LASSIE-FP7

Large area heat management for efficient SSL

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csem Fraunhofer IISB VTT Fraunhofer IIS REGENT LIGHTING SEVENTH FRAMEWORK PROGRAMME BASF We create chemistry GAIKER ik4 research alliance LFoundry AMIRES

Outline

- VTT in Brief
- VTT Printed and Hybrid Systems
- LED foil R2R pilot processing capabilities at VTT
- Thermal design, simulation and characterisation tools
- Heat management solutions
- Characterisation of structures
- Lighting module integration

VTT in Brief

- A leading R&D organisation in Nordic countries
- We provide expert services for our domestic and international customers and partners, both in private and public sectors

Net turnover and other operating income 272 M€ for VTT Group in 2015
(VTT Group's turnover 185 M€ in 2015)

Unique research and testing infrastructure

Personnel 2,470
(VTT Group 31.12.2015)

Wide national and international cooperation network

VTT Printed and Hybrid Systems

Integration of printed and surface mount discrete electronics components into freeform intelligent products using roll-to-roll compatible high volume manufacturing methods.

Printing

- **Roll-to-roll printing of wirings, active and passive components**

Printed components

- **OLEDs, printed solar cells**
- **Microfluidics, sensors**

Assembly and interconnection

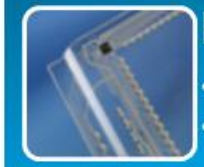
- **Roll form integration of chips**
- **Flex to flex integration**

Flexible electronics

- **Flexible hybrid electronics**

Over-molding

- **IML (in mold labeling)**
- **IMD (in mold decoration)**



Plastic integrated systems

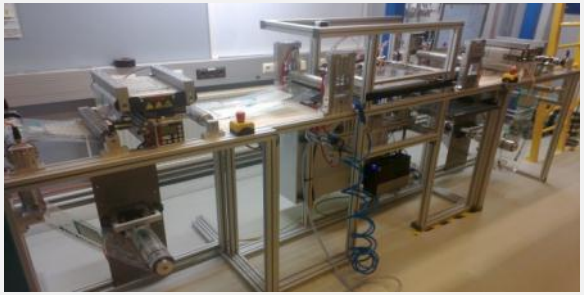
- **3D integrated devices**
- **Optics, mechanics and electronics**

