

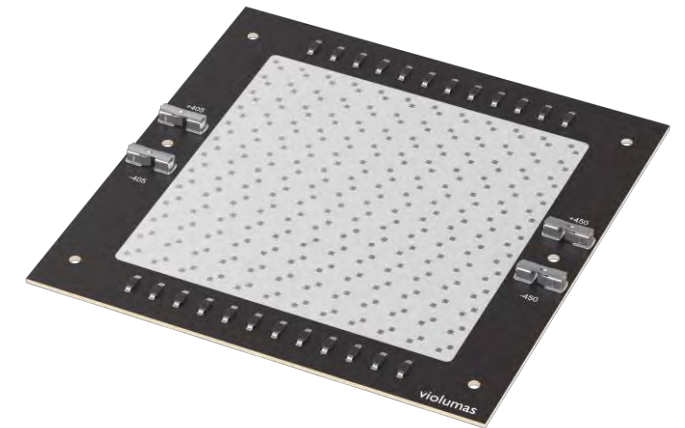
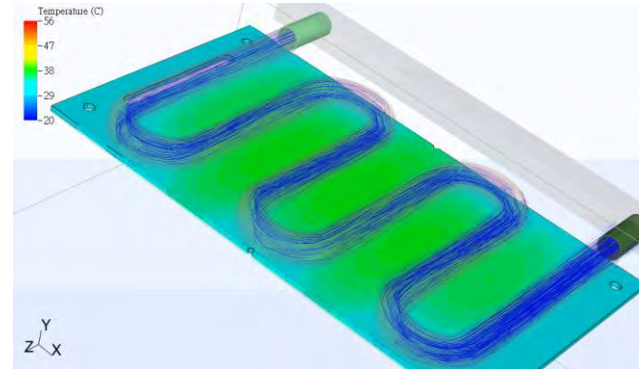
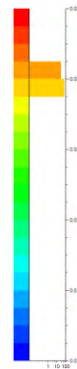
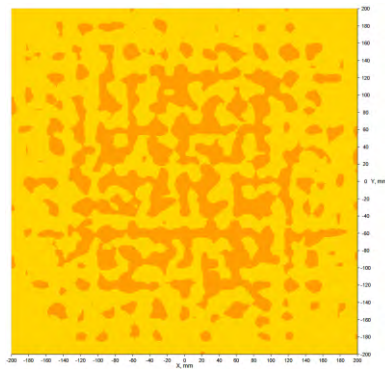
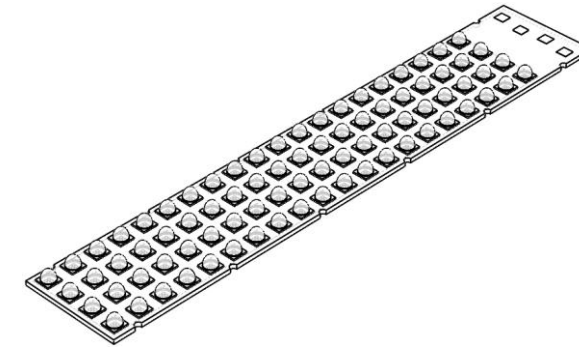
Significance of thermal analysis and design in high density UV LED array

Dr. Pao Chen

CTO, Violumas, Fremont, CA, USA

Violumas Identity

- One-Stop Service for UV Product Development
 - LED Packaging & Assembly
 - Optical Simulation & Design
 - Thermal Simulation & Solution
 - Custom UV LED Solutions



Market Demands & Development Trend

Mid Power

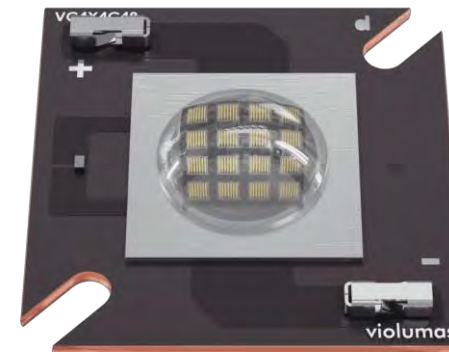
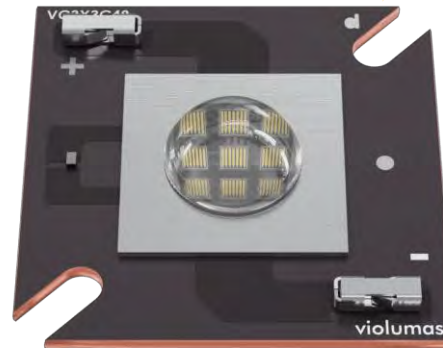
- Air Purification
- Phototherapy

High Power

- Water Treatment
- Fiber Coupling

High Density

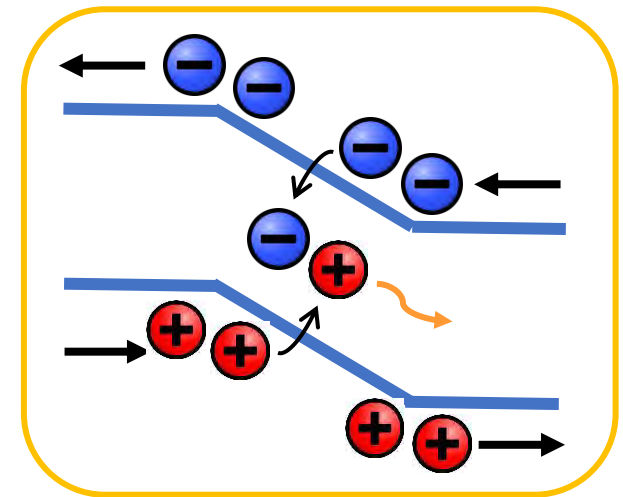
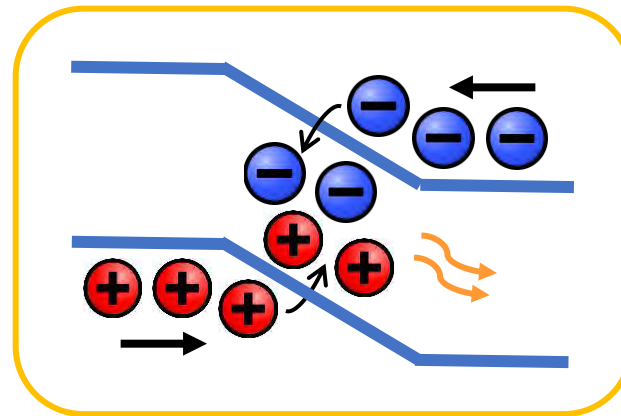
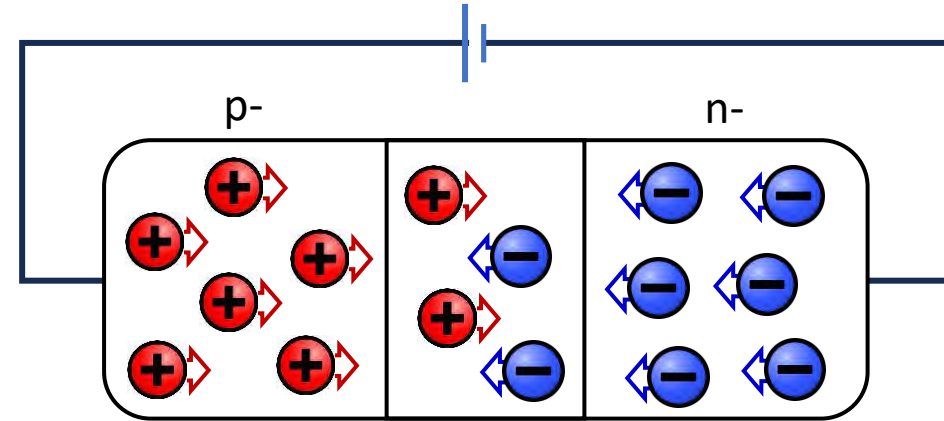
- Semiconductor Equipment
- Curing/Printing



