

# MEDIA KIT

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## FACTS ABOUT NOVALED



NOVALED – SOLUTION PROVIDER FOR

# OLED Display & Lighting Applications

## Fact Sheet

<b>BUSINESS MODEL:</b>	The company offers its Novalled PIN OLED® technology along with its proprietary OLED materials, the realisation of customized OLED products and further services
<b>ACHIEVEMENTS:</b>	several OLED world records in OLED lifetime and power efficiency (e.g. power efficiency -green-110 lm/W at 1000 cd/m <sup>2</sup> )
<b>IP POSITION:</b>	some 400 patents and over 85 patent families (both granted or applied)
<b>MARKETS:</b>	multibillion dollar flat panel display and lighting market
<b>FACILITIES:</b>	18,000 ft <sup>2</sup> occupied incl. clean Rooms (Class 10,000 and 100) and chemistry laboratories
<b>LEGAL STATUS:</b>	Stock Corporation (privately hold)
<b>FOUNDATION:</b>	2001, operative since 2003, headcount as per March 2010: <100
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### MGT. BOARD:



**GILDAS SORIN, CEO**

...started his career with Thomson in 1977, holding several positions in R&D. In 1986, Mr. Sorin became deputy general manager of the worldwide Thomson R&D organisation and in 1991 general manager Thomson strategic sourcing. He was appointed director of the joint venture Thomson / ST Microelectronics in 1991, of Thomson LCD in 1995, and president of Thomson plasma in 1997. In 1998 Gildas Sorin joined Philips to become vice president of Philips display division and general manager of Philips plasma displays. Mr. Sorin attended Thomson University during 1999 and was awarded a degree in Senior



**GERD GÜNTHER, CMO**

...studied Economics at Nuremberg University specialising in International Sales and Marketing. He started his career in the pharmaceutical industry in 1987 and later joined several consumer electronics companies in the field of marketing. In 1995, he was appointed Head of Business Unit Portable Audio at Grundig AG located in Hong Kong. In his last appointment, Gerd Günther was Director of Worldwide Marketing for Grundig. During this time he was also the Product Director for Flat Panel Devices.



**HARRY BOEHME, CFO**

... started his career as an attorney in private practice, with a focus on commercial and company law. In 2000, he joined a US-based international software firm, where he served as Legal Counsel for Central Europe for two years. In 2002, he joined an international e-Commerce Software company in Germany, serving as General Counsel and, from 2003, also as Director Finance for the worldwide activities. He has a broad knowledge in commercial and stock corporation law, and a wide experience in corporate finance activities. In his career, he successfully completed a number of Capital Markets Transactions, comprising fund raising activities and registration

Management.

processes.

## Interview with Gildas Sorin (CEO)

**Novaled appears to have an interesting technology, which gets some validation in the market. What proof-points suggest your success?**

**G. SORIN** Of course, there are no proof-points or guarantees, but OLED already emerges in a growing flat panel display markets. OLED displays are thinner, perform better picture quality, and require less production steps as LCD or Plasma. Novaled started its activities in 2003, nevertheless generated revenues of 8.8 Mio US Dollar in 2007.

**Who are your customers and what is your product?**

**G. SORIN** Novaled is the world leader for OLED power efficiency. All display manufacturers are potential customers of Novaled. They are mainly based in Taiwan, Japan, Korea and in the future we expect major players from Mainland China. Furthermore there is a multitude of applications in lighting and customers are all around the world. Novaled offers its Novaled PIN OLED(R) technology and OLED materials.

**Does Novaled plan to expand its operations?**

**G. SORIN** Yes, we doubled our manpower in the last two years, but still seeking talents globally to further strengthen our position. Besides our Headquarters in Dresden (Germany) we are present in Taiwan, Korea, Japan and China with sales force. We definitively intend to set up a technical team in Asia in the next future.

**How do you position Novaled in the value-chain the long run?**

**G. SORIN** We provide OLED technology and material to the OLED display and lighting makers.

**Today you sell IP and proprietary materials for the “OLED stack”. Have you considered to capture a larger stake in this field?**

**G. SORIN** Yes, we are selling know-how, IP and specific doping materials. The proprietary Novaled transport and doping materials are available in large scales. Due to our industrial collaboration with Ciba Speciality Chemicals we ensure highest quality and on demand availability for customers mass production.

