Solid-State Lighting for Europe Newsletter December 2011

Introduction

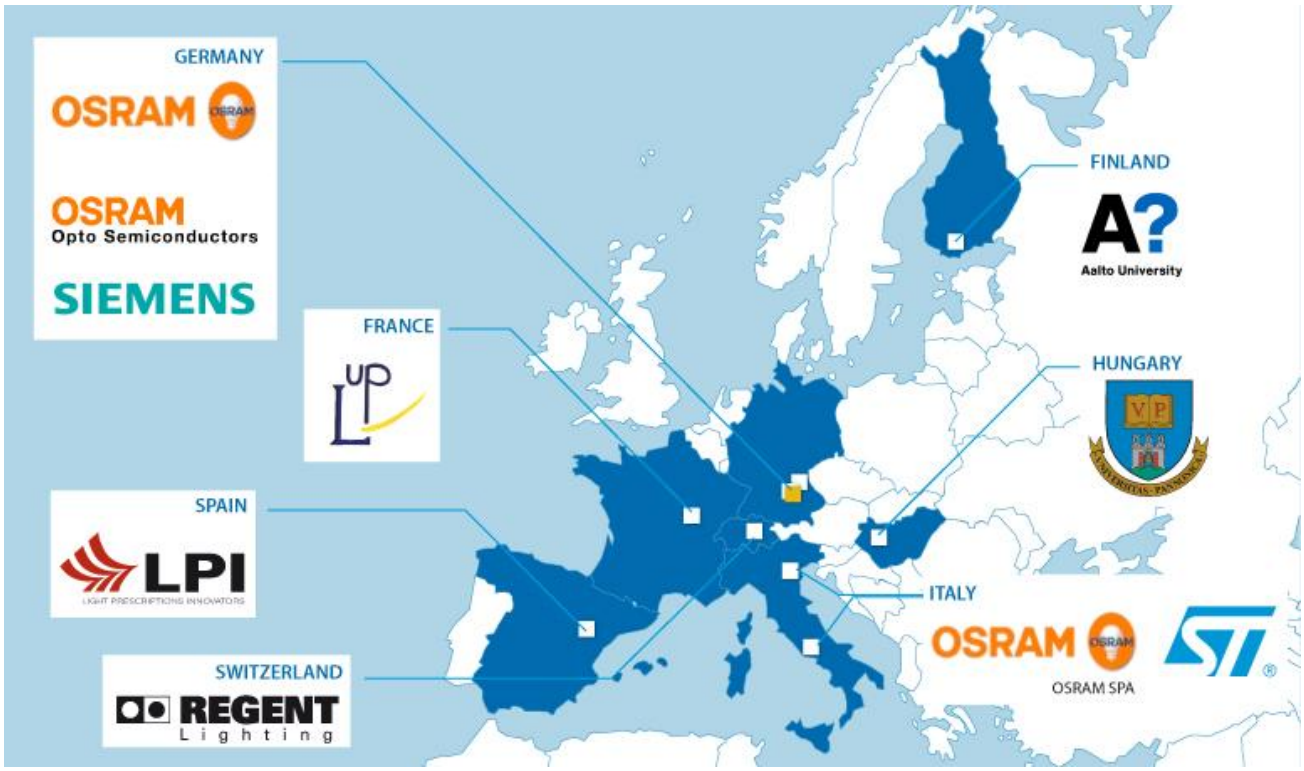
Welcome to the first Newsletter from the SSL4EU project.

SSL4EU stands for Solid State Lighting for Europe. It is an Integrated Project funded by the European Commission under the 7th Framework Programme. It gathers 10 partners from 7 different member states for a period of 3 years until 2013.

Our Goal

Explore universally applicable LED light engines with high colour rendering, a tuneable light output spectrum and an adaptable light output level. These will keep Europe at the forefront of the energy-saving SSL business and serve as leverage to push the LED luminaire business in Europe.

Consortium



The SSL4EU consortium includes large industrial companies, two SMEs, and two universities.

