



OLED

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Innovation in Solid State Lighting

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ANALYST CORNER
**OLED lighting
sparks innovation
frenzy**

COMPANY INSIGHT
**Quality underpins
OLED panel
progress**

INDUSTRY REVIEW
**Efficacy steps turn
OLED lighting on**



Astron Fiamm, under the brand name Blackbody develops OLED lighting according to its customers' designs, like this "Big Bang" luminaire. (Courtesy of Blackbody)

"We also want to make a dramatic step on cost. It's already come down, but we want to decrease that by a factor of 5-10 by the end of next year," said Jörg Amelung, Ledon OLED Lighting.

Efficacy steps turn OLED lighting on

Astron-Fiamm, Ledon, Novald, OSRAM and Philips Lumiblade tell Andy Extance and iLED their plans for commercializing OLEDs in the lighting market.

Non-existent until 2007, today OLED lighting is a young and growing industry - but still too young for significant sales volumes. Before entering the sector, the innovative new companies and powerful old ones populating it must have all asked: how can we commercialize this technology? With their rewards dependent on the answer, the companies' choice of strategy is critical for their future.

Though only founded in 2009, Dresden, Germany's Ledon OLED Lighting is a joint venture between industrially-experienced Zumtobel and OLED-pioneering Fraunhofer Institute for Photonic Microsystems. Established to supply lighting modules to luminaire and fixture producers alongside fellow Zumtobel group member Tridonic's drivers, Ledon does not have its own organic material deposition facilities. Instead, it can select the best OLED panels, explained Jörg Amelung, Ledon's general manager. But initially basic OLED technology had to improve for that approach to become viable. "Until the last year there were performance issues that made it impossible to use OLEDs commercially," he said.

Commercialization became possible as technology improvements allowed Ledon's Lureon Rep modules to leap in luminous efficacy from 10-20 lm/W to 40 lm/W. Then in February 2013 they surged further, to an industry-leading 50 lm/W. "The next step is to go up to 80 lm/W this year and 100 lm/W next year, where OLED will become comparable with other lighting sources," Amelung said. "Then we also want to make a dramatic step on cost. It's already come down, but we want to decrease that by a factor of 5-10 by the end of next year." That will partly be driven by increased automation and output at the company's mounting line, he added. And though Ledon also lists size, lifetime and colour quality as general targets, cost is now the most important factor for improving OLED lighting sales, Amelung said.

Jan Blochwitz-Nimoth, chief scientific officer and co-founder of OLED materials supplier Novald, also based in Dresden, said prices combine with other parameters to drive adoption. "Price per lumen has to be competitive," he said. "Also, because you can use light straight from flat OLED systems, their system efficacy should be able to beat 50 lm/W

for fluorescent and 50-100 lm/W for LED systems. But I believe that weight becomes an issue with large areas, while emitting too much light from a small area produces glare. Putting this area somewhere is becoming more complex, but paper-thin, flexible OLEDs can provide a solution to both the light and weight problems."

Blochitz-Nimoth emphasises Novaled's focus on charge carrier transport and scalable large-area outcoupling materials used in producing OLED modules, where its targets are to reduce voltages and absorption losses. But his company also offers Linternity luminaires, high-price carbon-fibre desk lamps commercialized through retailers. "It's introducing OLED technology to consumers, and we hope it will make money," he said. "We buy OLEDs from a customer who uses our materials. It has helped understand how our materials not only improve OLEDs' performance but also influence their appeal. For example, for some applications a milky effect is more appealing than a colored mirror effect if devices are switched off."

Germany's Osram underlined that the experts at its Regensburg OLED Development Center are also focussed on materials as they try to improve service life, efficiency and brightness. "The researchers can improve performance by skilfully combining the correct organic materials from the large variety available to them," said Christian Bölling, Osram's OLED technology spokesperson. "Research results on improvements in optical output coupling, which ensures that the greatest possible quantity of the light generated in the OLED

is actually emitted to the outside world, are useful here." Osram has used such advances to boost its Orbeos OLED panels, which first became commercially available in 2009. At the light+building show in Frankfurt, Germany, in 2012 it revealed it had increased service life to 10,000 hours, luminous efficacy to 40 lm/W and brightness to 2.000 cd/m². "These versions are already shipping," Bölling said.

