LED Technology Trends:

Material Science & Phosphor Innovations

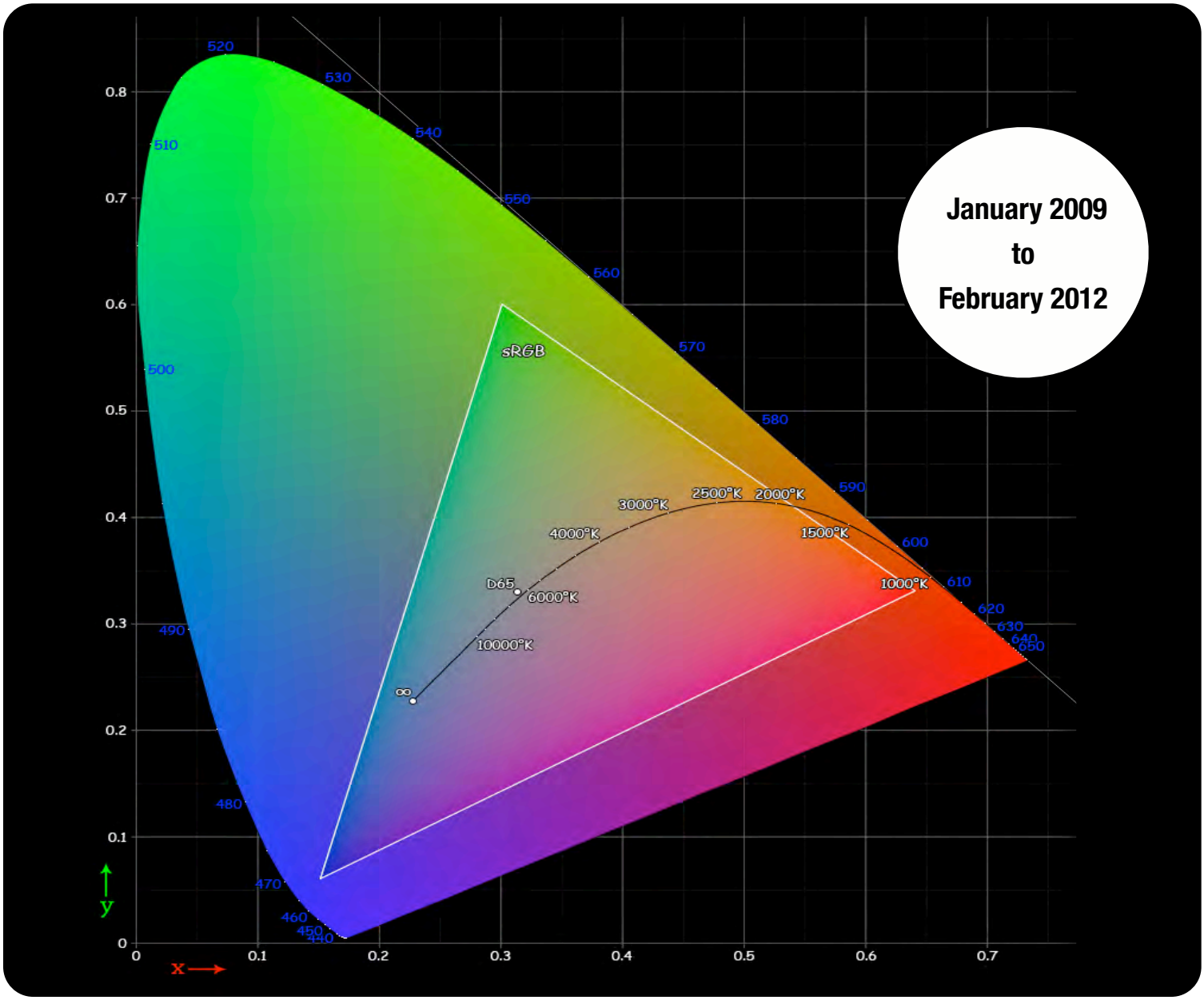

Image Credit: Wikimedia Commons, Spigget

TOP COMPANIES

See the top innovators in the LED material science and phosphors market, and check out the most prolific inventors.

NEW & NOTEWORTHY

Find out about recent developments in substrates, epitaxy, remote phosphors and other technology trends.

DATA CHECK

Learn about our LED patent database, a comprehensive solution to keep track of competitors and innovation.