Most Frequent Fault: Over Temperature

Over Temperature Faults:

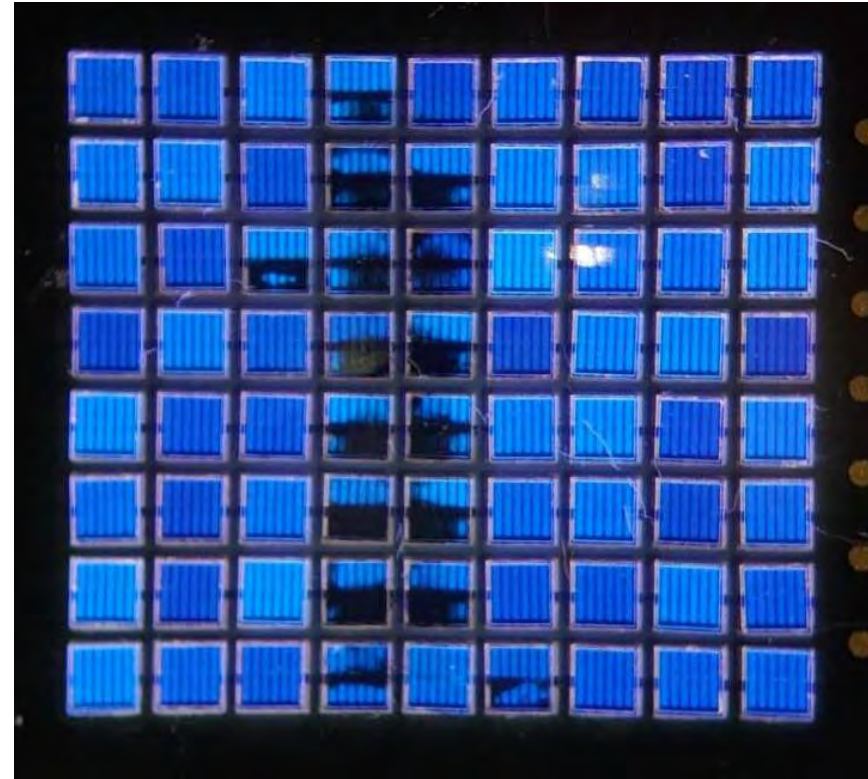
- Thermal Decay
 - Decrease of optical output
 - Recombination rate decreases
- Junction Meltdown
 - Permanent damage
 - Lattice structure destroyed
 - Dopant Diffusion
 - Short Circuit