I'd like to buy, but oh, my!

Another important approach for lowering cost-per-lumen is increasing panel size, noted Dietmar Thomas, official spokesperson for Lumiblade, Philips' Aachen, Germany, based OLED division. "Price is matter of production capacity and availability," Thomas pointed out. Lumiblade is therefore targeting 1 m² panel production by 2018, which Thomas called "a conservative goal". Philips is already progressing in that direction, having just inaugurated its newest OLED fab, and planning production starting in the first quarter of 2013.

Philips sees itself as leading OLED industrialisation, Thomas said, demonstrating the technology's capabilities to the whole lighting market. "We are in transition," he explained. "We started in 2008-2009 with the first high-class design projects, like the interactive wall, which is €60,000 for a 250 cm x 180 cm unit or our mirror, which is €3,400 per piece. This was never intended to be in the mass market, so we are also supplying panels to other luminaire makers, like Novaled. The future will see cheaper, more broadly targeted, Philips products. For example, the market is



Philips' Aachen OLED production line is set to begin production in Q1 2013. (Courtesy of Philips Lumiblade)

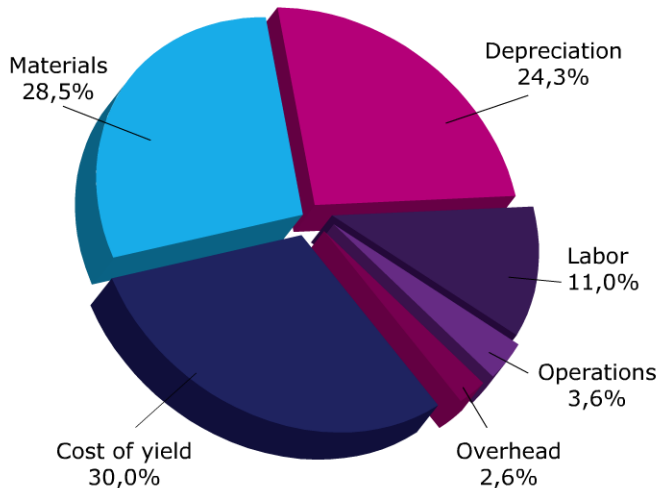
asking for our 124.5 mm x 124.5 mm GL350 panels. This is the first OLED panel going into the functional lighting area and will be one of the main products from the Aachen fab."

By contrast, Toulon, France's Astron Fiamm exclusively supplies tailor-made OLED lighting. It uses its own name for supplying technical lighting, and the Blackbody brand for its decorative products. "We make OLED lighting specific to our customers' needs," commented Bruno Dussert-Vidalet, Astron Fiamm's CEO. "We're a small company, with just 30 people, that's dedicated to tailor-made OLEDs. If customers are willing to invest a certain amount of money for tooling, they get OLEDs just for their lamp. For example, every car can have different fixtures, though we're not yet able to supply in large quantities."

The market is ready, although small, for decorative OLED lighting Dussert-Vidalet said, while for technical lighting purposes OLED technology has to be comparable to LED. "But OLED is already near enough to that level, today the problem is just price," he said. "Otherwise the major challenge is proposing designs the client likes." Astron Fiamm's bespoke operation has recently expanded its production capacity tenfold to 100 47 cm x 37 cm Gen 2 substrates per day, potentially yielding roughly 60 m² of lighting. Yet it is hoping that technology as well as scale will bring prices down. "In two years' time we expect 20-30 per cent more performance out of chemistry," Dussert-Vidalet said.

2012 OLED lighting panel manufacturing cost breakdown

(Source: OLED for Lighting report, November 2012, Yole Développement)



OVER A TOTAL OF NEARLY \$3,900/m²

The advances being made in OLED materials hold great potential agrees Philips' Thomas. "Overall research results for OLEDs are picking up momentum, both at Philips and across the world," he said. "Chemical companies have been improving efficiency, and making larger quantities available to the people who need them. Over the past year and a half, we've seen more efficient materials come on the market almost every month." That has helped push Philips' panels to 45 lm/W luminous efficacy, and 120 lm total output. It is also the only company in the market to provide OLED panels in all colours, shapes and also free forms, Thomas said.