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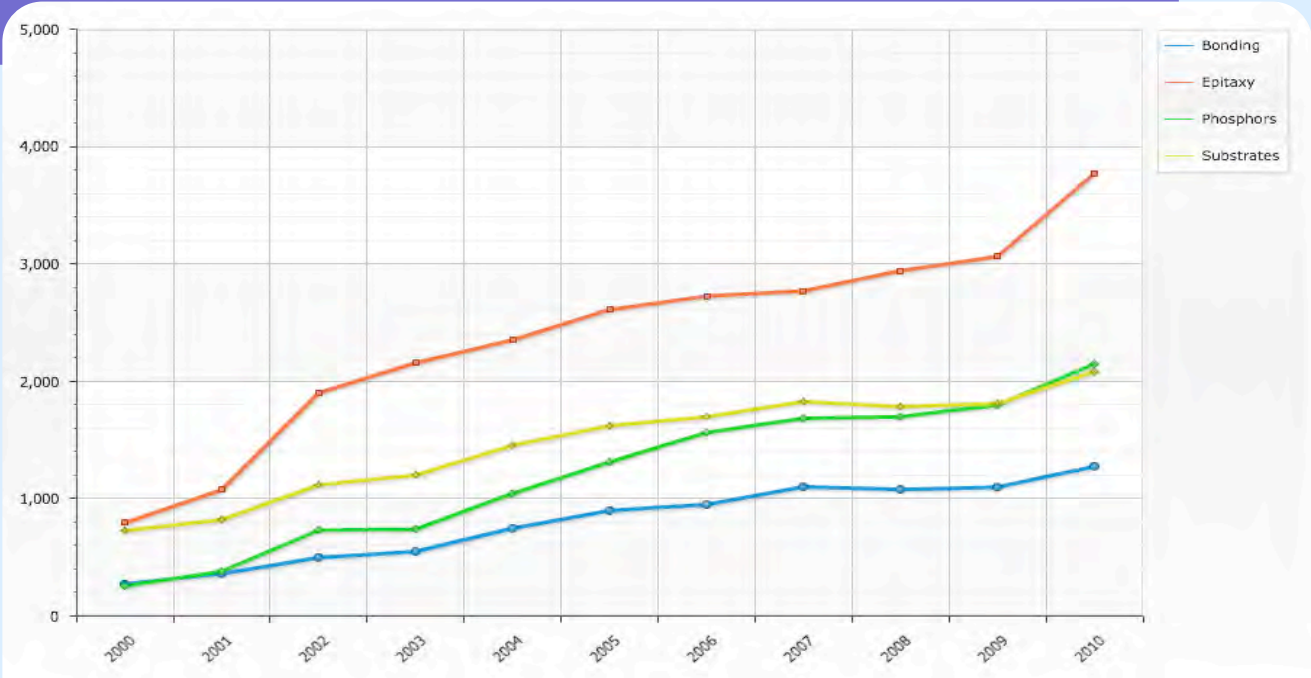
 Report Prepared By: Lily Li

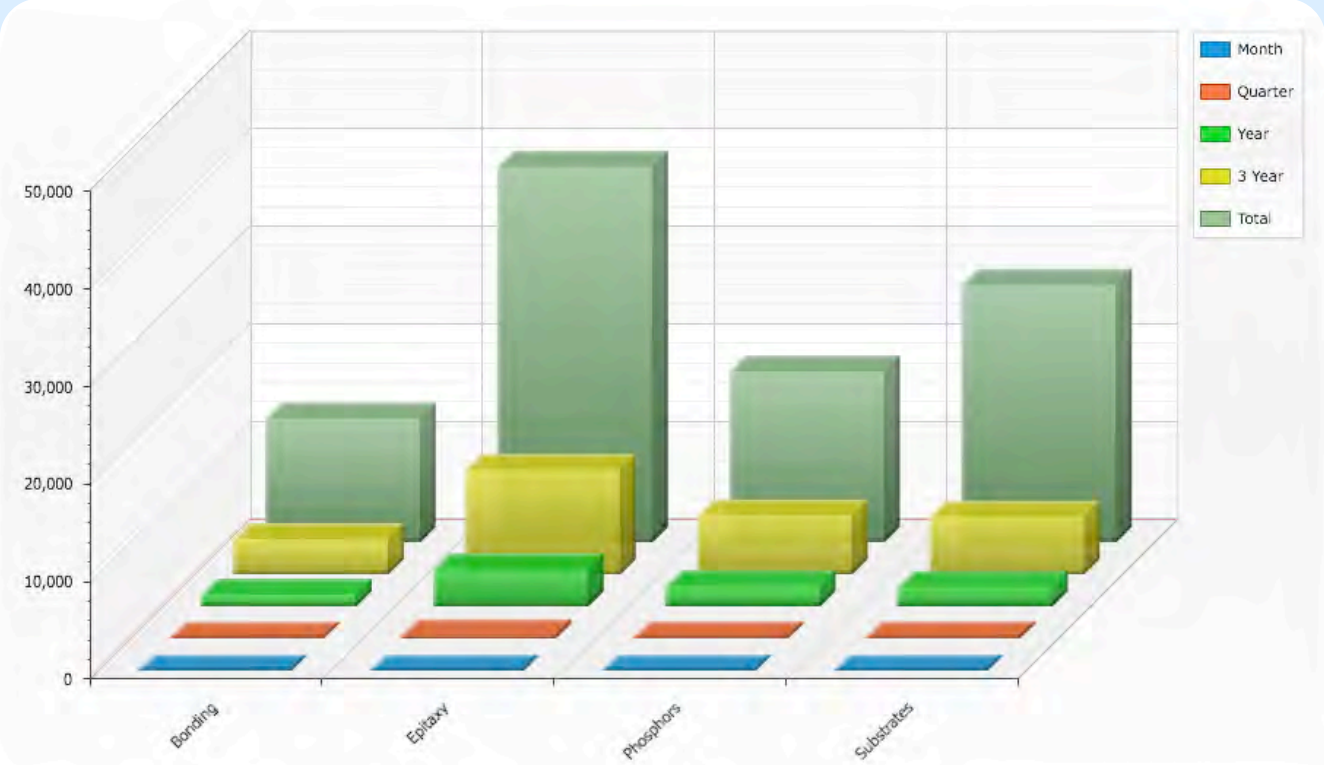
Broad Trends

All areas of LED materials technology have experienced rapid growth in technical innovation over the past decade. Epitaxy has led the way, with over 3500 new worldwide patent documents published in 2010 alone.