Pilot line manufacturing environment

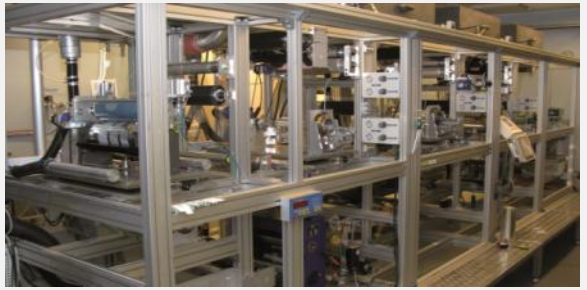
MAXI – In-air roll-to-roll pilot line

NICO – inert roll-to-roll pilot line

PICO – in-air roll-to-roll pilot line



TESLA – functional testing



ROKO – in-air roll-to-roll pilot line

ENGEL - Injection moulding R2R feeder

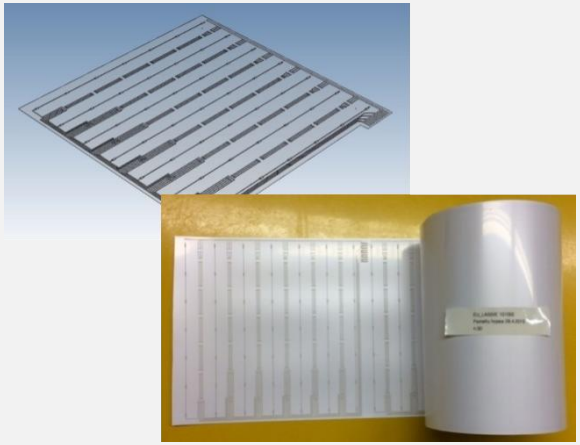
EVO - R2R assembly and bonding

LED foil R2R processing capability

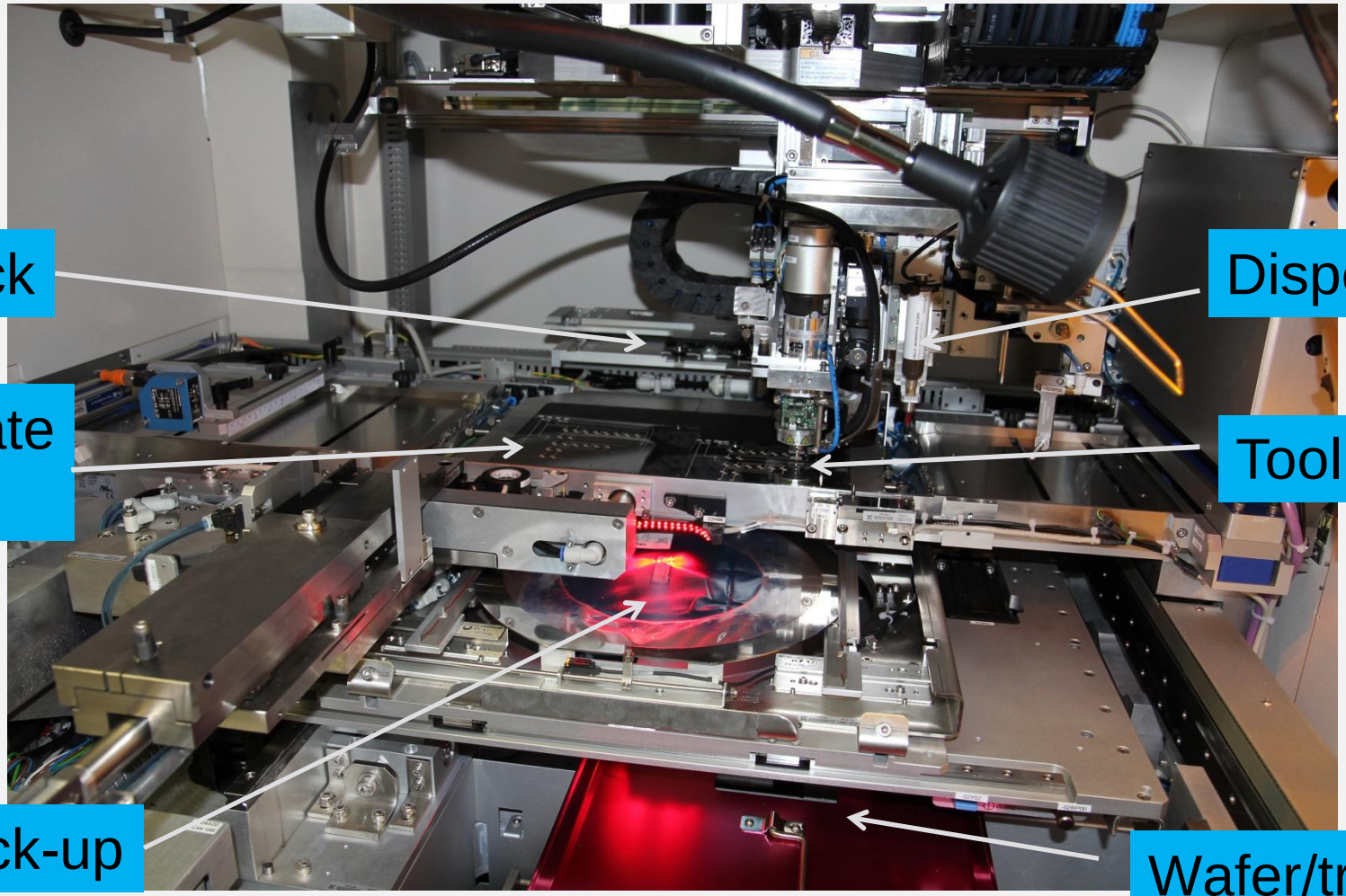
MAXI R2R pilot printing machine

EVO 2200 R2R bonding machine

ENGEL injection moulding machine with R2R feeder