OLEDs' ability to illuminate the world in new ways, such as windows or ceiling tiles unrecognisable as lights until they're turned on, also promises much, Thomas said. "OLED is not just a new light source - it's a material that emits wonderful light," he commented. "We have to think of ways to bring it into the market that don't look like old luminaires." In automotive applications OLEDs will never be used as headlights, Thomas added, but could enable thinner rear lights that increase trunk space or reduce vehicle size.

OLEDs: seeing semiconductors in a new light

Use in vehicles is an especially hot topic for Osram, Bölling said, after it presented an OLED rear light at the 2012 Electronica show in Munich, Germany. It also developed an OLED capable of withstanding temperatures of up to 85 °C for several hundred hours, which is important in automotive testing. "We will see the first cars featuring OLED lighting on the streets in 2015," Bölling predicted. And while the company emphasises that OLEDs' high quality, warm white light could be used in almost every application it also highlights its unique characteristics. "In contrast to traditional light sources, OLED panels do not become hot, and consequently they can be used directly on wood, for example for use in furniture," the spokesperson said. Osram is leading transparent

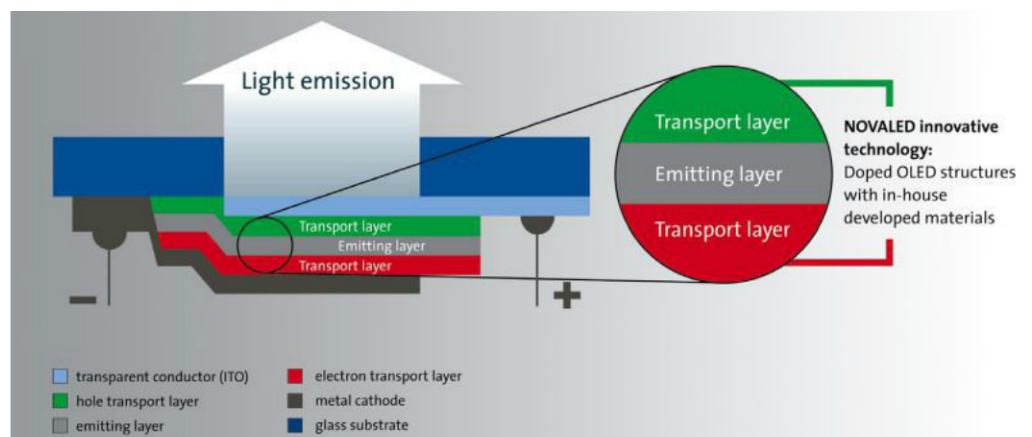
OLED lighting's commercialization, having presented its Rollercoaster luminaire featuring transparent panels in 2012. "These 'luminous glass panels' are intended for series-production from 2014 onwards," Bölling said.

Ledon's Amelung also stressed how obvious OLED progress was at trade shows like light+building in 2012, with. "We saw the first market applications, real luminaires, only in small volume, but it was still a big step," he said. Such advances will help Ledon penetrate its main target market: professional applications like offices, hotels, retail stores, or museums. "The main target is the light, rather than any other effects," Amelung said. "To deliver the best solution we look at the complete OLED, combining the best OLED element, mechanical, electrical and optical parts. We try to reach the point where the most efficient material and best colour quality meet. By combining these factors we offer state-of-the-art technology."

And while OLED will never replace LED lighting, underlined Dussert-Vidalet, it does currently have great prospects. "OLEDs are developing strongly and there's good potential to increase the performance," he said. "All the light you create you see, and production costs could be much lower than LED. Basic OLED light tiles are 2-4mm thick, and that could allow very thin light tiles on the wall. And while today everybody is working on glass substrates, in future they will be conformable or flexible." The ongoing advance of OLED in cellphone and TV displays is helping drive a steady market acceptance, he adds. "People are asking more competent questions than before," he says. "The more quickly the market accepts the technology, the faster we can sell, which is obviously very important."