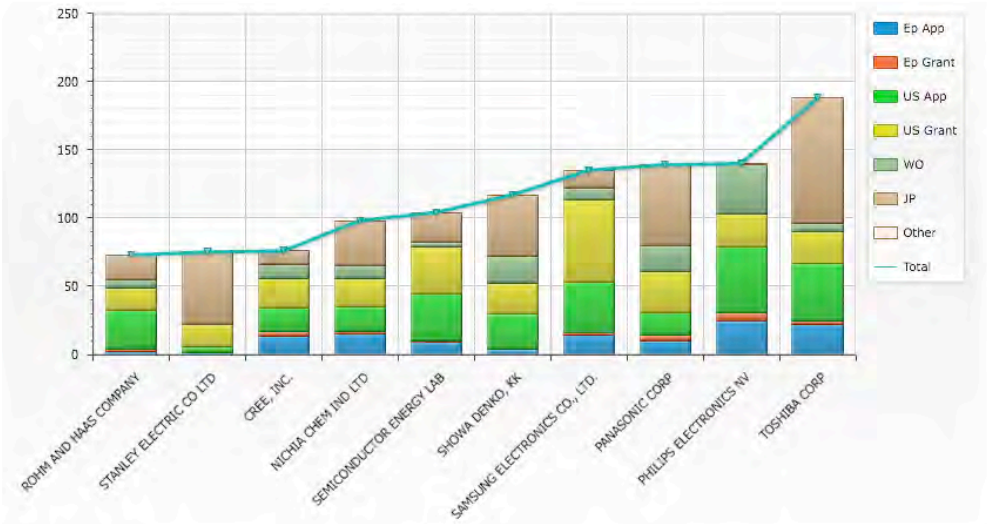
LED materials patent publication velocity from 2000-2010, across WIPO, US, Japanese, and European patent publications

The past three years have experienced unprecedented growth in LED material innovations, where new innovations comprise 10-20% of total patent output.

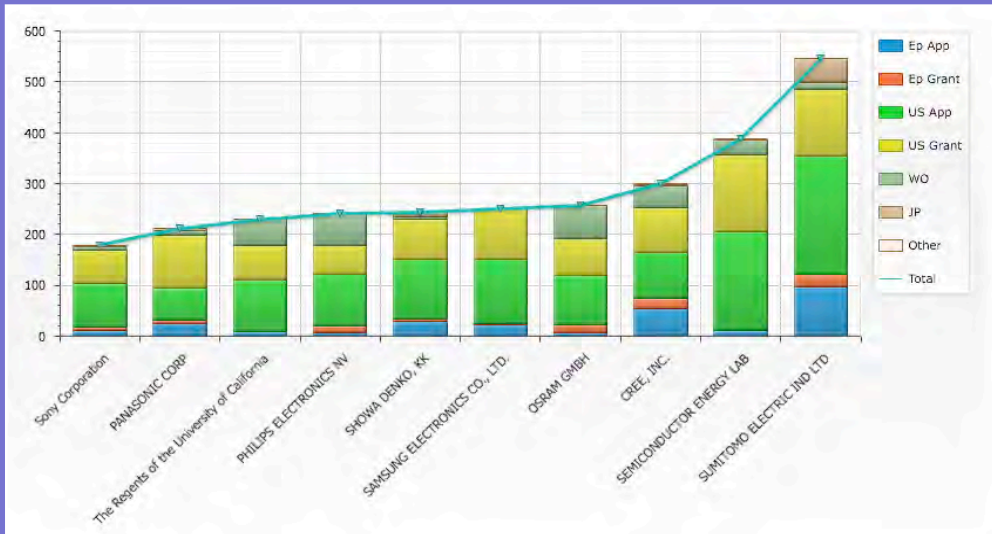


LED materials patent publication velocity by time period, across WIPO, US, Japanese, and European patent publications

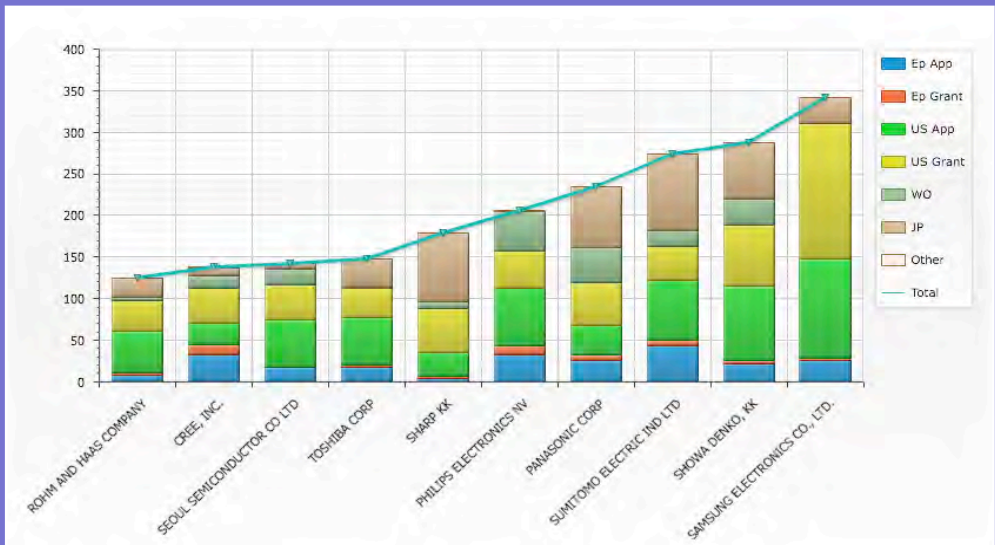
TOP INNOVATORS: BONDING, EPITAXY, SUBSTRATES