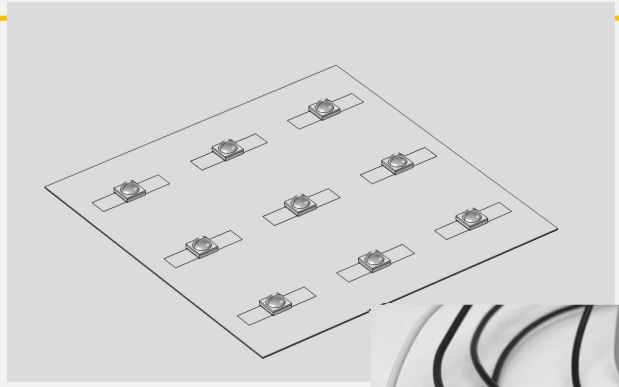


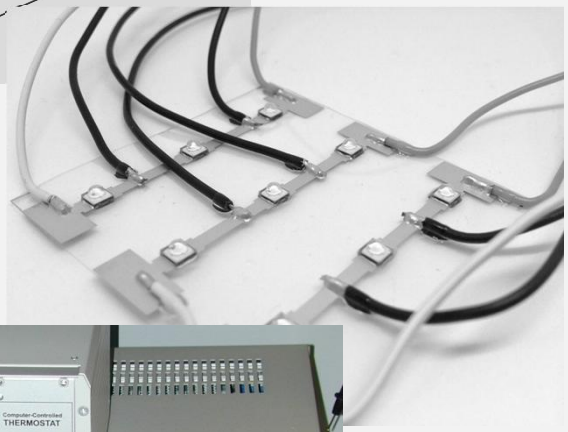
Assembly and bonding using EVO

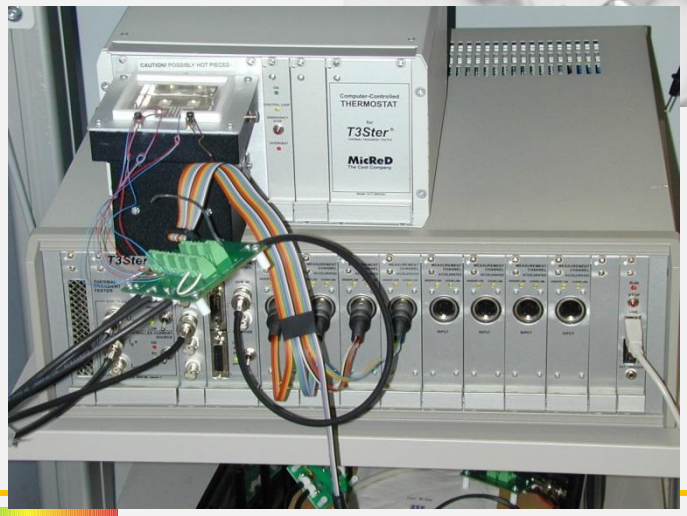


Thermal modeling and characterisation tools

- Applied heat management simulation softwares include COMSOL Multiphysics and Mentor Graphics FloTHERM.
- Mainly Multiphysics have been applied in LASSIE-FP7.
- Initial system model->test system implementation->test system charaterisation-> improved system model.
- T3Ster transient thermal characterisation tool was utilised in measurements.