**Recently Novaled announced several world records in lifetime and power efficiency, e.g. for a green OLED with 110lm/W. Does this development affect the market?**

**G. SORIN** In December 2003 we already set the world record and since improved the benchmark for the industry continuously. This underlines our competitive edge. Novaled is indisputably the leader for power efficient OLEDs. We are the first who broke the 100lm/W border and still work to accelerate the OLED transition towards a leading position in the flat panel display market and the promising business of large lighting areas.

**What are your next goals in the technical field?**

**G. SORIN** Our teams are preparing further breakthroughs and intend to strengthen leadership by enhancing the OLED power efficiency. For lighting applications Novaled holds records on power

efficiency together with Philips lighting. Our strategy aims to offer the most efficient and easily producible OLEDs.

### **Do you expect additional applications beside the lighting and display?**

**G. SORIN** A new world of electronics: the organic electronics (OE) is in front of us. OE can be described as electronics and photonics products created with the use of organic materials. These materials may be semiconductive, light-emitting or photo active. OLED display and OLED lighting are two OE constituents besides a multitude of other applications under preparation, from solar cells to RFID. The OE move is comparable to the silicon move in the late 1970's. But contrary to the silicon world, requesting heavy industrial investments, organic semiconductors can be produced via printing technology and cheap vacuum deposition methods. The market expectations show a rapid growth in the coming years to reach a value above US\$ 34 billion by 2014

### **How is Novalled positioned for the OE?**

**G. SORIN** Novalled with its doping materials and technology solutions for almost all applications of OE, e.g. organic transistors, OLEDs, organic solar cells. With its uniqueness on organic dopants Novalled is well positioned to become a major player in this fast growing OE business.

### **Why is Thin Film Encapsulation (TFE) of interest?**

**G. SORIN** Thin film encapsulation is a promising technology to hermetically encapsulate organic devices like OLEDs and replace the current glass plates by very thin organic and inorganic multilayer. TFE will allow for flexible and roll able organic products with a thickness in the micrometer range.

### **How can Novalled be an important player in TFE?**

**G. SORIN** Thin Film for encapsulation consists of a structure of several organic and inorganic layers. The current generation of organic material does not allow a proper lifetime and requires too long processing time. Novalled has the skills on organic materials to develop the new generation of organic materials to resolve the current issues.

### **Why is Novalled cooperating with Sunic?**

**G. SORIN** A new organic material for TFE needs to be developed together with the associated deposition tool. Sunic System is a major producer of vacuum deposition equipment. Novalled will call on its experience in organic structures and skills in organic materials. Sunic System will provide its expert knowledge on both organic and inorganic deposition and encapsulation equipment. The cooperation with Sunic System will bring to market a turn-key solution enabling customers to rapidly ramp-up to high volumes at reasonable costs.

### **Will Sunic and Novalled commercialise the outcome of the cooperation together?**

**G. SORIN** Both companies agreed in a first step to jointly develop the deposition process and equipment. The two partners will decide on commercialization in a second step at due time.

### **When do you expect first results to hit the market?**

**G. SORIN** We entered into a long term cooperation to develop future generation of TFE and flexible devices. The first tools, materials and applicable technology should be announced in early 2009.

**Why is your technology superior in terms of mass production?**

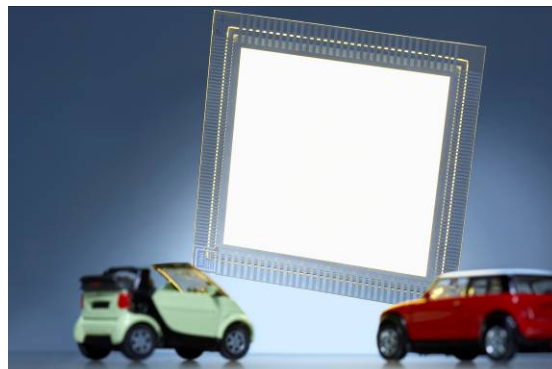
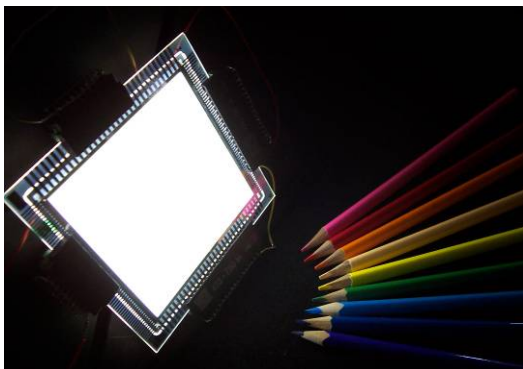
**G. SORIN** Our doping technology eliminates nearly all intrinsic losses of the OLED structure. Consequently, we have much lower operating voltages. Another issue is the overall yield. Thanks to the Novaled PIN OLED(R) technology that allows for thick charge carrier transport layers and wider process windows, one can expect to increase the yield.

