EPIC Members Event Report

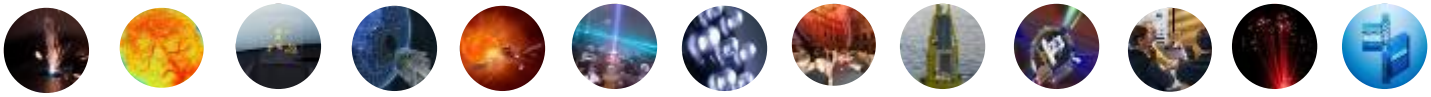
Leti Days Workshop – Lighting

26 June 2015
Grenoble, France
www.letidays.com/2015

Tematys attended the Leti Days Workshop Lighting in Grenoble on behalf of EPIC. The workshop was part of Leti Days. This report summarizes the talks presented.

About the EPIC Members Event Reports

Initiated by the founder of EPIC Dr. Thomas Pearsall in 2003, these reports are prepared by members of EPIC to the benefit of the wider community. If you did not have a chance to attend the event but would like to know some key highlight, this report is for you. Emphasis is placed on exploring technical and business opportunities for the members of EPIC.



SESSION 1: MATERIALS AND DISRUPTIVE TECHNOLOGIES

CLAUDE WEISBUCH - ECOLE POLYTECHNIQUE/UCSB: "LEDS FOR LIGHTING: STATUS AND CHALLENGES

As an introduction of the workshop, Claude Weisbuch was invited to give a comprehensive overview of LEDs and their applications. Beyond the flexibility they provide as lighting sources, a study by McKinsey states that they should be regarded as the most effective way of saving energy and reduce CO_2 production. It is easier to replaces lamps than increase the efficiency of car engines.

A lot of work is done to further increase the efficiency of LEDs. But in fact, 80% of the latest achievements come from improvements of the light extraction than the increase of the internal quantum efficiency.

One barrier for the adoption of LEDs is cost. Indeed, an LED based lamp is more expensive than older technologies. But the cost is decreasing exponentially. In 4 years, the selling price was divided by almost 4. As the total cost of ownership is in favor of LEDs, thanks to their long lifetime, it should be even more favorable in the coming years.

Coming back to technical considerations, scientists who want to increase the efficiency of LEDs have to face a major issue: the droop most probably caused by the Auger recombination. Here are some strategies currently adopted for improving LEDs:

- decrease electron density by increasing area
- increase the number of quantum wells (QW) to diminish the carrier density per well
- control wave function and electric fields in the QW
- Improve the growth of GaN on Si substrate
- Develop laser diodes for lighting
- Develop wired LEDs

For lighting applications, there are several challenges to face. Increasing the efficiency has already been mentioned but in order to have performing and competitive lighting equipment, there is a need for much better green LEDs but also improved red LEDs, better phosphors and a better control of colors.

In terms of societal challenges, many regions still need efficient lighting as they currently depend on kerosene. The challenge of adaptive or "smart" lighting is exciting for many applications markets like in the medical sector or in agriculture.

ANDRÉ STRITTMATTER - UNIVERSITY OF MAGDEBURG GAN: "EPITAXY ON SI SUBSTRATES FOR LED APPLICATIONS"

André Strittmatter of the University of Magdeburg described the solutions for growing GaN LEDs on Silicon substrates. What is at stake is the ability to use Si wafers which are already of a much larger diameter than sapphire substrates. The 2 main issues to be solved are the lattice and the thermal mismatch.

The first solution is to grow small square areas separated by a fine trench. This allows to limit the strain. The others solutions developed in the past 15 years are to growth AlN GaN buffers or AlN interlayers that strain progressively the lattice and compensate the tensile thermal strain. Another approach is to use GaN:Ge as alternative n-type doping.

Another issue raised by A. Strittmatter is that the Si substrate absorbs photons and causes 70% of losses. GaN on Si is not suitable for very high power LEDs unless tricks are used like removing the substrate and transfer the chip on a Si carrier. This method is currently tested by OSRAM.