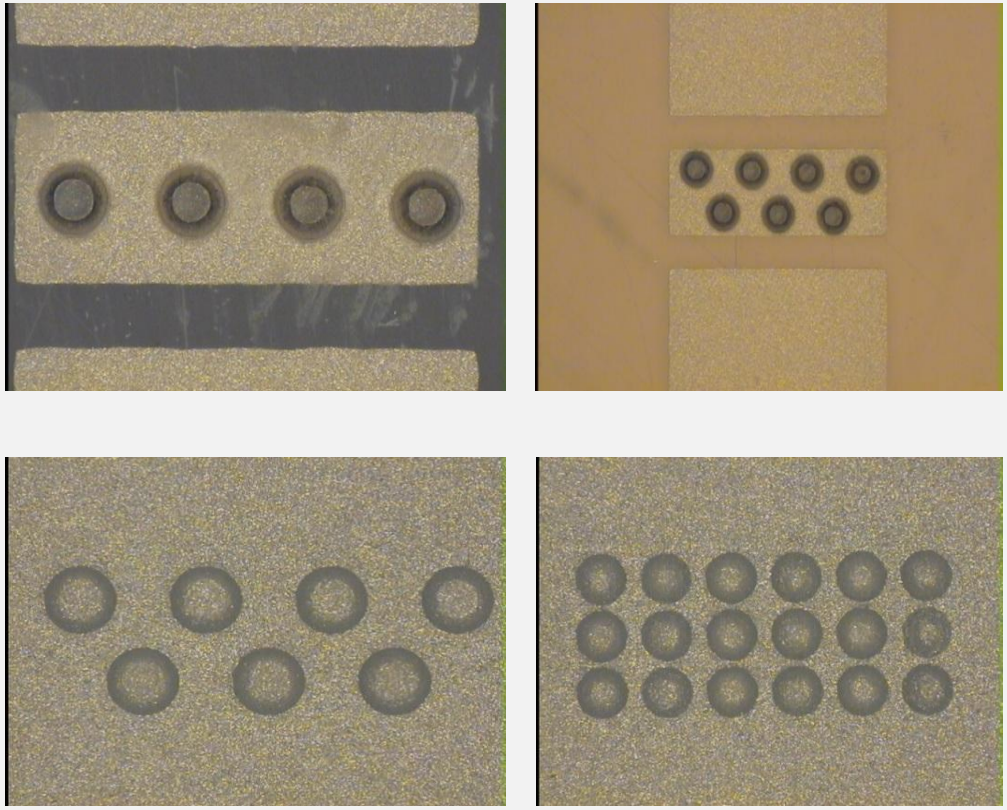






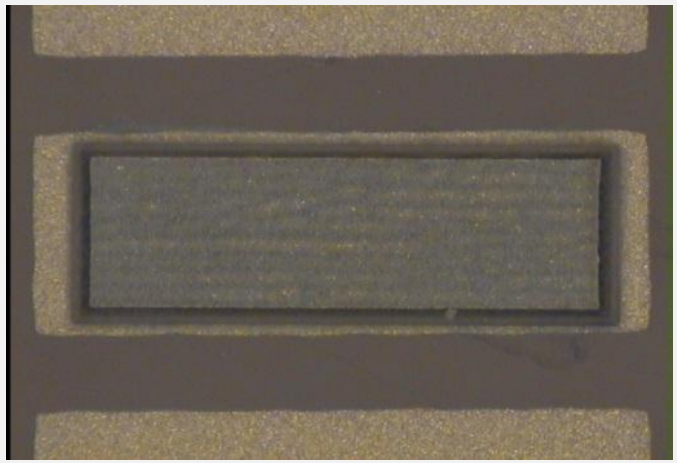
Heat management, thermal vias

- Vias were tooled to PET foil using mechanical punching, also laser drilling was tested.
- Vias were filled using silver ink by screen printing.
- Small and large vias were tested.
- Diameter of vias were 200µm and 320µm.
- Number of vias were variated from 4 to 18.
- Osram Oslon LED were used in tests.

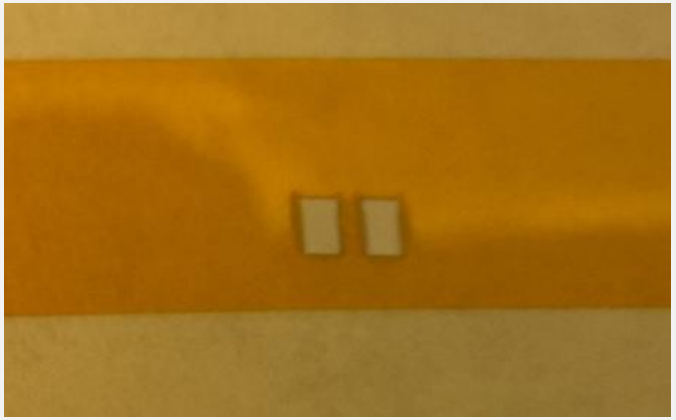


Heat management, thermal slugs

- Via for thermal slug was processed by CO2 laser.
- Metal foil piece which thickness was 125µm (same as PET) was inserted and adhesive bonded to the via.
- Both copper and ceramic/metallic foil material were tested.