OSRAM AG (Munich, Germany), is a wholly-owned subsidiary of Siemens AG and one of the two leading light manufacturers in the world. In fiscal year 2011 (ended September 30, 2011), it

generated revenue of about 5 billion Euros. OSRAM is a high-tech company in the lighting sector and more than 70 percent of its revenue comes from energy efficient products. The company, which is very much internationally oriented, has around 41,000 employees worldwide, supplying customers in 150 countries from its 44 production sites in 16 countries (as of September 30, 2011). Additional information can be found at www.osram.com.

OSRAM IT with its strategic R&D centre develops LED drivers and LED power supplies and produces power supplies electronic drivers and controls units for LED systems in Europe.

OSRAM Opto Semiconductors, a subsidiary of OSRAM AG, offers its customers solutions based on semiconductor technology for lighting, sensor and visualization applications. OSRAM Opto Semiconductors has production sites in Regensburg (Germany) and Penang (Malaysia). Its headquarters for North America is in Sunnyvale (USA), and for Asia in Hong Kong. OSRAM Opto Semiconductors also has sales offices throughout the world. For more information go to www.osram-os.com.

SIEMENS Corporate Technology is the heart of Siemens research and covers a broad portfolio of technologies and high-level scientific know-how on phosphor technologies for SSL.

ST-Microelectronics is one of the world's largest semiconductor companies strongly committed to R&D that addresses the needs of all microelectronics users.

LPI is an SME providing advanced and innovative optical designs in both fields, solid state lighting (SSL) and solar CPV (concentration photovoltaic).

REGENT is a luminaire manufacturer committed to new ground-breaking LED technologies for their luminaire products

Aalto University and **University of Pannonia** are the two leading universities in Europe in the field of lighting and acceptance studies and are both active members in the CIE (Commission Internationale de l'Eclairage = International Commission on Illumination), the head scientific and technical organisation in the lighting field.

L-Up experienced in EC project management assist the consortium in the reporting procedures and financial and administrative management of SSL4EU

Work Plan

To achieve our goals the work has been divided into several work-packages summarised here below.

The aim of **WP1** is to implement a versatile multi-chip LED package platform for the targeted spot light engine with 4000 lm output. LED packages will be developed for single-colour warm white and colour-temperature (CCT) adaptive solutions, both with high colour quality. The specific objectives are:

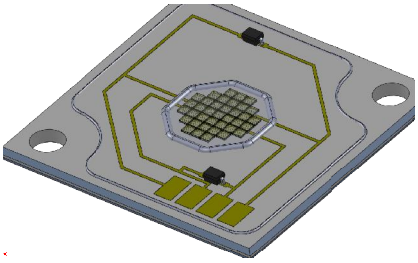
- Develop and investigate high quality phosphor precursors for warm white ceramics
- Develop and fabricate multi-phosphor ceramic converters for warm white high quality LEDs.
- Design and build multi-chip packages for use with ceramic converters in different setups.
- Implement concepts for tuneable white multi-colour packages with high colour quality.

During the first year of the project, the objectives 1) to 3) have been addressed.

Task 1 & 2: As a first step suitable red phosphor precursors for the realization of warm white multi-phosphor ceramic platelets had to be identified. By using sophisticated simulation tools one promising phosphor precursor could be identified

for targeting the goals of high efficacy and high colour rendering index for correlated colour temperatures around 3000K. In a next step this phosphor powder has been subsequently optimized to meet the requirements of good sinterability. In parallel, a processing was developed for the sintering of the susceptible red phosphor material and different technology routes for multi-phosphor ceramics have been investigated. With M12, first samples of multi-phosphor ceramic platelets are available for assembly of LED light engines.

Task 3: For realizing LED spot light engines, a major goal is to maximize the luminous density of the chip array leading to a densely packed array of surface emitting LED chips. Thus the focus here is to develop interconnect and assembly technologies for LED light engines that enable on one side a narrow chip to chip distance and on the other side lead to a low thermal resistance of the overall system. A compact and planar interconnect technology has been addressed in order to realize an inter-chip spacing of 100µm. An additional benefit of the approach is that the overall feed line layout of the PC board can be processed simultaneously with the chip interconnects leading to reduced packaging costs. The first prototype consists of 37 high power thinfilm chips within a light emitting surface of 9mm diameter. For comparison: a 4000lm state of the art light engine consisting of single package LEDs or a chip-on-Board module (COB) needs 21mm or more as diameter. Thus, the approach of this project leads to a reduction of light emitting area of 82% or more and hence significantly reduces the package size and costs for the final luminaire.