Amélie Dussaigne – CEA Leti: "GaN epitaxy for advanced LED"

Amélie Dussaigne showed several strategies for growing GaN and use its morphology and get new substrate benefits. For 2D LEDs, it might be possible to reduce the thickness of LEDs by using sapphire or Molybdenum substrate. Both have been tested and compared. A strategy was also proposed to shape the sapphire substrate in order to reveal the C-plane of the crystal on which GaN shows a preferential growth.

Another goal is to grow LEDs on Si. The main targeted interest is the cost reduction thanks to the large scale integration with microelectronics. But for achieving this objective, one must deal with an important lattice mismatch and differences of thermal expansion coefficient. The adopted strategy is a 2 step growth: first, a multiple grain growth, second, a broadening of grains to produce "plates". This work paves the way to the growth of GaN rods on Si substrate in order to produce wired LEDs.

SESSION 2: PROCESS AND DEVICES

Xavier Hugon – Aledia: "High cost-disruptive technology of LEDs"

Xavier Hugon, co-founder and COO of ALEDIA, described the stage of advancement of industrialization of the WiredLEDs developed by the company. He demonstrated the huge commercial potential of this disruptive technology as it could replace a great part of usual 2D LEDs when they are ready to be commercialized. The main advantage of WiredLEDs is to allow a great simplification of the electronic control of the LED which is where the major weakness of LED lighting lies. The WiredLEDS are directly powered at 110/220 VAC. They are driver free.

In fact, if the promise that they can stand 10 000 hours of operation is valid for the LED chip itself, it is questioned by the lifespan of the electronics part which cannot be of high quality because of heavy cost constraints.

Currently at ALEDIA, the production process is ready. The full flow is qualified and shows no specific weakness. The focus is now to validate a 3D structure that will reach the same efficiency than 2D LEDs. The target is to begin sales in 2017.

Matthias Sabathil - OSRAM Opto Semiconductors: "Future Trends and Limits in LED Technology"

Matthias Sabathil, Director of Pre-Development, described the state of the art of LEDs developments at OSRAM Opto Semiconductors. He stated the limits of current LEDs architecture around 200lm/W caused by the loss of efficiency when on increased the current density. Today, LEDs in industrial production show an efficiency of 130 lm/W. Their research has confirmed along with of research teams that the Auger effect is responsible for the droop.

To overcome the droop; Osram is experimenting 3D designs, rods LEDs. With this architecture, they calculated that a 10 times better efficiency is potentially reachable. All the more as the rod design allow a closely couple to the epi structure. But there is still way to go.

Another possible technology is under investigation: solid state laser diode used for lighting. It is for now still too expensive to produce and cannot be expected in a near future. But this research enabled a novel application not targeted initially. It is used for laser garden illumination. This is an example of all the opportunities of new functions that can be envisioned by LEDs in indoor, commercial, residential and outdoor lighting.

François Templier –CEA Leti: "GaN LED arrays for ultra-highbrightness microdisplays"

Beyond the use of LEDS for lighting, CEA-LETI has worked on GaN LED arrays for ultrahigh brightness micro-displays. These components are embedded in devices like head-up displays (HUD), see-through systems, smart glasses and augmented reality systems.

The production process developed by the CEA-LETI along with III-V Lab allows the production of displays with a pitch of 10 µm. Incoming micro-displays should have a pitch shorter than 10 µm. It should also enable HD-720 images with a brightness higher than 20,000 cd/m2 and a frame rate up to 120Hz. Such components should also last more than 40,000 h for being used in defense and security applications.

Isabelle Wuest - Saint Gobain: "Integration of Led and Oledsources in Construction materials"

Isabelle Wuest, from Saint-Gobain, explained how the building sector can adopt LEDs and integrate them in the construction material. From their point of view, LEDs are very convenient because they use low voltage i.e. a non-trained electrician can manipulate and install them. They are also easy to embed, live as long as building material, are energy efficient and allow new concepts and design. This is why Saint-Gobain has initiated cooperation lighting companies. Their subsidiary GlassSolutions, with Knoll, has developed glass doors for shower cubicles for kitchens with embedded LEDs. With Philips Lighting, they created roof elements both able to absorb sound and illuminate a room. The subsidiary Adfors produces now light fabric for wall applications. Saint-Gobain is intensely experimenting new concepts and designs enabled by LEDs. They released demonstrators of decorative partition walls which integrate superior high-efficiency OLED lighting devices.