OLED lighting also benefits from technological progress in displays, said Novaled's Blochwitz-Nimoth. "Our PIN doping technology is used in every Samsung cellphone, and lighting is much smaller than

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 said Bruno Dussert-Vidalet, Astron FIAMM.



Novaled is focussed delivering on charge carrier transport and outcoupling materials. (Courtesy of Novaled)

that, only pilot production," he said. "But we're seeing a constant increase in efficacy, and more serious products." Publicly-funded research programmes have also helped advance OLED lighting in Europe, the executive added. "For example, the OLED100.eu project developed 50 lm/W white panel tandem or triple stack technology," he said. "Also, the So-Light project produced new host transport and doping materials that are less absorptive."

But despite these collaborations, Novaled pursues "customer dedicated adaptation" to each application specification, in contrast to highly-regimented inorganic semiconductor technology. "OLED measurement techniques do have to be standardized," Blochwitz-Nimoth conceded. "The industry could standardize panel size or connections to accelerate adoption, but that's under debate, as it would restrict their aesthetic appeal. And while we can get make key, 'standard', universally distributed materials cheaper, standardisation isn't a driving force in OLEDs. Larger-scale production will play a bigger part in lowering costs. Standardisation is sometimes just used as a buzzword. Material standardisation probably won't happen in organic semiconductors."



In February 2013, Ledon's Lureon Rep modules reached 50 lm/W luminous efficacy. (Courtesy of Ledon OLED Lighting)

Andy Exance for Yole Développement



Jörg Amelung, General Manager, Ledon OLED Lighting

Jörg Amelung received his diploma in physics from the University of Duisburg, Germany. From 1999 until 2008 he was responsible for the OLED activities inside the Fraunhofer Institute for Photonic Microsystems (IPMS) in Dresden, Germany. In 2003, he co-founded Novaled AG. In 2009 he founded LEDON OLED Lighting, a joint venture of Zumtobel and the Fraunhofer Society, whose mission is development and fabrication of OLED module solutions



Jan Blochwitz-Nimoth, Chief Scientific Officer and Co-Founder, Novaled

Jan Blochwitz-Nimoth studied physics at the TU Dresden and the University of Oldenburg. He completed his diploma thesis at the Institute for Applied Photo Physics (IAPP) of the TU Dresden in the field of ultra-short laser spectroscopy. Afterwards he worked for one year on inorganic optoelectronic and light projection devices. While working on his PhD at IAPP, he conducted intensive research on applications of doped charge transport layers for OLED. He successfully completed his PhD in July 2001. With his outstanding knowledge of doped charge transport layers for OLED Jan Blochwitz-Nimoth is a key inventor of the Novaled PIN OLED Technology. In 2011 he received the 'Deutscher Zukunfts-preis' award.



Bruno Dussert-Vidalet, Chief Executive Officer, Astron FIAMM

A graduate of ISEP (an engineering school specialized in Electronics & Computer Science) and from HEC in Marketing and Business development, Bruno Dussert-Vidalet has followed an international career path and benefits from strong experience in innovation management, business and industrial development. From 1995 to 1998, he worked for Alcatel IRS and from 1998 to 2002 he was employed by the Multimedia Department at Siemens VDO. From 2002 to 2007, he was responsible for diversifying the activities of the FIAMM Group, in Italy. In 2007, supported by FIAMM he stepped into the OLED business by creating Astron FIAMM and its brand BLACKBODY.



Dietmar Thomas, Official Spokesperson, Philips Lumiblade

Thomas and his colleagues oversee the worldwide marketing activities for Lumiblade, Philips' OLED lighting division. Dietmar Thomas is an avid writer and journalist with over 25 years of experience in communication. In that time he worked for large corporations in the entertainment and car manufacturing industries, PR agencies and publications in Europe and the U.S.



Christian Bölling, Spokesperson Technology, OSRAM

Bio not available