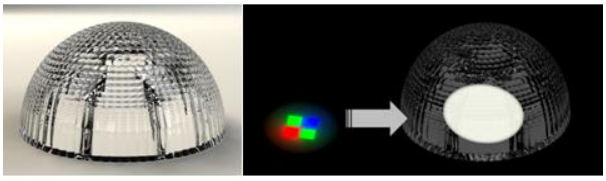


37 chip spot light engine with planar interconnect technology

The aim of **WP2** (LED system components and light engines) is to investigate novel solutions for electronics, optics and cooling for a light engine as well as investigating their reliability behaviour. Furthermore WP2 takes care about the system integration of all subcomponents to realize a small size universally applicable LED light engine.

For cooling a novel concept of acoustic streaming is investigated to enable a noiseless active cooling.

To overcome the usually encountered artefacts in luminaires such as color shadows, color fringes etc., a solution based on the Köhler concept is investigated, an “integration” approach that is compatible with many different optical applications. In the first part of the project SSL4EU simulations have been carried out to find the optimal layout of such a mixing optic with respect to size, performance and manufacturability. Simulations have been finished and the first mixing optic is ready for prototyping.



The multichip module from WP1 is integrated with the electronics, optics and cooling components to build a universally applicable LED light engine. The first light engine demonstrator is planned in February 2012.

One important output is to provide a numerical model of the system including interactions, especially temperature and optical radiation. The aim of the model is to predict the reliability in terms of key performance parameters such as light output, power, CRI, CCT and color

coordinates as a function of operating conditions such as ambient temperature and driving current.

The objectives of **WP3** are:

- to define the specifications of the LED packages, LED light engines and the luminaires in close collaboration with all partners
- to design demonstrating devices by implement all components
- to build luminaire demonstrators

A first spot light luminaire is shown in the picture below. This sample is based on a PrevaLED®-like light engine. The next samples will include multi-chip LED-modules from WP1.

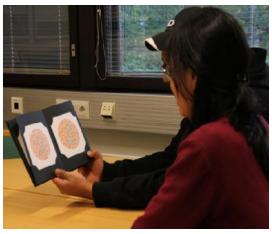
User acceptance studies are being carried out in **WP4** (Acceptance studies) to study user lighting requirements and preferences to be able to suggest preferred spectral distribution for SSL products. These studies are performed in two stages:

1. Small-scale lighting booth investigations in laboratories
2. Full-scale investigations in office, home and shop lighting environments

Small-scale experiments are performed in test booths to restrict the range for optimal solutions for the full scale experiments. Evaluations are based on questionnaires and objective measurements.

Small-scale experiments have been carried out at Aalto University Finland, University of Pannonia Hungary and at Osram Germany. Experiments conducted with 130 observers on preference, naturalness and acceptance show clearly the direction in which full-scale experiments will be conducted. In the full-scale experiments Aalto University will concentrate on office lighting, University of Pannonia in home lighting and Osram in shop lighting. A big number of subjects (young and aged) will participate also in the full-scale experiments. The triple-booths built at Aalto for the small-scale experiments:

All the observers are tested for visual acuity and colour vision before the experiments.



The objective of **WP5** is to disseminate the results of the project, both scientific and technological, around Europe. This will be done through publications, workshops, participation to conferences, in the Zhaga consortium (www.zhagastandard.org) work, in CIE (www.cie.co.at) work etc.

The first training workshop was held at Aalto University in September 2011 (link to: http://www.lightinglab.fi/activities/2011/index.html). The other workshop will be held at Aalto University on January 19 2012. The second workshop at the end of the project will include a session open to potential end users such as European luminaire manufacturers.

You are welcome to visit the SSL4EU website at: **www.ssl4.eu**

Upcoming Meetings

- Project 18M meeting January 20, 2012, Aalto University Finland
- Project internal Workshop 'Acceptance Studies for LED Lighting' January 19, 2012, Aalto University Finland

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SSL4EU receives funding from the European Commissions's Seventh Framework Programme under grant agreement n°FP7-257550