Top assignees in LED bonding materials by patent publications from 01/01/2009 to 02/01/2012



Top assignees in LED epitaxy by patent publications from 01/01/2009 to 02/01/2012



Top assignees in LED substrates by patent publications from 01/01/2009 to 02/01/2012

The Breakdown:

- The top innovators in LED materials technology are consistently large Japanese and Korean electronics conglomerates such as Toshiba, Sumitomo, and Samsung.
- In bonding and substrates, the top companies are dividing their R&D efforts across markets in the United States, Japan, and Europe. In the epitaxy sector, however, almost all innovation is tied to the United States market.
- The companies that feature most prominently across all three materials sectors are: Showa Denko, Cree, Samsung, Panasonic, and Philips.
- Some companies that are prominent in the LED space, such as Nichia, do not file patents as aggressively and therefore do not rank prominently in these figures.

Best in Class?

Samsung, with the Highest Number of US Issued Patents

A Closer Look at Phosphor Innovations

In contrast to the leaders in the previous categories (bonding, epitaxy, and substrates), Philips is the clear leader in phosphor innovations. Philips NV holds approximately 5% of the phosphor patents issued in the last 10 years.

Philips dominates the patent landscape, with almost twice as many patent documents as the next major competitor, Cree. This is a break from other LED materials sectors where large Japanese and Korean companies are the top patent filers.

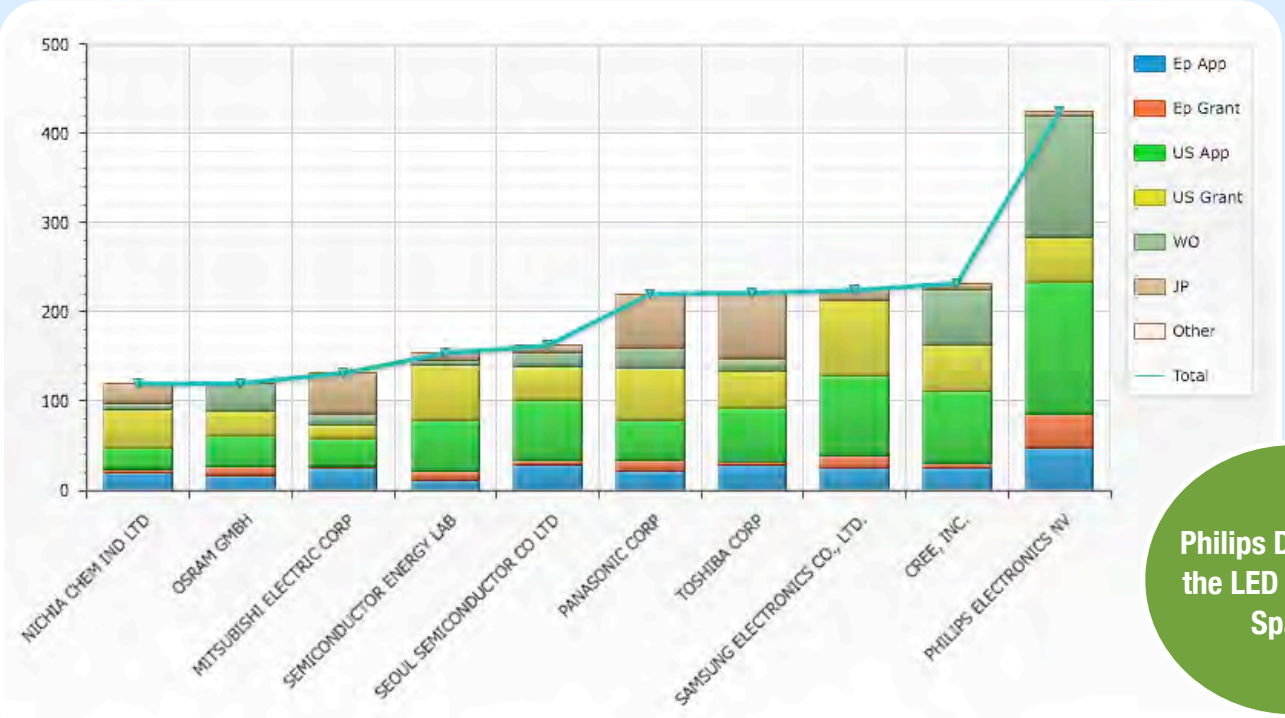
The introduction of remote phosphors may change the competitive landscape as Cree and other companies capitalize on this new innovation. Cree's recent launch of its remote phosphor patent licensing program, for instance, represents an attempt to consolidate and control the LED phosphor space.

