life Sciences, Healthcare and Agri-Food
  Medical devices, Medical imaging, Microfluidics, Biotechnology, Pharmaceutics, Food-processing

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Freedom-to-operate analysis
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Technology trends
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Make strategic decisions
Sustain competitive advantages
Speed R&D and enhance innovation process
Align R&D and IP with key business objectives
Strengthen IP portfolio and acquire technologies
Anticipate risks and defend core businesses
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Dedicated analyses

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Direct interaction between your team and our experts at your site

Prior art search
Freedom-to-operate analysis
Patent assessment
IP due diligence
Patent landscape analysis
Litigation & licensing support
Scientific literature analysis
Technology scouting
IP/Tech watch service

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  • Manual selection of relevant and related patents
  • Manual segmentation by technology & application

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Evaluate the patentability of your invention in the course of a patent filing. Invalidate competitor’s patents in the course of patent litigation or in anticipation of one. Make third-party observations concerning the patentability of competitor’s inventions.

Patent landscape analysis
Understand the competitive environment and the technology trends from a patent perspective. Identify key players, their IP strategy and their key patents. Know IP collaborations, licensing agreements and litigation history.

Freedom-to-operate analysis
Assess the risks to infringe third-party patents. Ensure that your products/processes can be safely manufactured, sold and used in specific countries without infringing patents held by others.

Litigation and licensing support
Evidence of infringement/non-infringement for offensive/defensive support. Defend your position in licensing negotiation or patent litigation.

Patent assessment
Identify most valuable patents prior to patent acquisition/sales, licensing agreement, capital fundraising process, M&A or IP due diligence. Estimate the financial value of your patent portfolio.

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Assess the patent portfolio of a company and reveal the SWOT matrix prior to patent acquisition/sale, licensing agreement or M&A.

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- VCSEL - Patent Landscape 2018
- RF GaN - Patent Landscape 2018*
- Power SiC - Patent Landscape 2018*
- GaN - Patent Watch 2018
- Patent Trolls in the Semiconductor Market - Litigation Risk and Potential Targets 2017
- GaN Devices for Power Electronics - Patent Landscape 2015
- GaN-on-Silicon Substrate - Patent Landscape 2014
- GaN Substrate - Patent Landscape 2014

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**RF DEVICES & TECHNOLOGIES**
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- RF Front End Module - Patent Landscape 2018
- RF Acoustic Wave Filters - Patent Landscape 2017

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- Patent Trolls in the Semiconductor Market - Litigation Risk and Potential Targets 2017
- TSV Stacked Memories - Patent Landscape 2016
- ReRAM and Memristor Technologies – Patent Landscape 2015
- Emerging Non-Volatile Memories (eNVM) - Patent Landscape 2014

**BATTERY AND ENERGY MANAGEMENT**
- Solid-state Batteries - Patent Landscape 2018*
- Status of the Battery IP - Patent Activity 2017
- Battery - Patent Watch 2018
- NMC Li-ion Batteries - Patent Landscape 2017
- Microbattery - Patent Landscape 2016

**IMAGING**
- VCSEL - Patent Landscape 2018
- iPhone X Proximity Sensor and Flood Illuminator - Patent-to-Product Mapping 2018
- LiDAR for Automotive - Patent Landscape 2018
- MicroLED Display - Patent Landscape 2018
- Biomedical Photoacoustic Imaging - Patent Landscape 2015
- Honeywell Microbolometer - Patent Portfolio Analysis 2015
- Capsule Endoscopy - Patent Landscape 2014

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