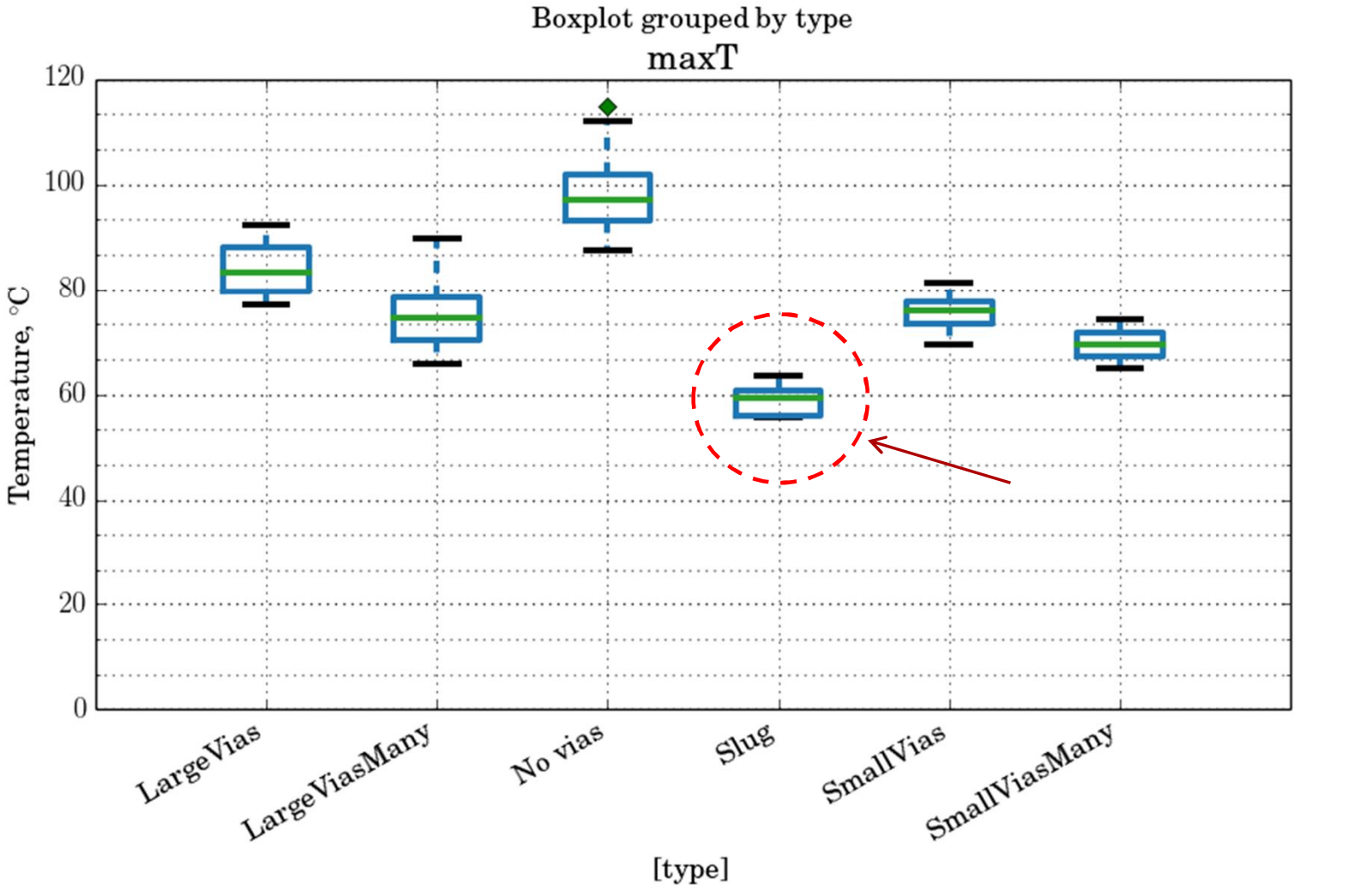


Copper thermal slug for Oslon LED



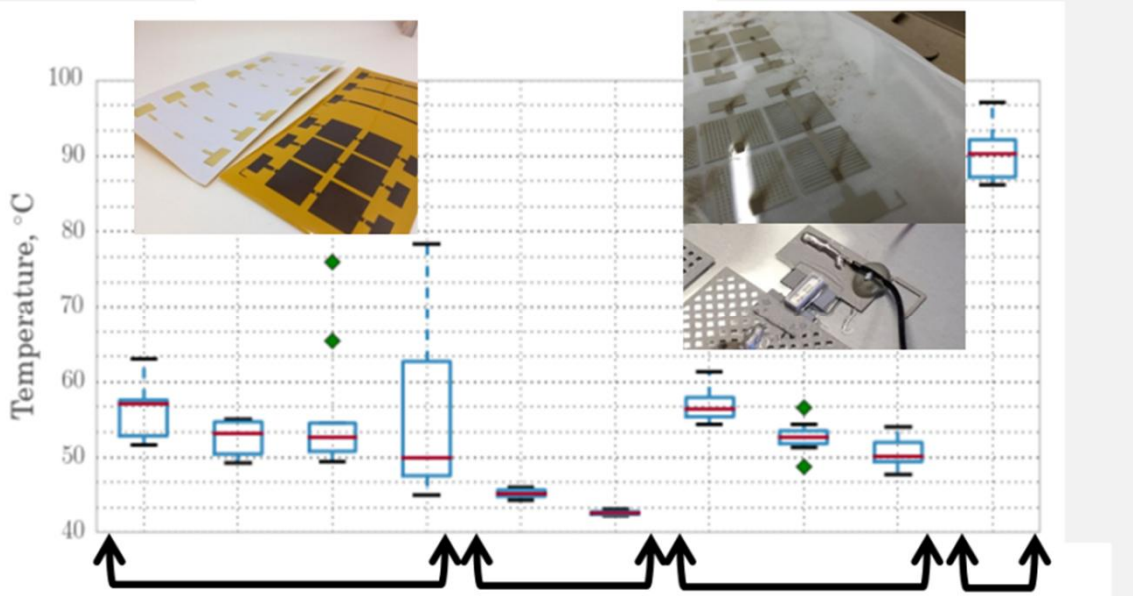
Ceramic/metallic thermal slug for Nichia LED

Heat management, performance of basic structures (Oslon LED)



Heat management, thermal slug structures and performance

- OSRAM Topled
- Test T = 25°C
- 180 mA

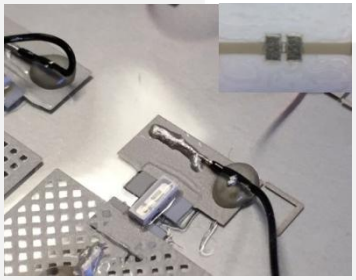


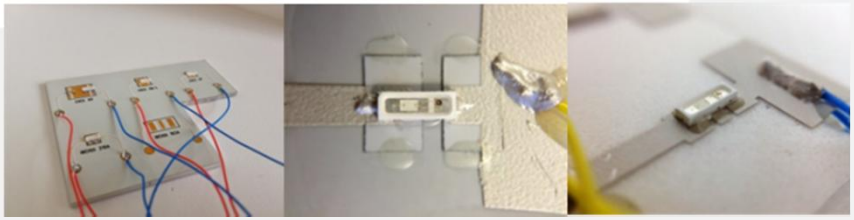
Cu Flex
- Glue
- Solder
- No heat spr.
- With heat spr.