NEW & NOTEWORTHY PHOSPHOR PATENTS

US8093802
Light emitting diode with a deoxyribonucleic acid (DNA) biopolymer
Assignee: US Government, Secretary of the Air Force

US8101443
LEDs using single crystalline phosphor and methods of fabricating same
Assignee: Cree

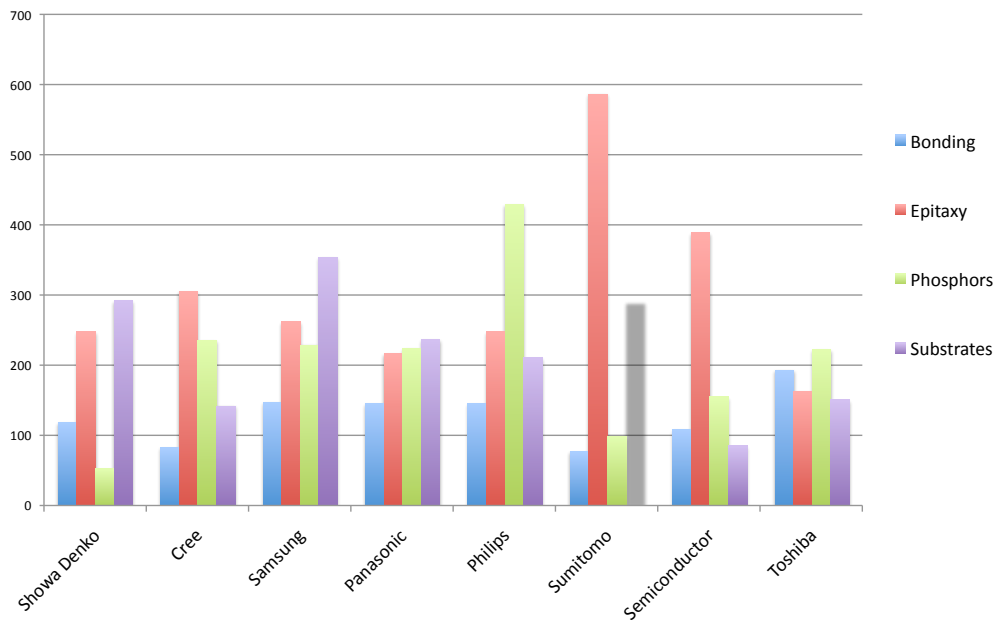
EP2031039B1
Light emitting device employing non-stoichiometric tetragonal alkaline earth silicate phosphors
Assignee: Seoul Semiconductor



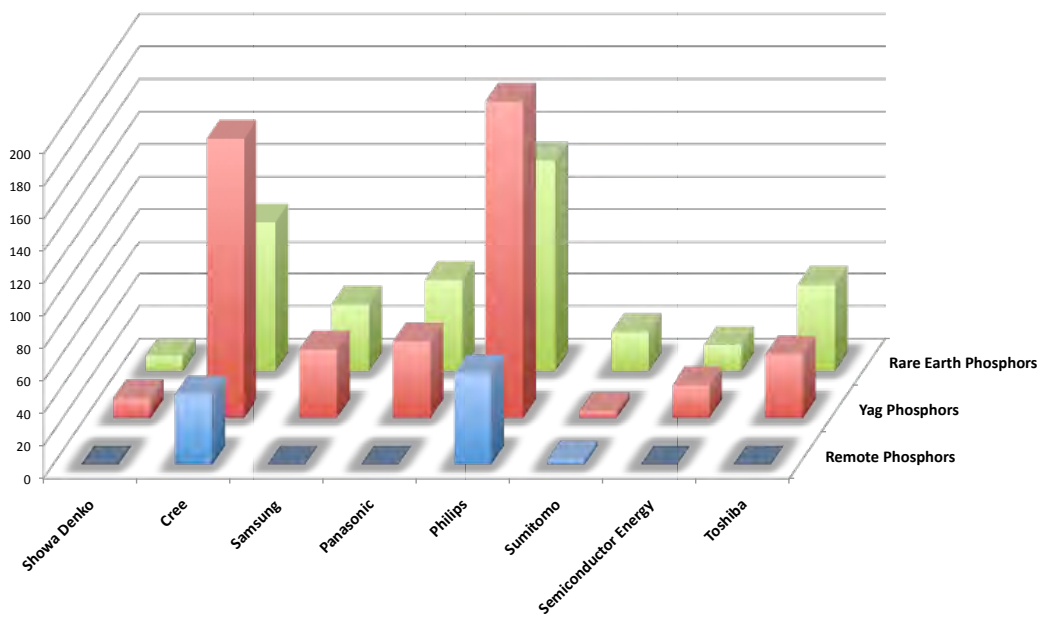
Top assignees in LED phosphors by patent publications from 01/01/2009 to 02/01/2012

Philips Dominates the LED Phosphor Space!