SESSION 3: SMART LIGHTING AND APPLICATIONS

Pars Mukish – Yole Développement: "What Smart Lighting could bring to the LED industry?"

According to Pars Mukish from Yole Développement, the LED industry came initially from the display application, first the small displays then the LCD display application. But the display industry faced an overcapacity that put a price pressure and manufacturers searched for a new growth perspective. They found that lighting, especially smart lighting, could be the killer application for LEDs thanks to their flexibility and their ability to be controlled and integrated in smart systems.

Smart lighting can be defined as intelligent lighting solutions enhanced by the attachment of external control units, and that can provide functional lighting (through fully integrated systems).

The lighting market is nowadays a stacking of several generations of equipment. Incandescent bulbs were the first generation. One bulb costs around 1$. Then came compact fluorescent lamps which last longer, cost around 5$ but contain Mercury. LED bulbs emerged recently. But the first LED products were LEDs inserted in a bulb which shape is constrained by a 100 years old socket. Now equipment fully designed for LEDs are available. They are the first step toward smart lighting.

But LEDs manufacturers and integrators have to face several challenges. Fully-integrated Solid State Lighting solutions often require a dedicated infrastructure and have significantly higher up-front cost. That is why adoption will be slow and initially limited to new building projects. Besides, standards are needed to enable this change on a massive scale and allow interoperability.

Another challenge lies in the longer lifetimes of LEDs. This will significantly increase the replacement cycle length and reduce the replacement market (aftermarket). Manufacturers need to offer high added-value products with improved functionalities in order to recapture the lost revenue.

Fernand Courtois – Luciom: "And if…….Li-Fi Technology!"

Fernand Courtois, engineer at Luciom, detailed many possible applications of the LIFI technology. LiFi is wireless and uses the IEEE 811.15.7 protocol, similar to the WIFI 802.11 protocols; but it uses visible light communication (instead of radio frequency waves), which has much wider bandwidth. The company Luciom was created in October 2012. It is based in Caen (France), includes 12 persons in 2015, and develops LIFI systems for its clients. The main expected applications of the LIFI technology are:

- Indoor localization and guidance
- Equipment monitoring and maintenance
- Internet of thing applications
- Localized communication and broadcast
- ADAS (Advanced Driver Assistance Systems)

Its main benefits are to be very safe and green compared to RF. It is secured, with data only available within the lighted zone. It is capable of high data rates and compatible with subaquatic wireless transmission.

Olivier Andrieu – PISEO: "End User Driven Innovation in LED and SMART Lighting"

Olivier Andrieu has introduced the platform PISEO, based in Lyon (France). This institution was created by the CEA-LETI & several members of the French cluster dedicated to lighting called "Lumière". Its mission is to provide support to help actors of the lighting sector to develop and deploy innovative and performing light sources and lighting systems. In other words, PISEO helps companies and collectivities to manage the technology transition towards LED & Connected Light. It also helps companies to create new product/systems and service offers by reducing development time and costs and demonstrating the quality of new products. Its clients are manufacturers of LED packages and modules, luminaires, displays for buildings and LED systems of other markets like automotive or medical. It serves also specifiers and users in the building and the infrastructure sectors:

- Property developers of buildings, shops, roads…
- Architects, lighting designers, engineering offices…
- Retailers
- Installers, contractors
- Tenants

PISEO can provide services and support for photometrical, electrical & thermal tests, product qualification and certification, research and innovation and training. It runs several test equipment like gonio-photometers, a photobiological test bench, a thermal camera, integrating spheres and a video-luminancemeter.

Alexandre Lagrange –CEA - Leti: "More than Lumens for Energy Efficiency"

Alexandre Lagrange concluded the workshop by a prospective overview of the use of LEDs. He mentioned the environmental challenge behind lighting as 20 % of the energy is consumed for lighting. But beyond the saving enabled by LEDs, he mentioned the emergence of smart lighting along with visible light communication (VLC), which is very promising in terms of market growth. But these new expected applications set a new demand for LEDs in terms of efficiency, color control, modulation etc. Research undertaken on LEDs on Si or LED arrays will enable to face these challenges.

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