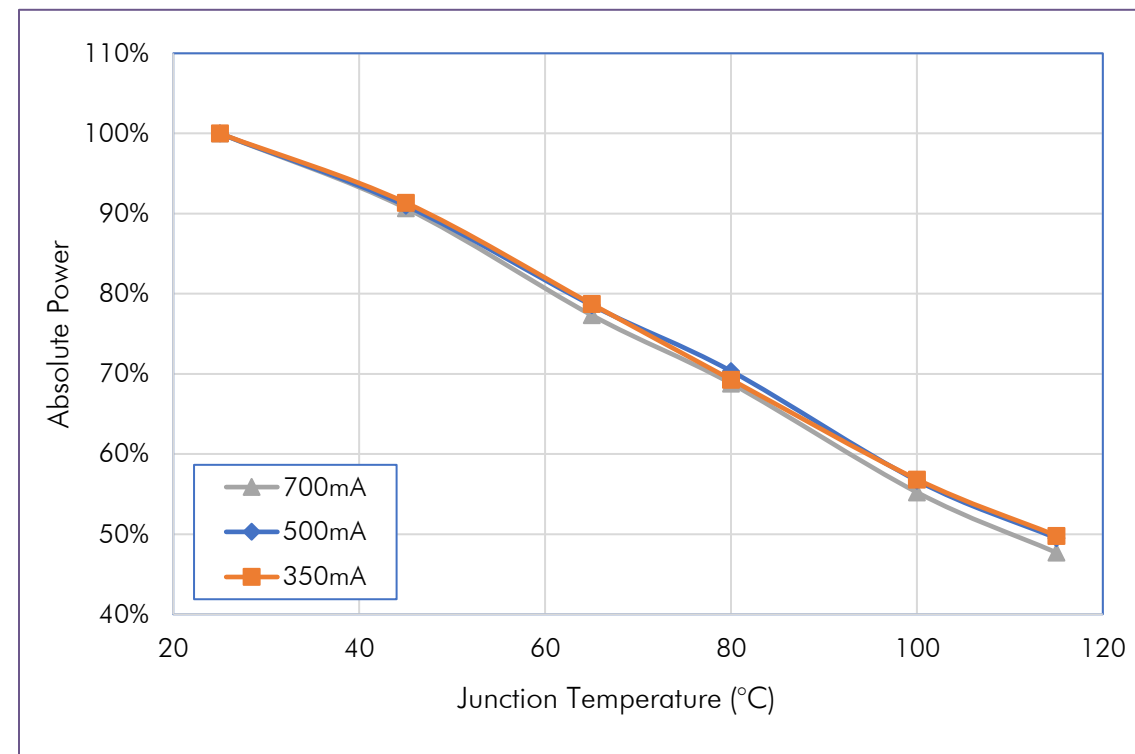
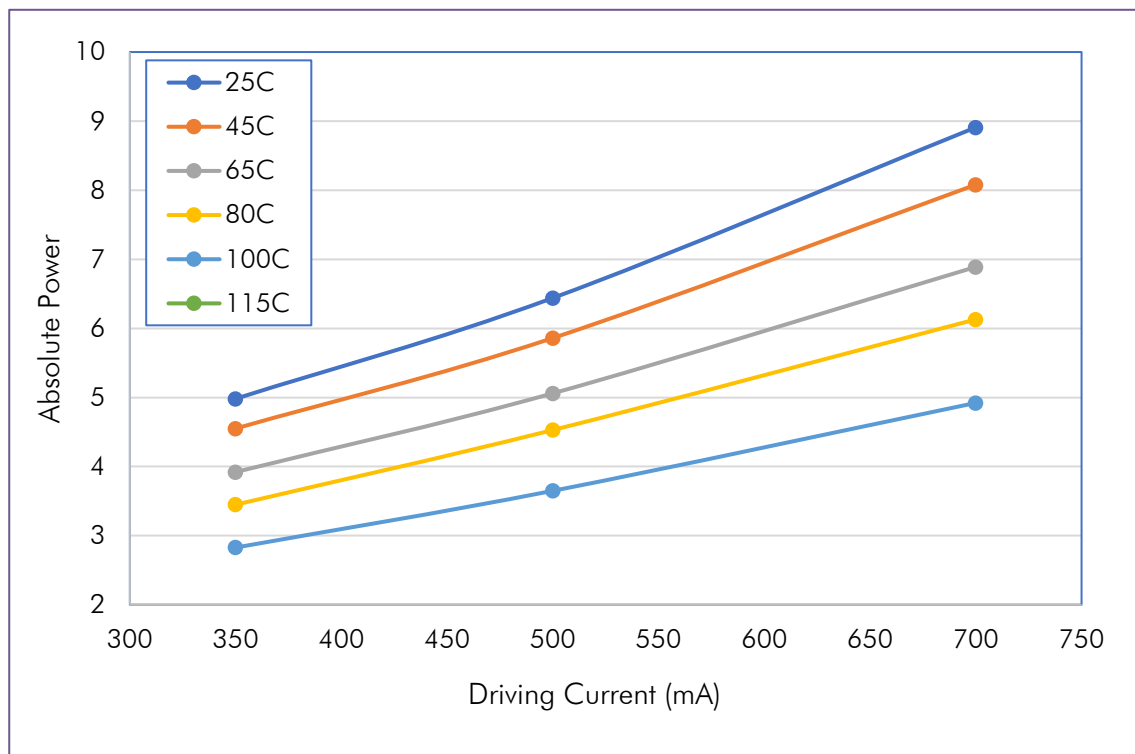
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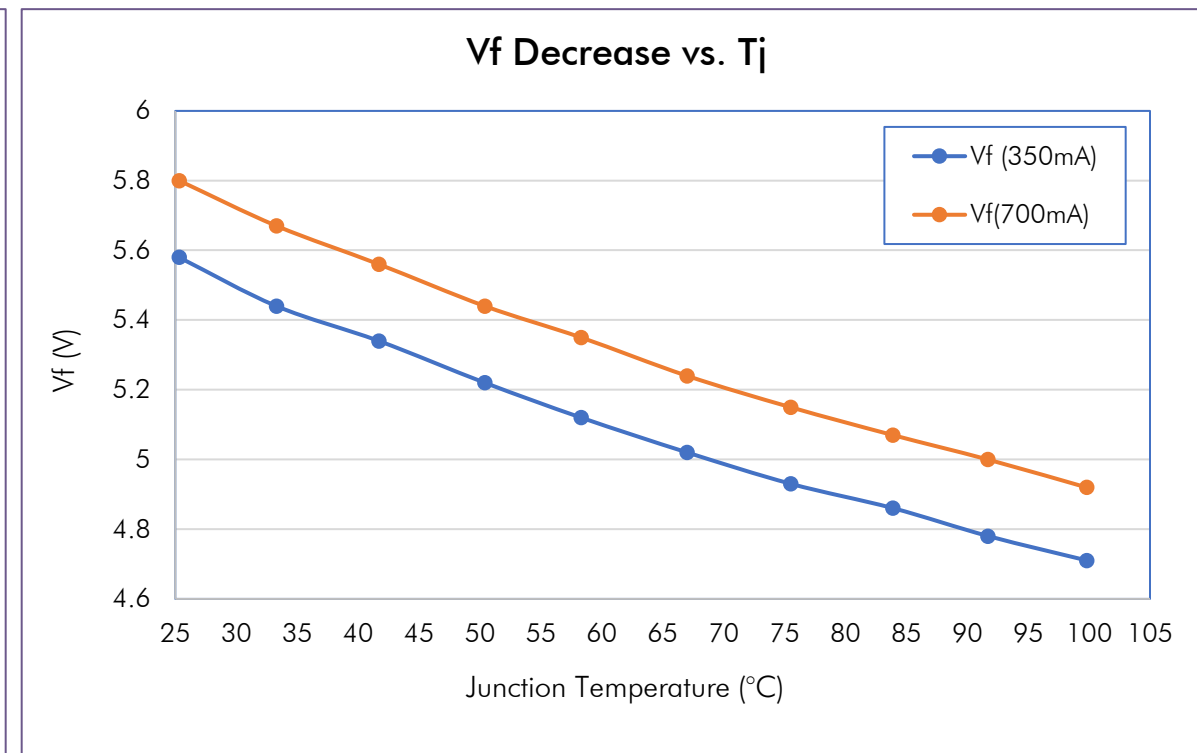
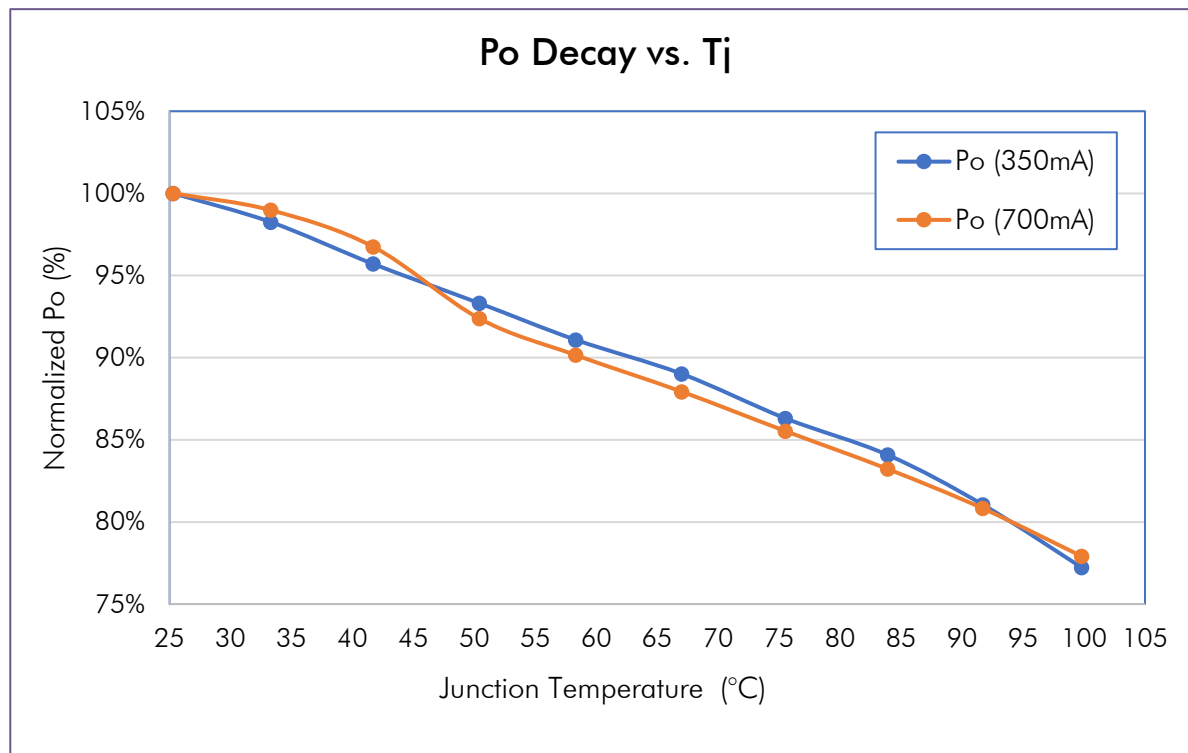