A COMPARISON OF TOP COMPANIES' PATENT PORTFOLIOS



Company comparison of patent publications from 01/01/2009 to 02/01/2012

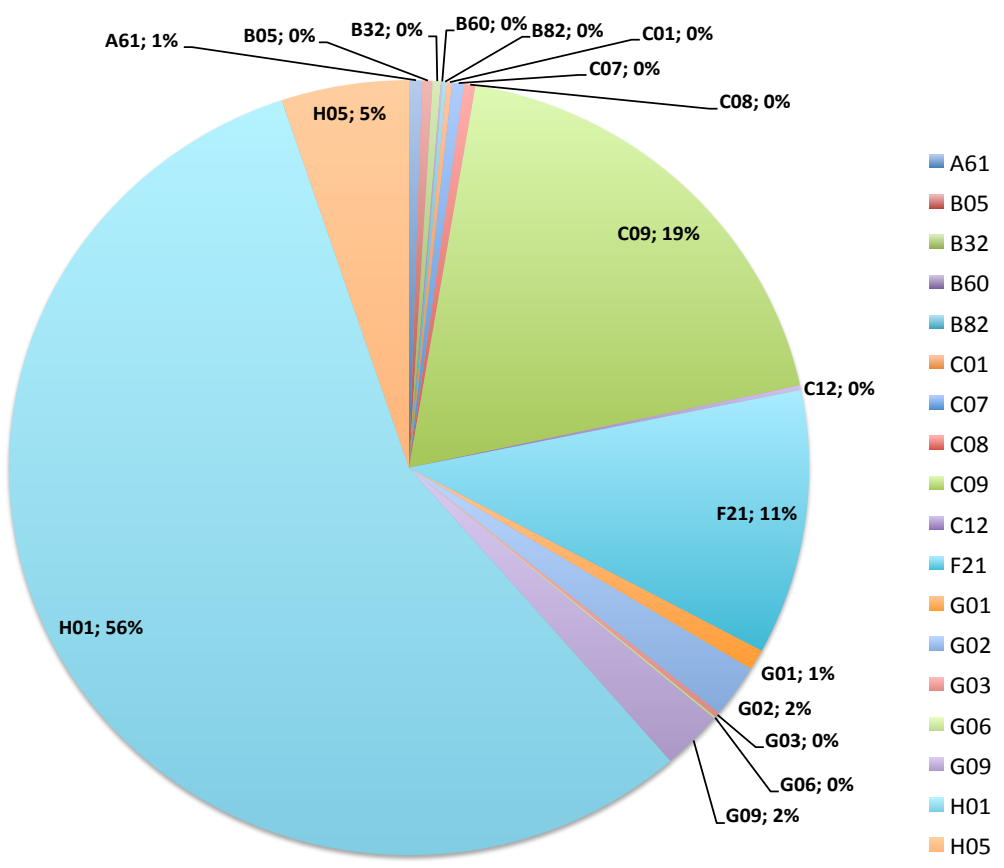


Company comparison of phosphor technologies and applications. Publications from 01/01/2009 to 02/01/2012

The Breakdown:

- Despite the size and market power of these top companies, there is still competition in innovation. No company sweeps the field, as each innovator features different competencies across bonding, epitaxy, phosphors, and substrates.
- The chart suggests that all of the top companies are filing patents strategically within a limited budget.
- For example, Toshiba files a similar number of patents across different material sciences, but does not exceed 300 patent documents in any given space.
- Sumitomo, on the other hand, has over 540 patent documents in epitaxy, but has limited capacity for patenting within bonding and phosphors.
- Within phosphors, Philips and Cree dominate all three categories of remote phosphors, Yag phosphors, and rare earth phosphors.

PHOSPHOR TECHNOLOGY TRENDS:
INTERNATIONAL PATENT CLASSIFICATION (IPC) CODES



IPC classification code breakdown of phosphor patent publications from 01/01/2009 to 02/01/2012

Most Prevalent IPC Codes (in order):

