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Laurent Canale, P Dupuis, A Zerrouki, Georges Zissis

► To cite this version:

Laurent Canale, P Dupuis, A Zerrouki, Georges Zissis. Accelerated ageing of OLED under different temperature and current conditions: photometric and electrical characterizations and analysis. 9th International Conference on Organic Electronics (ICOE), Jun 2013, Grenoble, France. hal-03238163

HAL Id: hal-03238163

<https://hal.science/hal-03238163>

Submitted on 26 May 2021

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Accelerated ageing of OLED under different temperature and current conditions: photometric and electrical characterizations and analysis

L. Canale, P. Dupuis, A. Zerrouki, G. Zissis
E-mail :laurent.canale@laplace.univ-tlse.fr

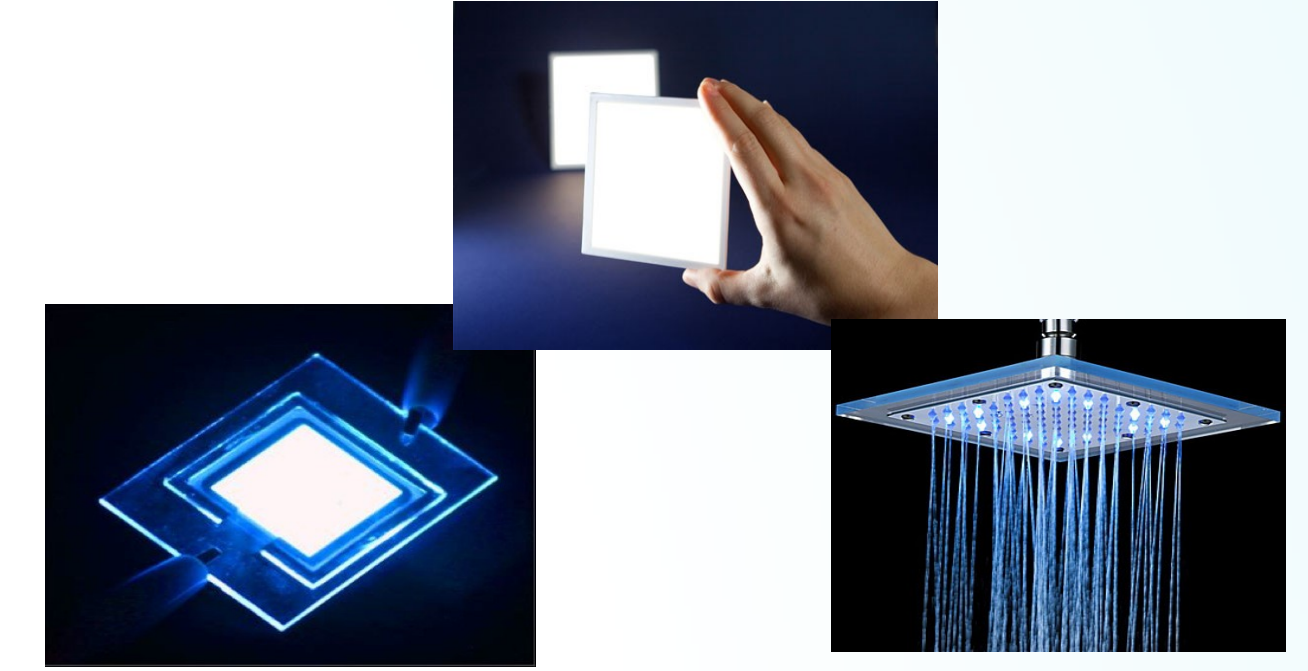


LAPLACE, CNRS - Université Paul Sabatier, 118 route de Narbonne, 31062 Toulouse cedex 9, FRANCE

Introduction

OLED are constantly technologically evolving. Performances evolve, and materials also. In a context in permanent revolution, it is necessary to maintain up to date our knowledge on the most common commercial products, ageing and failure mechanism. We need to have a deeper expertise, characterize them and study them to predict their life expectancy otherwise to anticipate the possible causes of failure.