Example: 385 nm UVA LED Thermal Decay



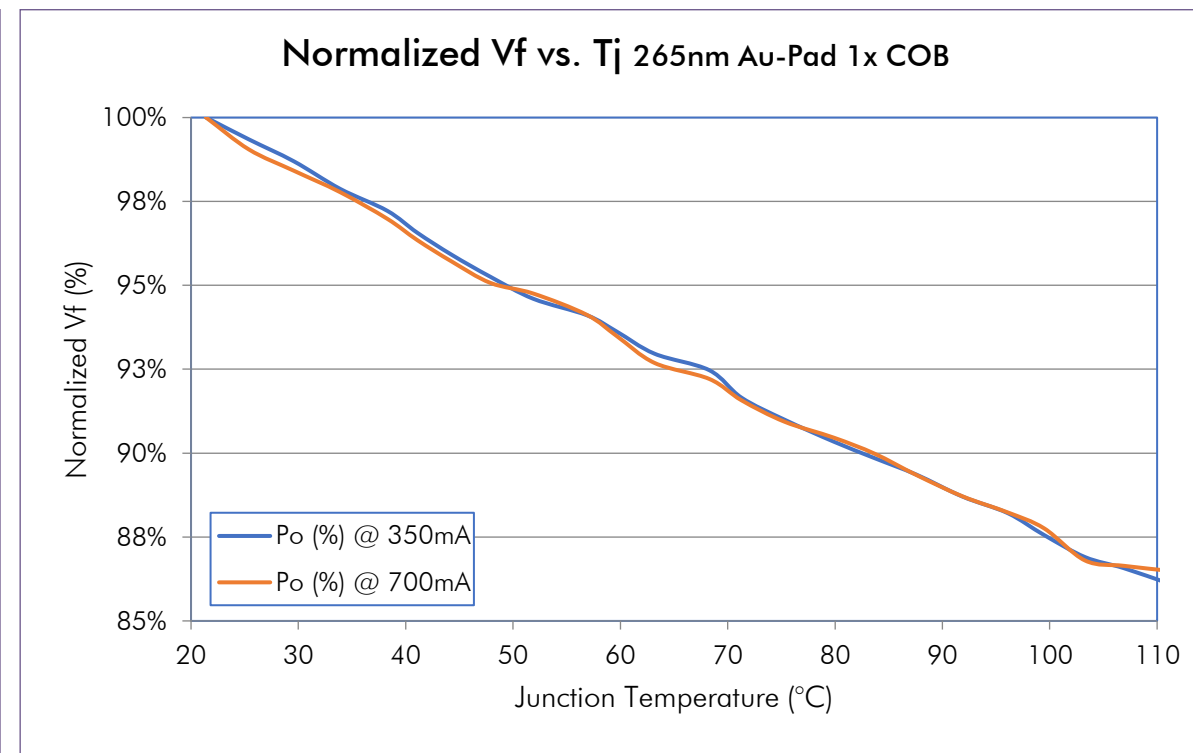
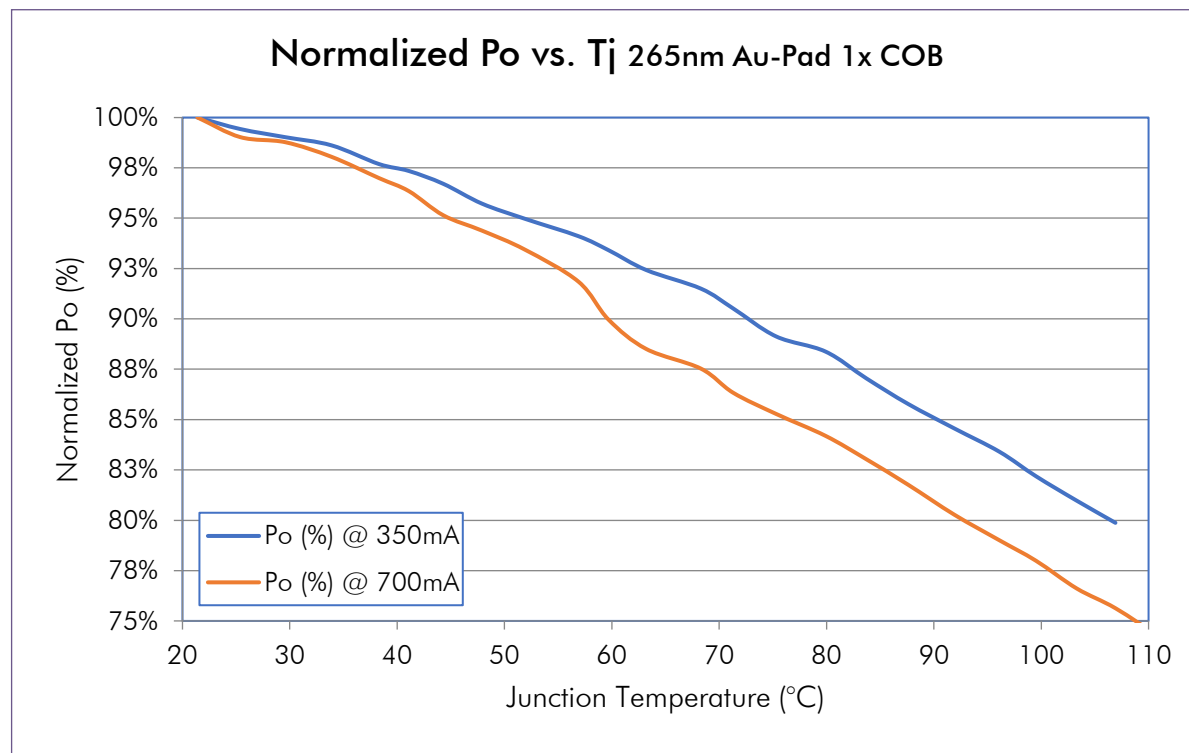
Testing Sample: Violumas 385nm 1X1 COB – VC1X1C45-385

Example: 310 nm UVB LED Thermal Decay



Testing Sample: Violumas 310nm 1X1 COB – VC1X1C48-310

Example: 265 nm UVC LED Thermal Decay



Testing Sample: Violumas 265nm 1X1 COB – VC1X1C48-265

Thermal Solution Equipped High Power Module

Standard Products – Booth 217

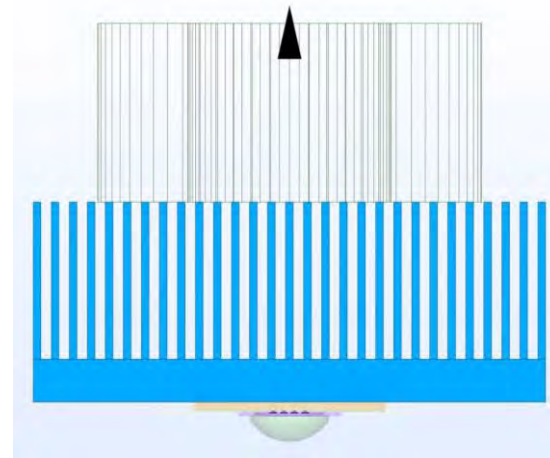
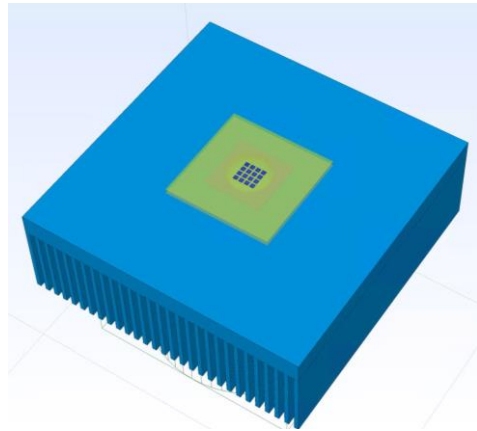