**What makes your technology special or why it is a “must have” for the display industry?**

**G. SORIN** We increase power efficiency by factor two to three compared to our competitors by keeping the operating voltage close to the lower theoretical limit. Consequently, the Novaled PIN OLED(R) technology allows displays having the lowest power consumption in combination with top of the art lifetime and temperature stability. Power efficiency is crucial for portable devices but also for large screens concerning heat dissipation. In addition we offer high flexibility for our customers satisfy their need for inverted or non-inverted and top or bottom emission structures. Thus our technology fits to all kind of substrates. Our inverted top emission structure perfectly matches with amorphous Silicon Active-Matrix backplanes as needed for video application and television.

**Is your technology suitable for lighting applications?**

**G. SORIN** OLEDs will open up new fields of applications in the lighting domains. Very thin but very large lighting surfaces are feasible, in addition enhanced features, e.g. bendable and flexible substrates, colour setting and transparent devices. The Novaled PIN OLED(R) brings the lowest power consumption which is a mandatory criterion for lighting. Novaled will be a major player in the OLED lighting industry.



Source: Novaled, Large Area White OLED Panels for lighting applications

**What developments in the display market do you expect in the coming 5-10 year frame?**

**How is Novaled positioned for that?**

**G. SORIN** We expect the AM OLED display market to grow drastically. Highly efficient, temperature stable, long-lived OLED structures will be used. Most probably, top-emitting structures will be applied as well as white and RGB OLEDs could share the market in the future. Eventually, curved, bendable or flexible displays will start to penetrate the market. Novaled is very well positioned to fulfil these needs in the future. Up to date Novaled is the market leader in power efficiency. On top of this, Novaled PIN OLED(R) technology offers extremely high lifetime and temperature stability for red, green, blue and white OLEDs both in top and bottom emitting architecture. For backplanes based on amorphous Silicon, so-called inverted OLED structures might be necessary. Already 2 years ago, Novaled has demonstrated highly efficient inverted OLED structures.

## NovaLED Technology

### **NOVALED OFFERS ENABLING DISPLAY AND LIGHTING TECHNOLOGY**

NovaLED AG is engaged in the research, development and commercialization of OLED (organic light-emitting diode) technologies and materials. The company is committed to the development of a new OLED generation, focusing on achieving highest power efficiencies. NovaLED positions itself to be a fabless technology provider, generating revenues primarily from royalties, the selling of technology access and from customization.

### **ORGANIC LIGHT EMITTING DIODES (OLEDs) CHANGE THE WORLD OF DISPLAYS**

OLEDs are organic semiconductors made of a few nanometer-thin organic material layers, which emit light. Their use in ultra-thin displays opens large opportunities for the producers in these two markets. OLED technology, however, still lacks power efficiency and suffers from limited lifetimes of the devices.

This is the anchor for NovaLED's technology offer. NovaLED's enhancement of power efficiency makes the difference for the implementation of OLED technology. OLED is the technology of choice for the 90 Billion US \$ flat panel industry.

### **OLEDs PREPARE THE LIGHTING REVOLUTION**

OLED is the only technology being capable to provide a light surface, a design using flexible and bendable substrates. At the same time it offers a tremendous potential to save energy. OLEDs are expected to win a substantial share of the over 100 Billion US\$ lighting market.

### **KEY TECHNOLOGY: DOPING OF THE CHARGE CARRIER TRANSPORT LAYERS**

NovaLED's key technology is the improvement of the charge carrier transport. This is achieved by doping the charge carrier transport layers with proprietary dopants to increase the conductivity and optimize the structure of the whole OLED to achieve low operating voltage and highest efficiencies at a high level of brightness. This doping approach can be easily implemented by co-deposition in today's OLED technologies.