MCPCB
- Glue
- Solder

Heat slugs
- Laser
- Punched

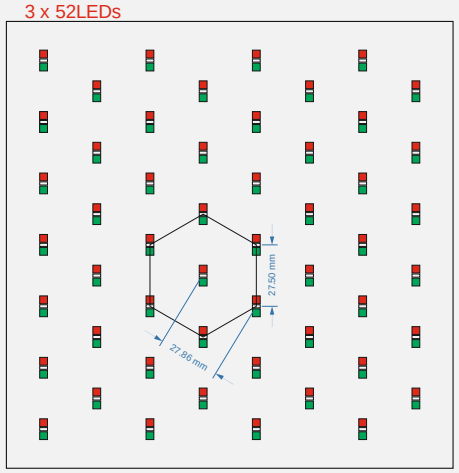
Reference
- No vias

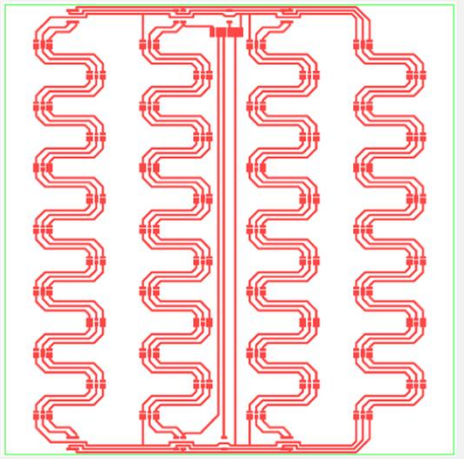


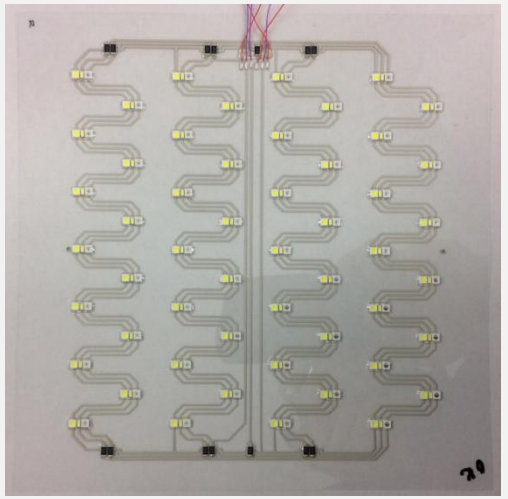


LED foil processing for lighting module prototype

- LED foil substrate layout design based on LED foil optical layout was performed.
- Based on layout design PET substrate was perforated with USHIO mechanical puncher.
- Wafer diced ceramic/metallic foil pieces were bonded to vias using EVO 2200.
- Circuit wiring and contact areas were printed with silver ink on top of heat management structures.
- 52 LUXEON 3014 cool white LEDs were bonded with ICA on top of contact pads with heat management structures below by EVO.
- LUXEON 3535 Color Line LEDs (52 red and 52 lime) were bonded with ICA on top contact pads without heat management structures by EVO 2200.
- In addition, 14 zero ohm resistors were bonded to enable wire crossings.

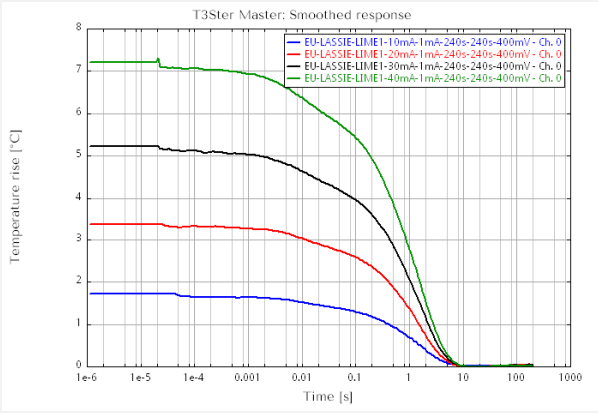


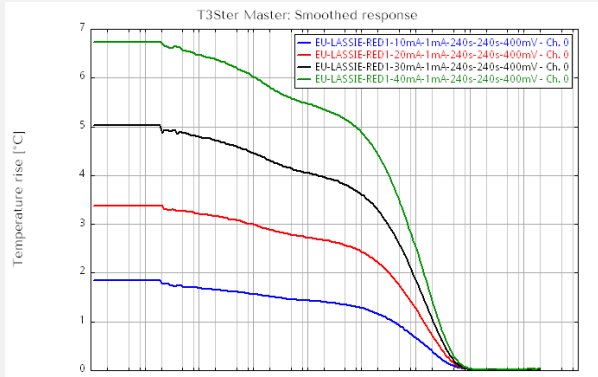


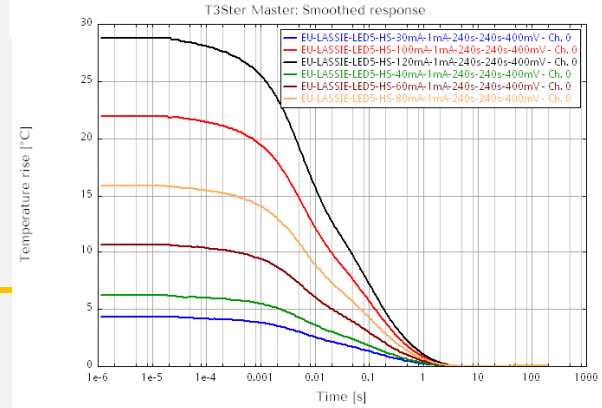


LED junction temperatures

- Lime LUXEON 3535 LED junction temperature without heat management structure about 7°C above 40°C heat plate with 40mA driving current.
- Red LUXEON 3535 LED junction temperature without heat management structure about 7°C above 40°C heat plate with 40mA driving current.
- White LUXEON 3015 LED junction temperature with ceramic/metallic foil heat management structure about 30°C above 40°C heat plate with 120mA driving current.