Part Number: M3X3L9 Module
9-Chip 90° Module



Part Number: M4X4L9 Module
16-Chip 90° Module

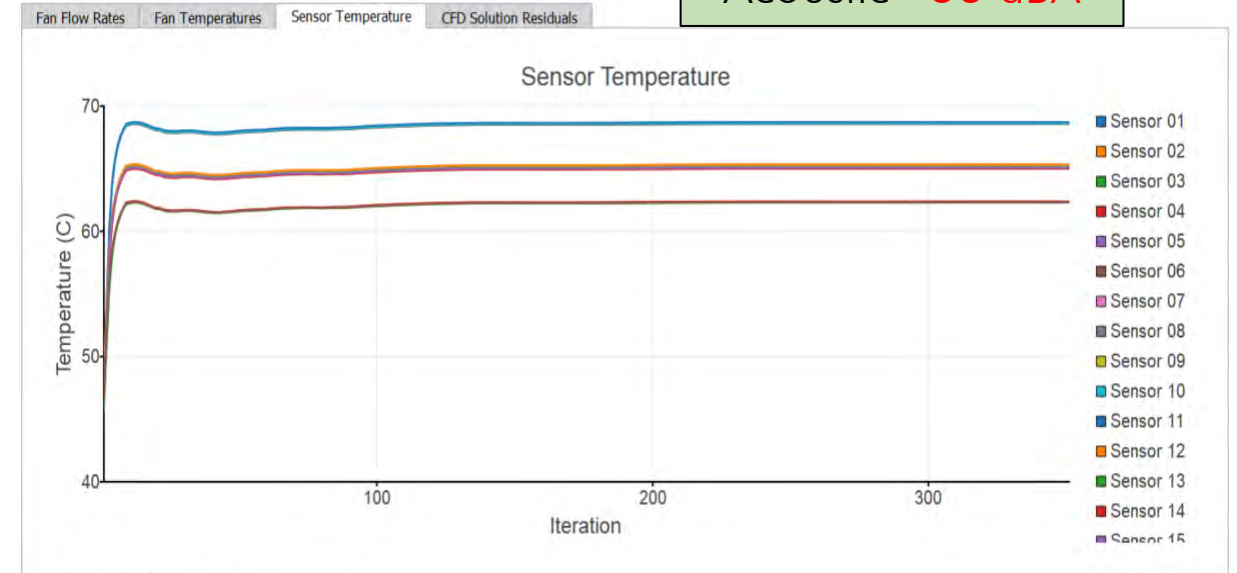
Thermal Analysis & Design: Target $T_j < 70^\circ\text{C}$



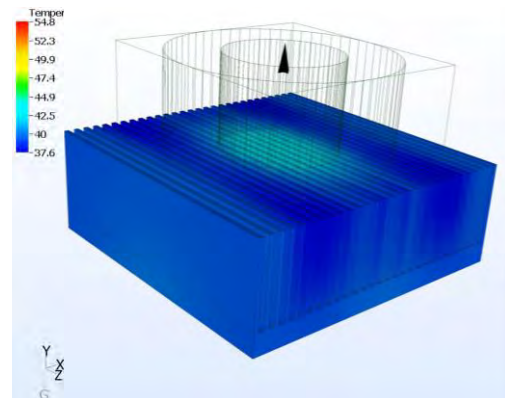
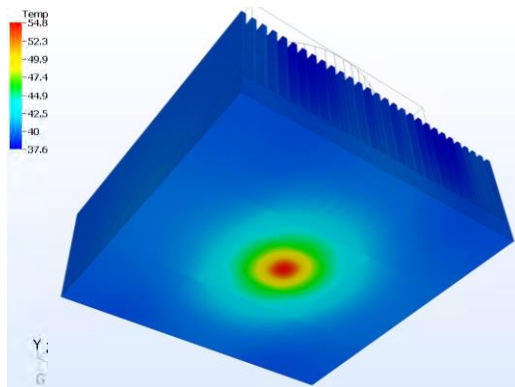
Solve On My PC : VC4X4C48L9.equipment / 5C-Baseline-8038_6100RPMLEDup80x80HS

Model Currently Running with 100.00% Of Unlimited Grid

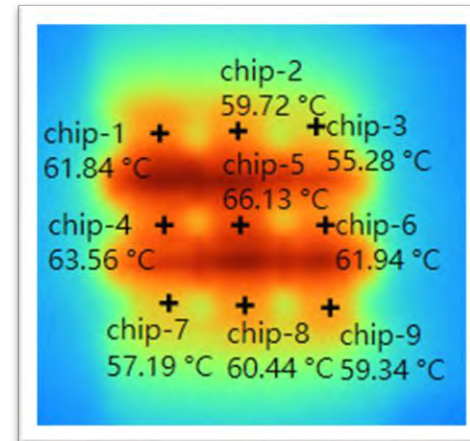
6,100 RPM
 $T_{j-max} = 68.7^\circ\text{C}$
Acoustic = 56 dBA



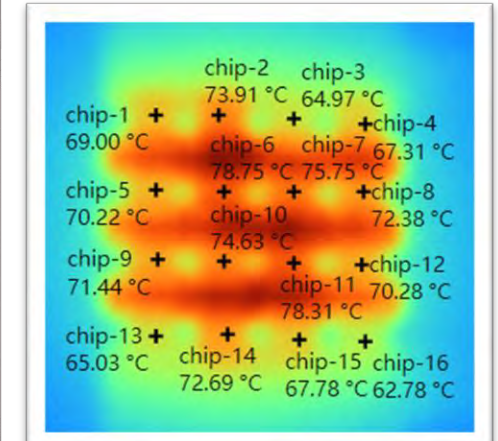
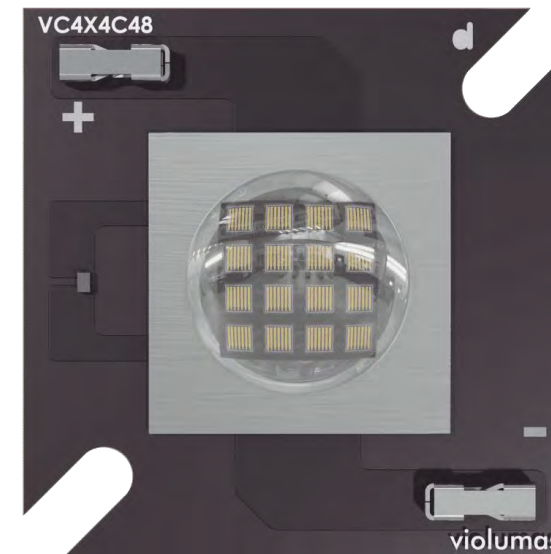
3X3 Module