### **NOVALED TECHNOLOGY: A SUMMARY OF BREAKTHROUGHS**

NovaLED has developed a new generation of OLED technology that puts the company in the best position to overcome the disadvantages common OLEDs have. Its unique approach of doping the charge carrier transport layers has achieved industry breakthroughs in:

- Low operating voltage
- High power efficiency
- Inverted, top-emitting structures in a simple way
- Thicker layers possible w/o compromising energy efficiency
- Adaptability to numerous substrates
- Transparency

#### **WORLD RECORD IN POWER EFFICIENCY**

NovaLED, together with IAPP, set the world record in achieving the highest power efficiency (110 lm/W) for green OLEDs and for white in cooperation with PHILIPS (35 lm/W).

#### **NOVALED PROVIDING HIGH PERFORMANCE FOR ORGANIC ELECTRONICS**

NovaLED with its dopant materials intends to become a major contributor providing high performance organic semiconductors necessary for all OE applications.

#### **THIN FILM ENCAPSULATION (TFE)**

Thin film encapsulation is a promising technology to hermetically encapsulate organic devices. Such devices can be described as electronics and photonics products created with the use of organic materials. These materials may be semiconductive, light-emitting or photo active. OLED display and OLED lighting are two OE constituents besides a multitude of other applications under preparation, from solar cells to RFID.

TFE will replace the current glass plates by very thin organic and inorganic multilayers. It will allow for flexible and roll able organic products with a thickness in the micrometer range. The current generation of organic material does not allow a proper lifetime and requires too long processing times. NovaLED has the skills on organic materials to develop the new generation of organic materials to resolve the current issues.

## **OLEDs: One Technology – Two different kinds of application**

#### **WHY OLEDs?**

OLED is a synonym for organic light emitting diode. OLED technology has the outstanding advantage to serve two different industries – displays and lighting applications.

Displays based on these diodes could be cheaper, thinner and don't require backlighting compared to liquid crystal displays (LCDs). Brighter color, wider viewing angle and high switching speed for video applications also emphasize OLED's superiority.

Furthermore OLEDs promise exceptional power-efficiencies for lighting applications and portable devices such as cell phones. One technology for two different application kinds.

For the lighting sector organic light-emitting diodes (OLED) offer an entirely new way for architects, designers, system integrators, planners and luminaire makers to create with light. OLED devices are ultra-flat and emit very homogeneous light.

OLEDs made on glass substrate can be transparent in the off state. This feature enables special lighting applications, e.g. windows or furniture with

transparent or translucent elements.

**STATE-OF-THE-ART**

Although OLEDs have been introduced into some markets recently, three key factors must still be improved:

- Power Efficiency
- Lifetime
- Manufacturability

Currently the power efficiency of OLED displays is comparable to LCDs. To get momentum regarding market share of OLEDs it is essential to enhance this feature, especially for active matrix displays. A larger market share would result in reduced costs due to mass production.

Novalled has achieved unprecedented power efficiencies at operating voltages close to the lower theoretical limit. The company's technology for ultra-thin OLEDs enables light emission on either side of a carrier or both sides at the same time. This feature is crucial for active matrix and transparent displays. Moreover the technology is highly flexible regarding the carrier material, e.g. thick glass plates or thin plastics foils.

**HIGHEST POWER EFFICIENCIES**

The power efficiency of OLEDs depends mainly on the operating voltage and the current efficiency. Present OLED product generations require twice as high operating voltages as that of Novalled's diodes at the same light output. Novalled's products require only 50% of the power.

A current efficient light emitter is characterized by a high ratio of brightness to current through the device. Selecting an appropriate material combination, well defined processing and subsequent encapsulation for protection are fundamental for high current efficiencies. For example phosphorescent materials typically exhibit superior current efficiencies compared to fluorescent materials. However the lifetime of latter is usually much longer.

Roughly 80% of the excited light is either trapped inside the OLED-device or exits the device in an undesired direction. Therefore cost-efficient solutions for out-coupling of light, e.g. surface modification of the substrate contain enormous potential for improving the current efficiency.

Novalled's doping technique enables a high degree of freedom regarding the total thickness of a diode. Therefore the out-coupling of light can be optimized by the diode thickness without influencing the number of photons generated.

**WORLD RECORD  
IN POWER  
EFFICIENCY**

Novaled successfully employed its patented doping materials, which significantly reduce the operating voltage and boost the current efficiency at the same time. Novaled keeps several world records in highest power efficiency like for green OLEDs with a power efficiency of 163 lm/W at 1,000 cd/m<sup>2</sup> initial brightness. Furthermore, the utilized doping method enables thicker charge carrier transport layers. Thicker layers are less susceptible to leakage currents or voltage breakdown and thus advance the reliability of OLED devices.