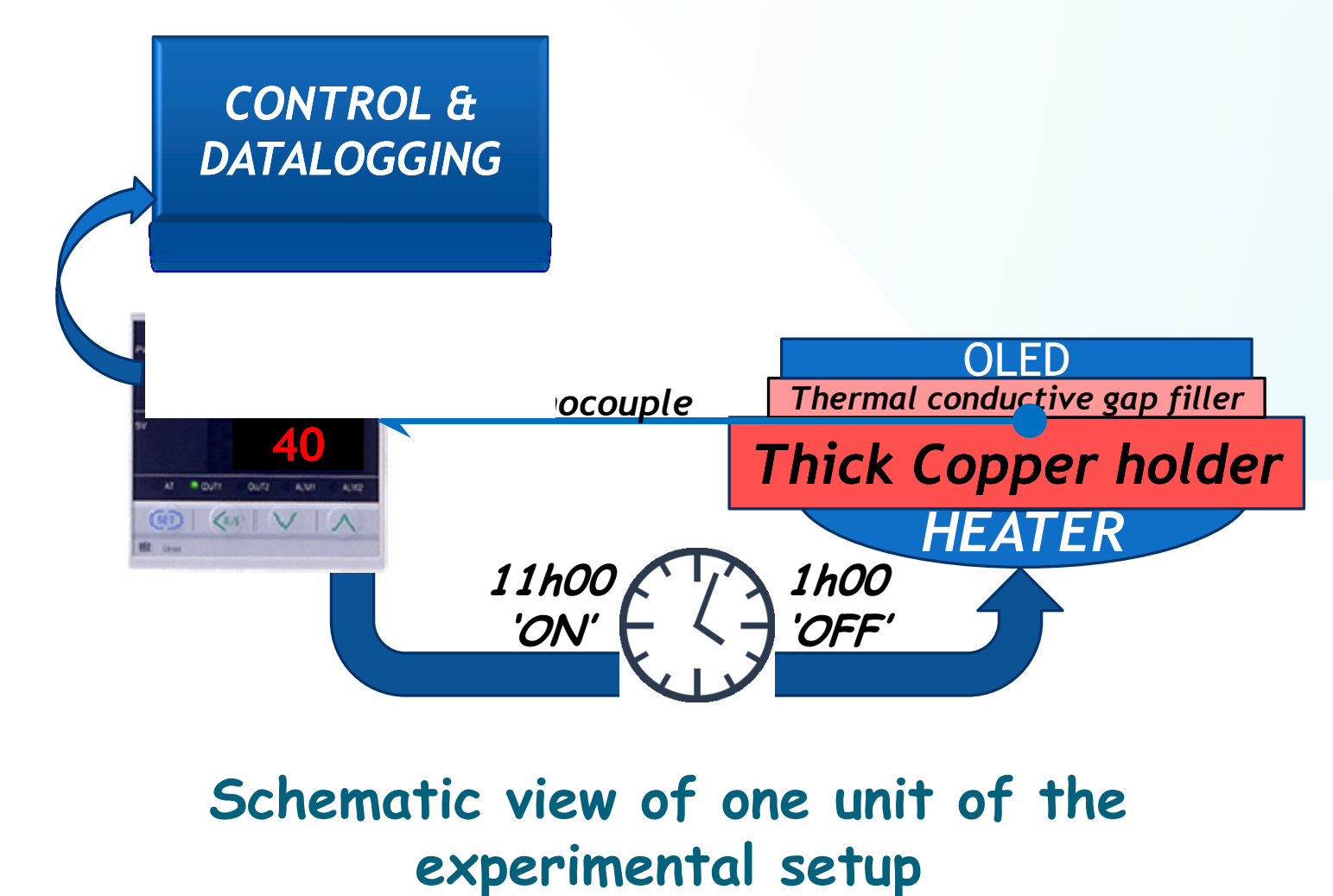