Thermal Verification



Max. $T_j = 66^\circ\text{C}$



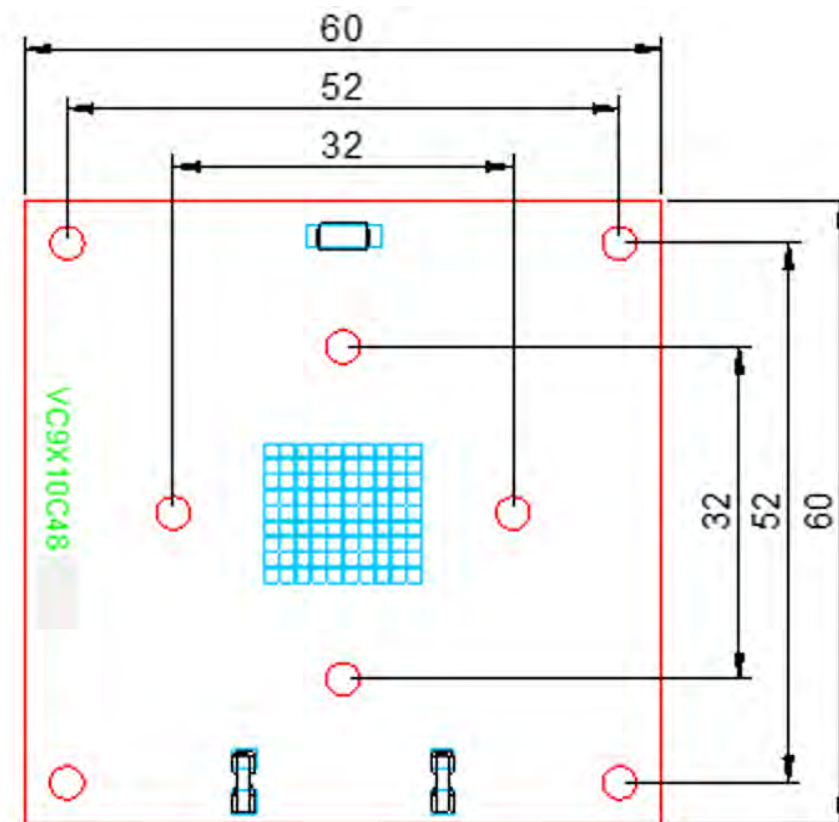
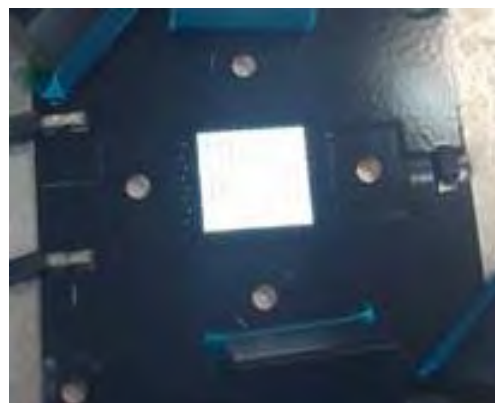
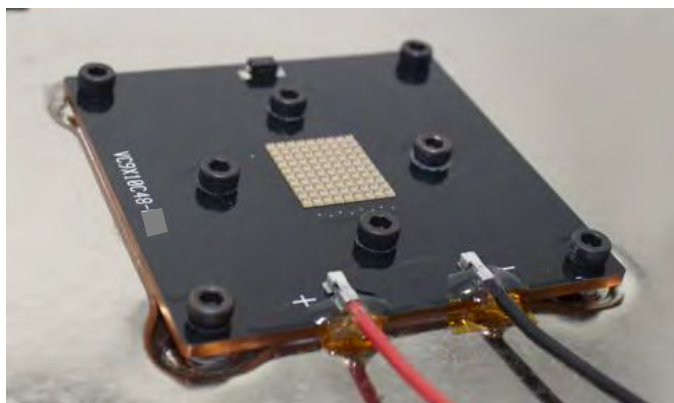
Max. $T_j = 78^\circ\text{C}$

Thermal Solution Showcase

Solution Development for High Density Array

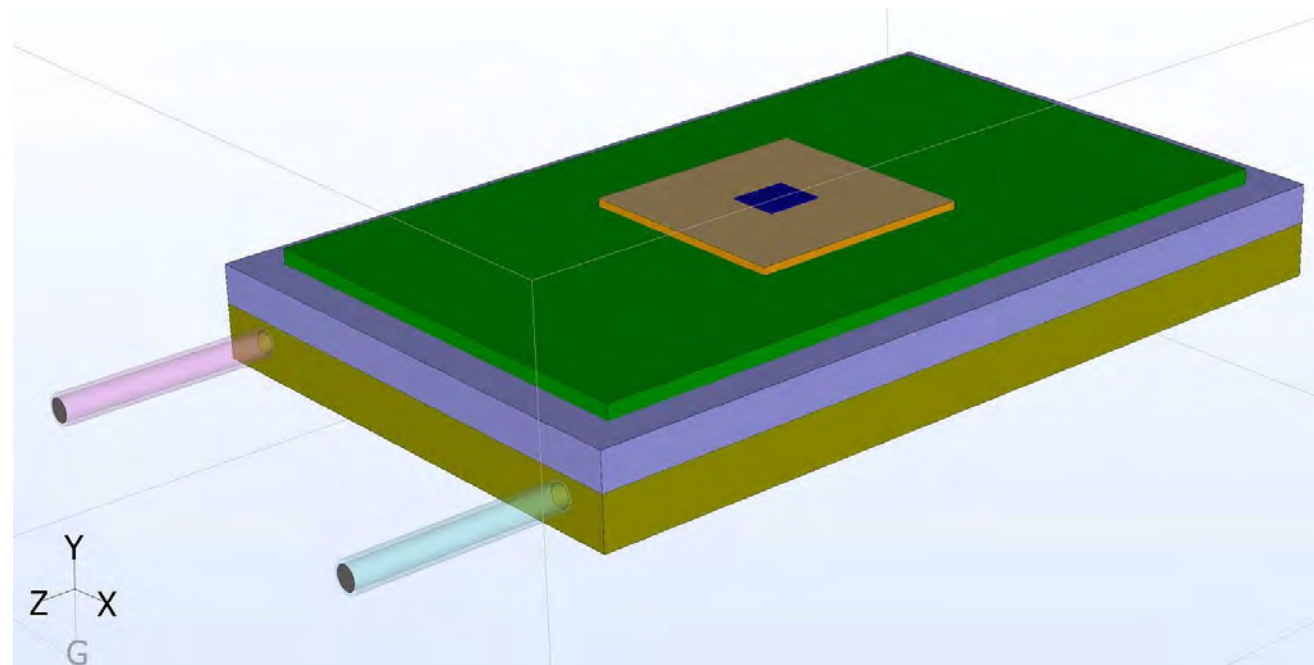
High Density Chip-On-Board

- COB Parameters
 - Wavelength: 265 nm / Chip size: 1.22 mm x 1.22 mm
 - Circuit: 9S10P / Electrical Power: 378 W
 - Emission Area: 14.8 mm x 13.2 mm
 - Optical Power: 7.2 W / Surface Intensity: 3.7 W/cm²
 - Target 1 W/cm² at TD=30 mm
 - Heat: 360 W / Thermal Density: 184 W/cm²