H01: Basic Electronic Elements

C09: Dyes; Paints; Polishes; Natural Resins; Adhesives

F21: Lighting

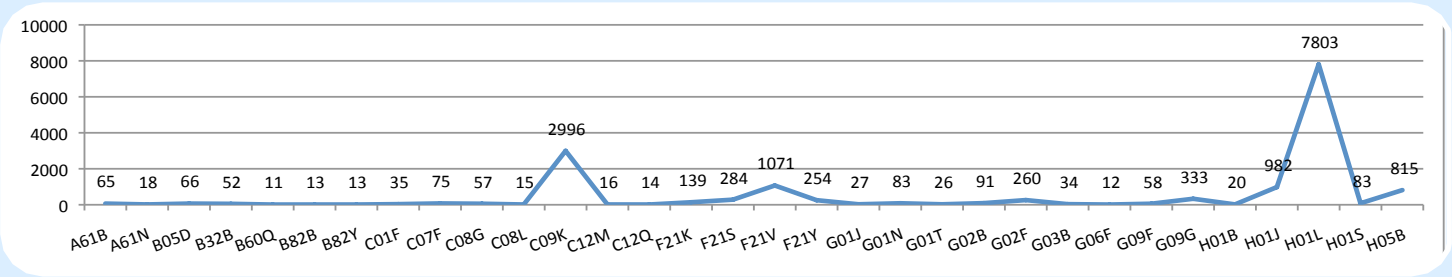
H05: Electrical Techniques

G02: Optics

G09: Display: Indicating Devices

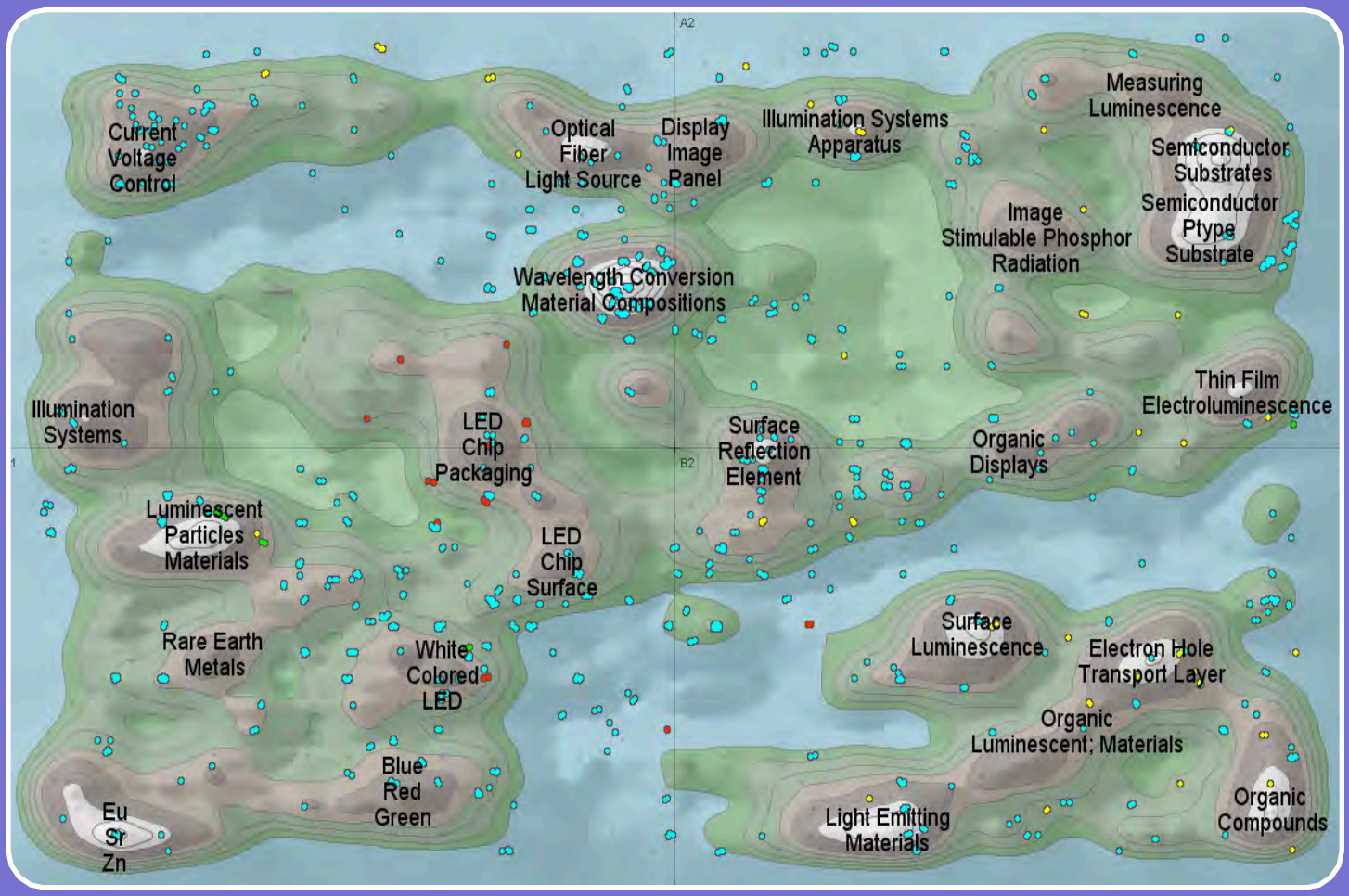
Outlier Technologies

International Patent Classification (IPC) codes provide a hierarchical classification of patents according to different areas of technology. An analysis of IPC codes can show the types of innovation within a particular sector, and whether companies are focused on innovative "outlier" technology spaces. For example, in the phosphor space, outlier technologies can be found in the A, B, and G class codes. These technologies include a Philips tanning device using LED lights (IPC A61N, EP1624931B1), nanocrystal-metal oxide composites and preparation methods (IPC B32B, US8092719), and LEDs as a source of illumination for medical endoscopy (IPC G01N, US8098375).



PHOSPHOR TECHNOLOGY & PATENTING TRENDS:

PATENT LANDSCAPE MAP



Themescape landscape map of 2009-2012 LED phosphor patent publications. Map provided by Thomson Reuters.

The software-generated map above provides a visualization of high level trends in the LED phosphor patent landscape. The words represent relevant concepts that frequently occur in the titles and abstracts of patent documents. The white areas, or "peaks", represent concentrated areas of patent activity related to the concepts listed on each peak. The blue areas, or "seas" represent areas in which there is a lack of concentrated patent activity. In this map, semiconductor substrates (top right) and Europium, Strontium, and Zinc phosphor materials (lower left) are areas of high technological innovation.

Legend:

- **Blue Dots: Philips**
- **Green Dots: Nanosys**
- **Red Dots: Everlight**
- **Yellow Dots: Xerox**

Onto this landscape map, we identified four United States companies in the phosphor space to compare and contrast their patent portfolios and innovation techniques. Philips stands out as the dominant player in the field, occupying all areas in the LED phosphor technology space with its own technological innovations. Everlight, though small, still has a strong innovation stance - focusing most of its R&D efforts into the chip packaging space. Xerox, on the other hand, has a much more diffuse patent portfolio across the phosphor landscape, suggesting that this area is not one of the company's core competencies.