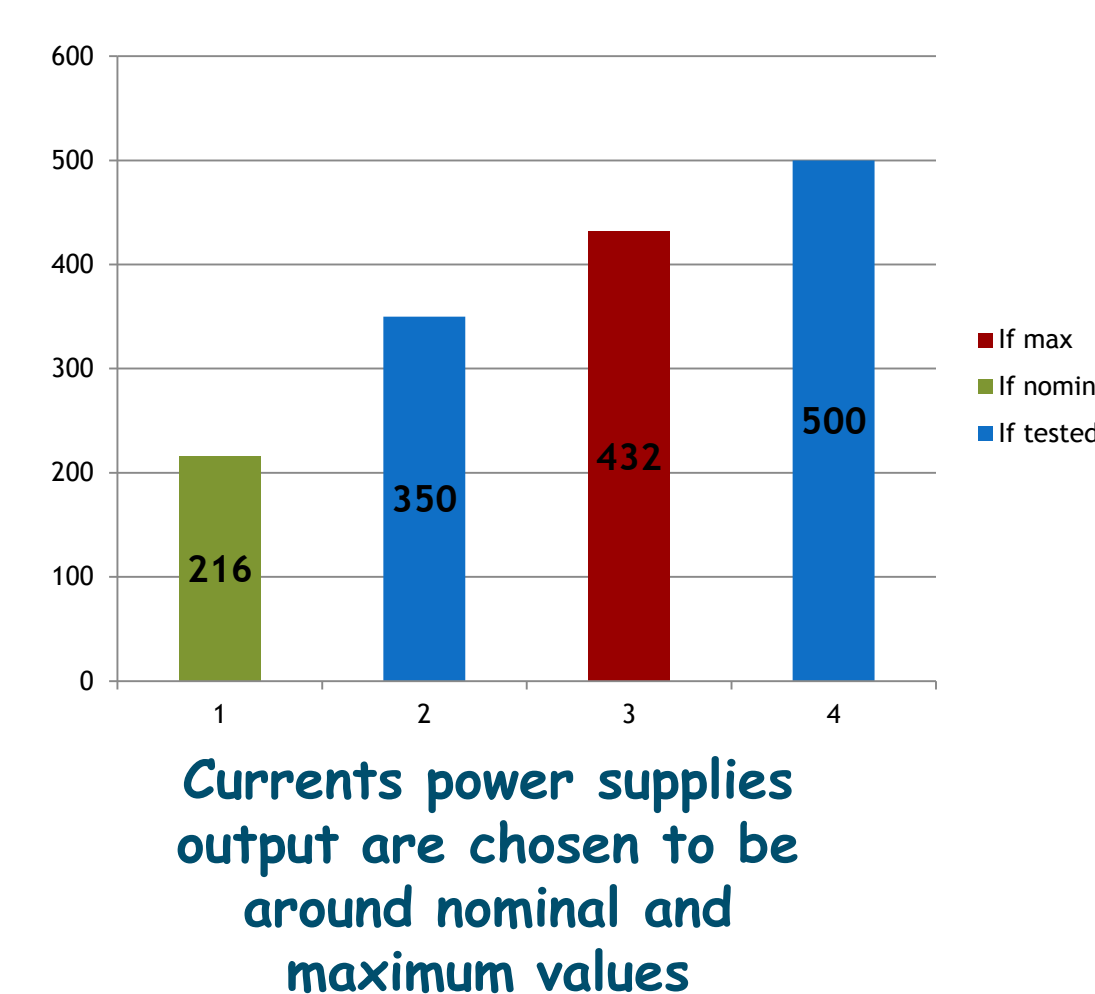
OLED applications