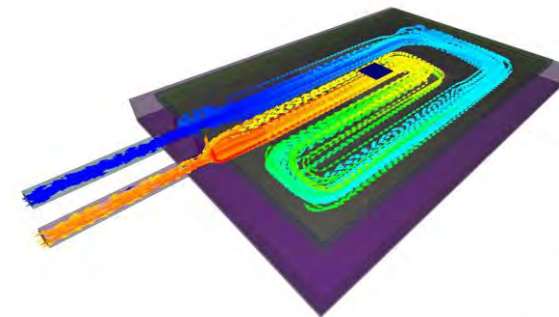
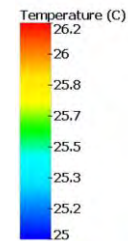
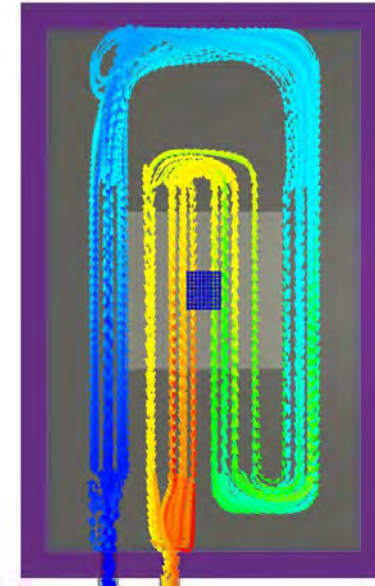
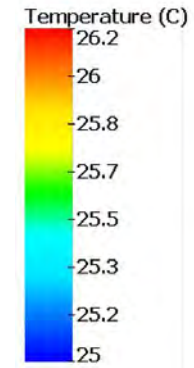
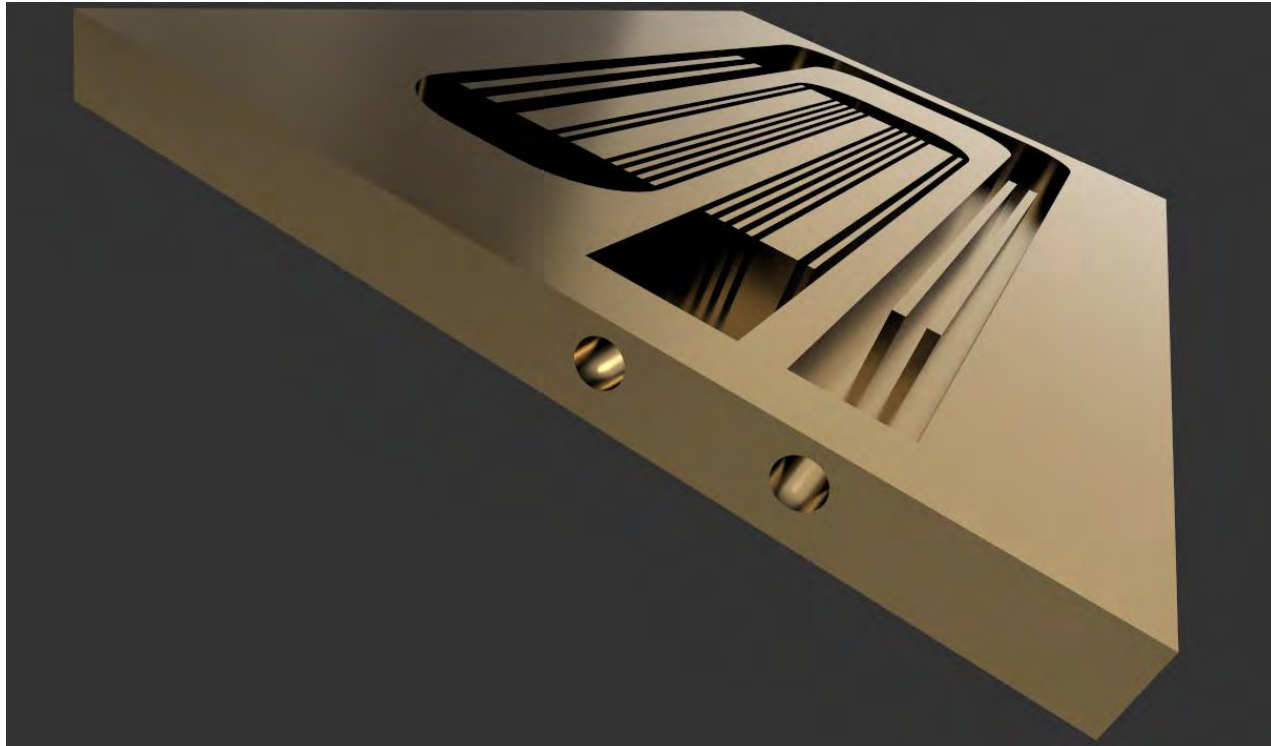


Concept of Thermal Solution

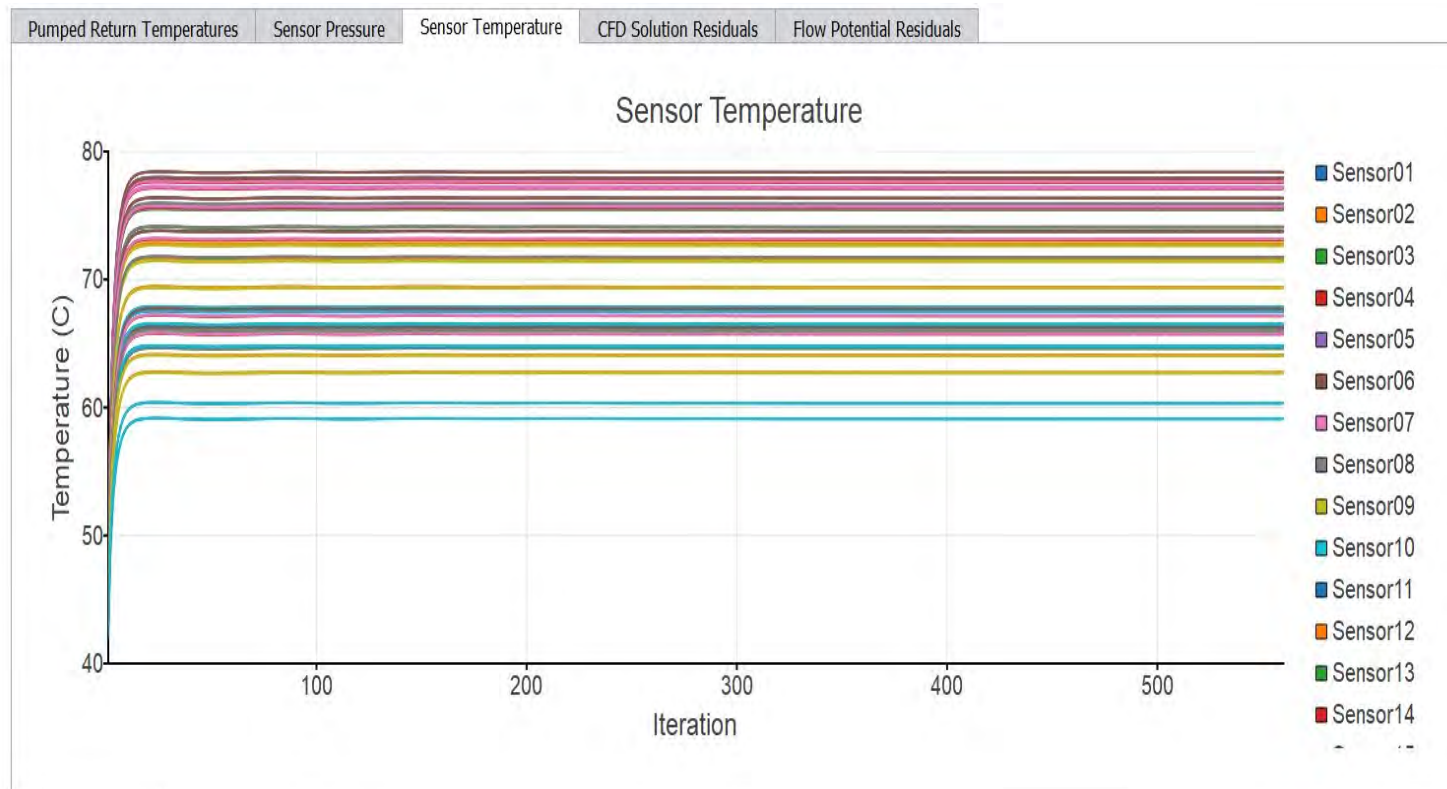
- Key Factor – 184 W/cm^2 thermal density
- Solution - A combo of vapor chamber and cold plate
 - Vapor chamber
 - Lose the restriction from high thermal density
- Cold Plate
 - Accelerate heat removal