No innovation is possible without top minds behind it. On this page we celebrate our superstar inventors.

Superstars of US Patents?

Published Patents: Yi-Qun Li of Intematix

Issued Patents: Shunpei Yamazaki of Semiconductor Energy Labs

Superstars of European Patents?

Published Patents: Hisayoshi Daicho of Koito

Issued Patents: Naoto Hirosaki of Sumitomo Chemical

Superstar Inventor of All Time in Phosphors?

Shunpei Yamazaki of Semiconductor Energy Labs

SUPERSTAR INVENTORS: PHOSPHORS (2009-2012)

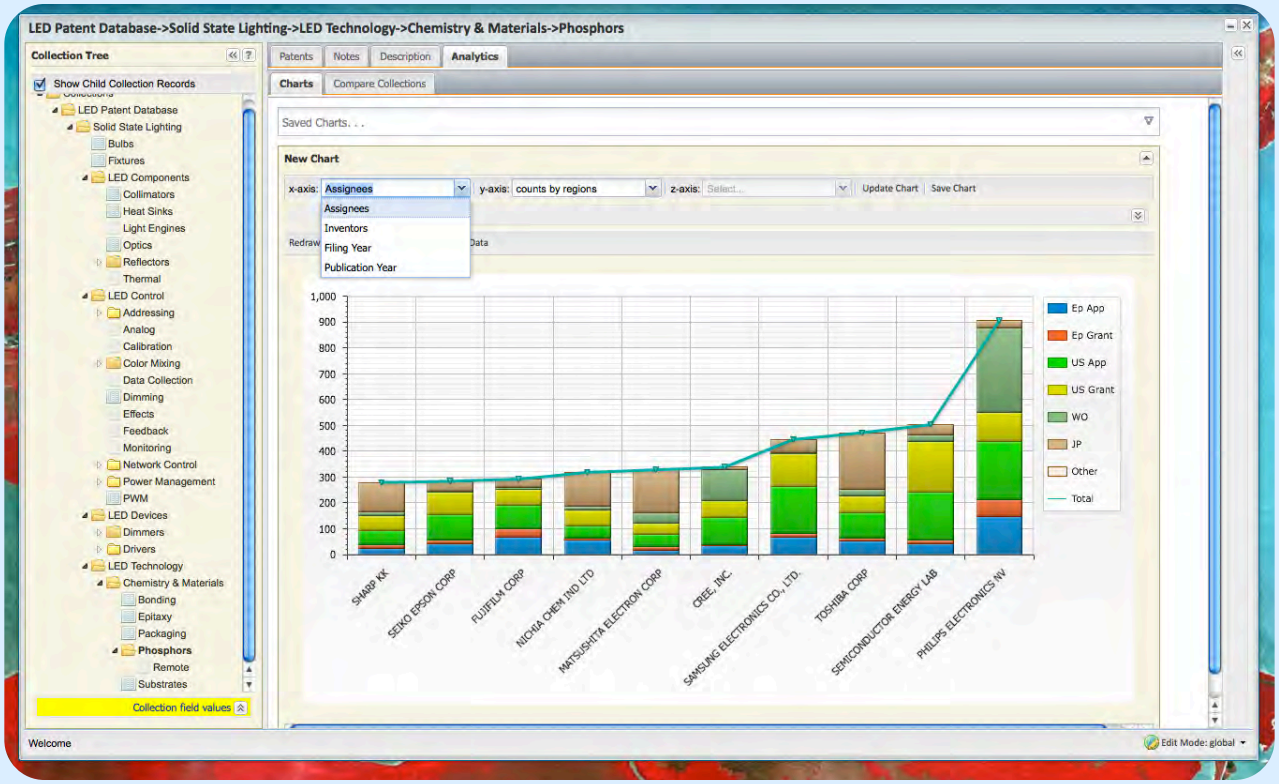
INVENTOR	COUNT	AFFILIATION
Yi-Qun Li	47	Intematix Corporation
Gerald Negley	40	Cree Lighting Solutions
Chung Hoon Lee	40	Seoul Semiconductor Co.
Serge J. Bierhuizen	32	Philips Electronics
Shunpei Yamazaki	32	Semiconductor Energy Labs
Yoshinori Shimizu	31	NIchia Corporation
Hisayoshi Daicho	31	Koito Manufacturing
Naoto Hirosaki	29	National Institute for Materials Science/ Sumitomo Chemical Co.
Gerard Harbers	26	Xicato Inc./ Philips Electronics
Hideo Nigai	26	Matsushita/ Panasonic Corp.

APPENDIX:

THE LED PATENT DATABASE - POWERED BY CLEANTECH PATENTEDGE

The LED patent database is a unique patent-focused solution aimed at serving the solid state lighting industry.

Our LED patent database allows you to identify and analyze industry trends, competition and technologies among different fuel product types and cultivation methods. Set alerts, monitor, and access updated patent information at the click of a button.



Stay ahead of the competition! Easily access and review relevant patents from more than 35 solid state lighting market categories by company, inventor, IPC codes, and keywords.