Methodology

OLED are operated at two currents, one in the middle of nominal operating range and one producing a small overdrive with respect to the normal operating conditions. At regular intervals, the driver is switched off and the devices returned to ambient temperature. A complete electrical characterization is performed both in the time and frequency domains. To avoid self-heating, short current or voltages pulses are applied with a low on-off ratio. Optical parameters are measured during the pulses: spectrum, chromaticity coordinates, color temperature and color rendering index. An optical setup permits to produce an image of the OLED directly at the spectrometer input slit, avoiding the need to use dark rooms.

In parallel, a deep bibliography study has been conducted in order to consolidate our knowledge about many aspects leading to OLED premature failure.

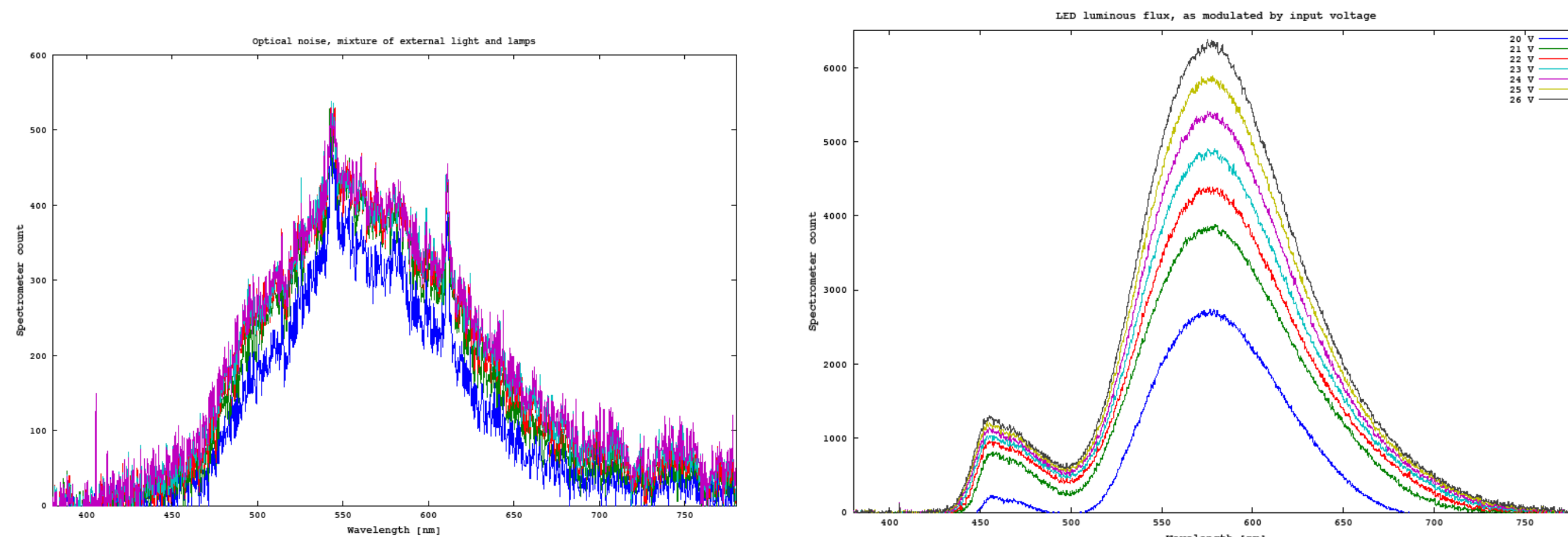


Results

Time resolved spectrum measurements

The optical system permits to produce an image of the lighting device onto the input fiber of an Ocean Optics HR4000 spectrometer. This device is triggered by the electrical power source, permitting to evaluate spectra in strict synchronism with the voltage pulses. The illustrated figures were obtained with an exposure time of 16 milli-seconds and voltage pulses whose amplitude run from 20 volts up to 26 volts in steps of one volt.