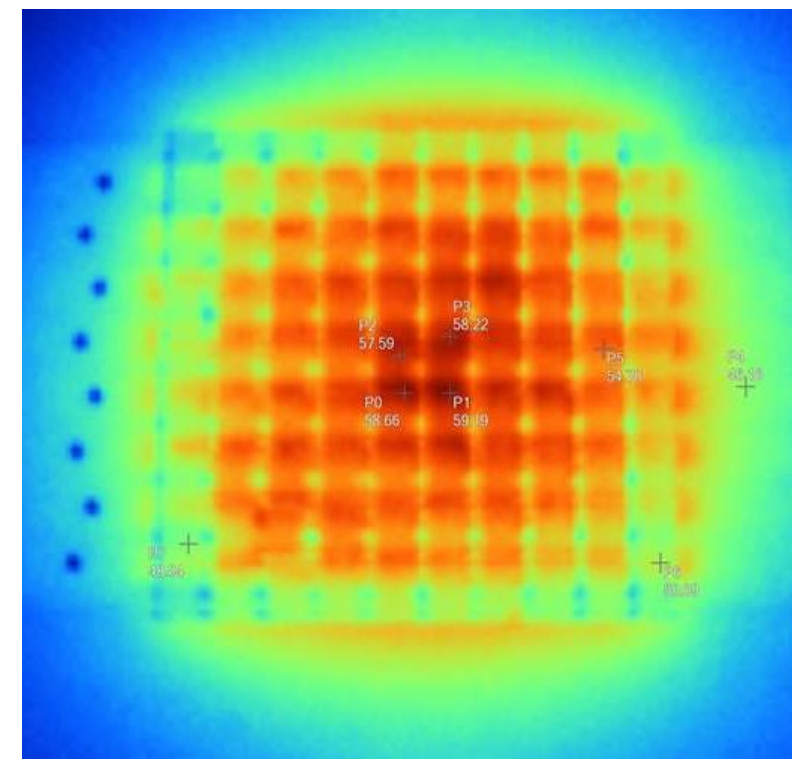
Customized Cold Plate



Thermal Simulation and Verification

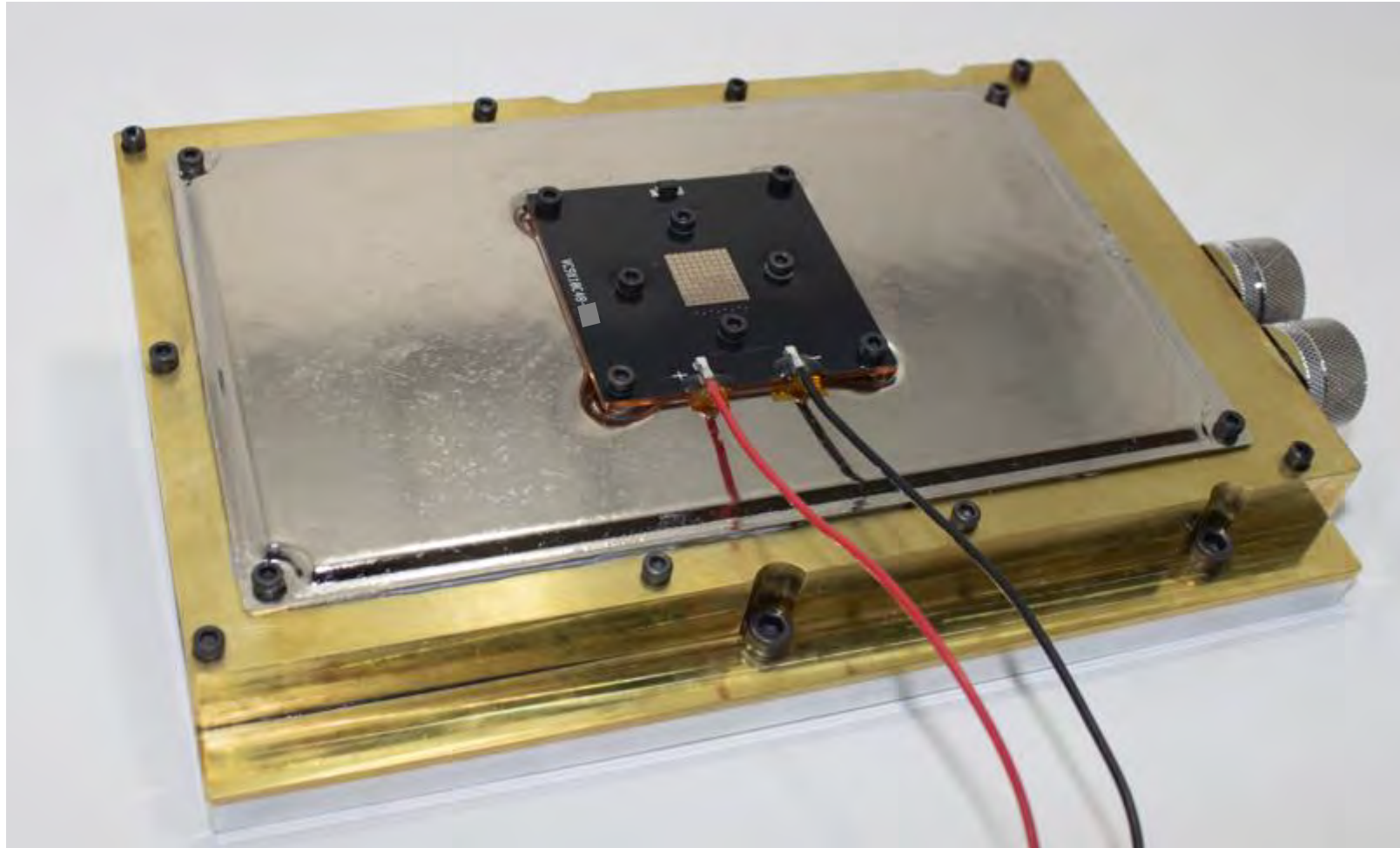


Design Phase - Worst Operating Conditions
Max. $T_j = 78^\circ\text{C}$



Normal Operating Conditions
Max. $T_j = 60^\circ\text{C}$

Final Design and Assembly



Conclusion

- High density array is a trend to provide high intensity for latest applications
- Thermal solution is the most important part of a system that employs a high-density array of UVC LEDs
 - Penalty includes lower optical output and reduced lifespan
- To have a successful system, it is recommended to integrate following
 - LED packaging
 - Optical simulation / Optical design
 - Electrical/Circuit design
 - Thermal solution



Thank you!

violumas

High Power UV LED Solutions

pao.chen@violumas.com

www.violumas.com