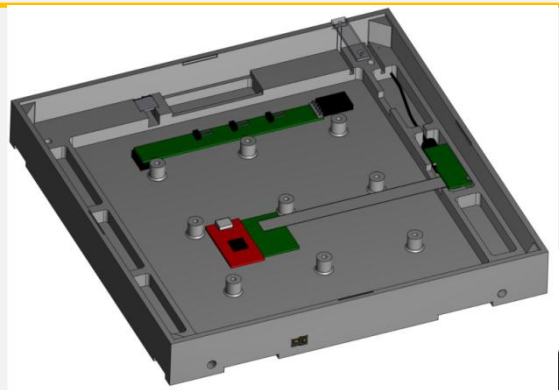


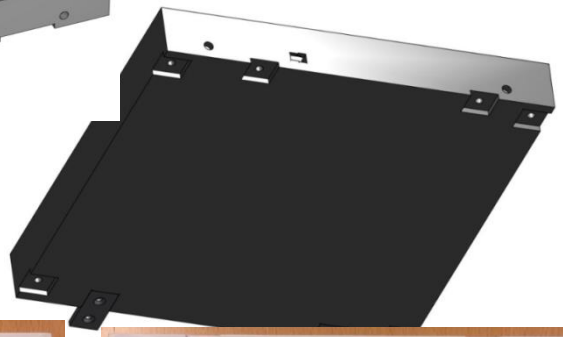


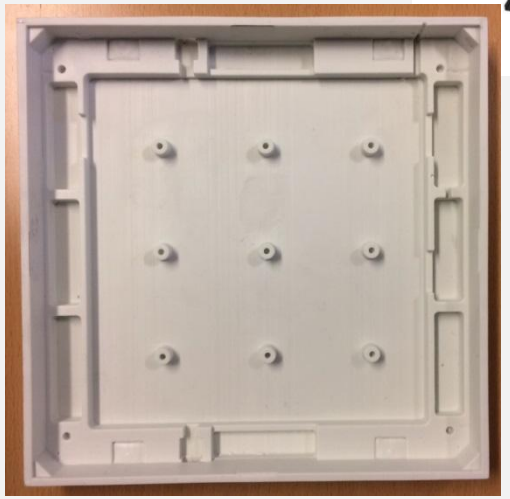


Lighting module optomechanical design, injection moulded case

- Optomechanical design for prototype lighting module casing was performed.
- Prototype casing was 3D printed using white polyamide SLA material.
- Prototype was used as master to implement tool for moulding.
- 10 + 10 moulded casings were manufactured using white PC/ABS material.

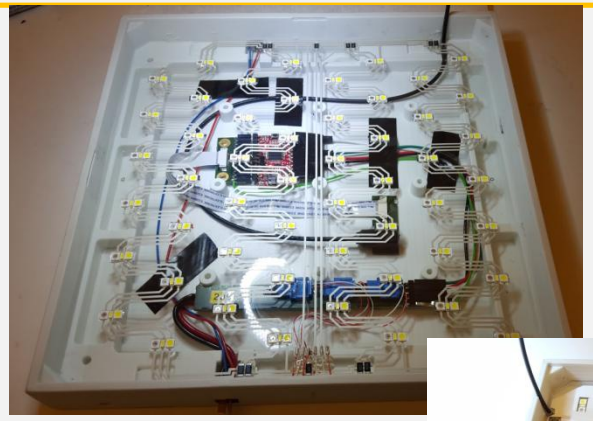






Lighting module assembly

- Sensor system was assembled to the bottom cavity of the casing.
- LED foil was assembled on top of bottom cavity.
- Perforated Makrofol film was assembled on top of LED foil.
- 2 mm thick transparent polyacryle casing lid was equipped with CCF and BEF on botton side and two 90deg crossed AGFs were assembled on top side of the lid.
- Module assembly was finalized by assembling casing lid on top the casing.
- Initial optical thickness of the module was 15 mm. Also 18 mm optical systems were implemented by adding 3 mm collar to the casing.



Final functional module