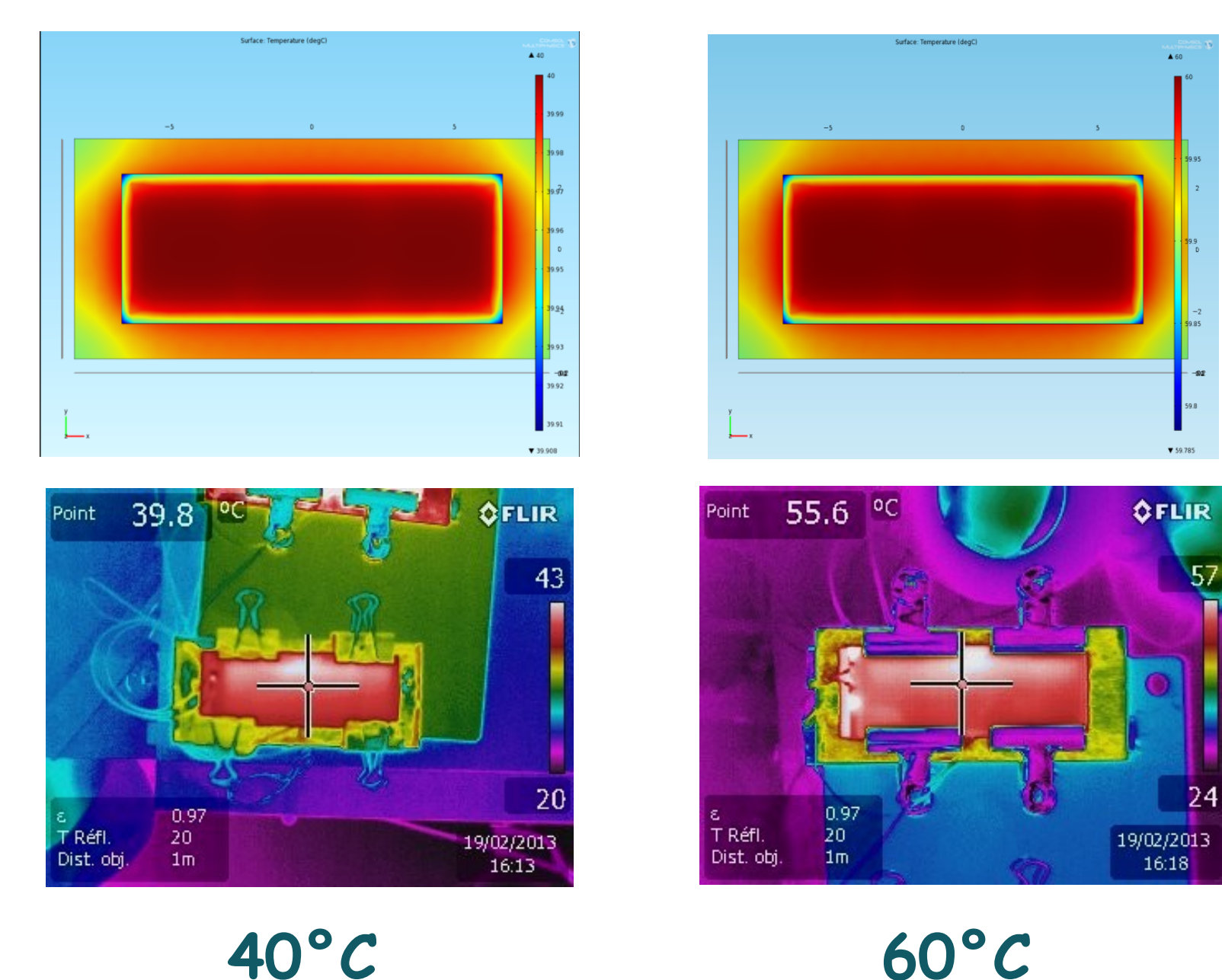
The pulse period is 500 ms, avoiding device heating by self-dissipation. The input fiber is placed in a simple cardboard cylinder, in a room with no special optimization with respect to optical conditions. Daylight and artificial lights were present into the room.



Thermal 3D modeling in COMSOL

Simulated temperature distribution from top view of the thermal conductive gap filler ($k = 6 \text{ W/m.K}$) at 40°C and 60°C temperature set point

- ✓ Foresee the experiments results
- ✓ Verify the homogeneity of the copper layer
- ✓ Good thermal homogeneity



Conclusion and Perspectives

At the time of writing, the full system results from the assembly of a number of functional blocs. Each block has been separately tested and validated:

- ✓ Thermal measurements corroborates the thermal simulation;
- ✓ Electrical and optical measurements have been optimized with respect to self-heating & environmental lighting;
- ✓ The on/off cycles are fully automated, and the whole process is computer monitored.

Various tendencies have been observed on a prototype and are under review with respect to our database of failure and ageing patterns. The measurements performed on the prototype lack the optical part. The new system now covers the whole range of measurements required in order to fully characterize OLED ageing.