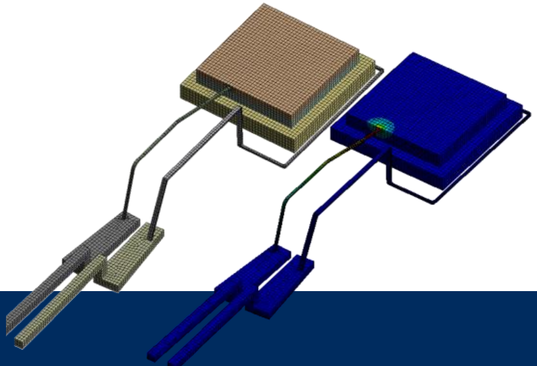
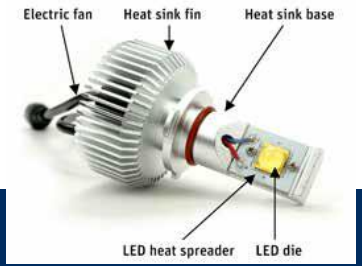
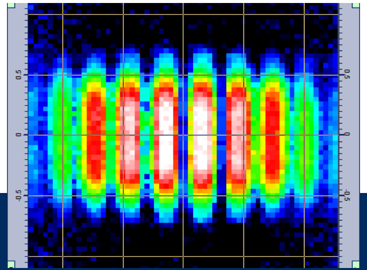
Simulation is more than Software®







Multiphysics numerical simulation for photonics packaging

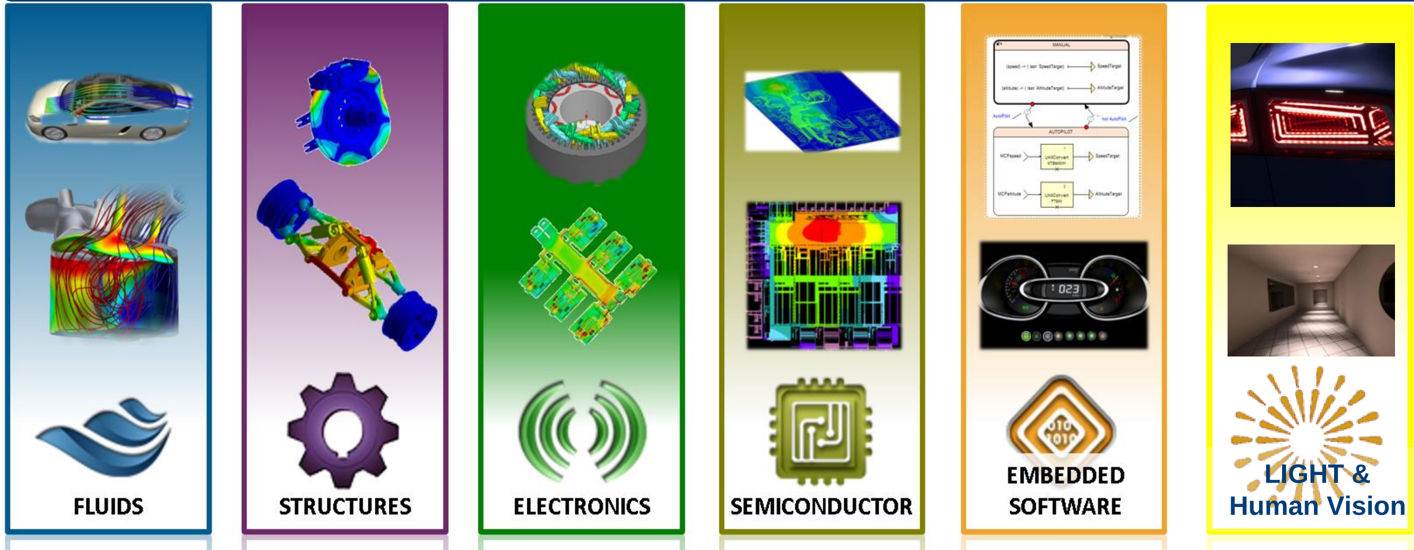
Joël Grognuz

Cyber Physical System Portfolio

Model Based Engineering

Systems ⇔ Robust Design Optimization (RDO)

Metamodels, MOR, Co-simulation, Strong Matrix coupling, Parameters



Integrated (I)IoT Assets

Rendered with ANSYS SPEOS

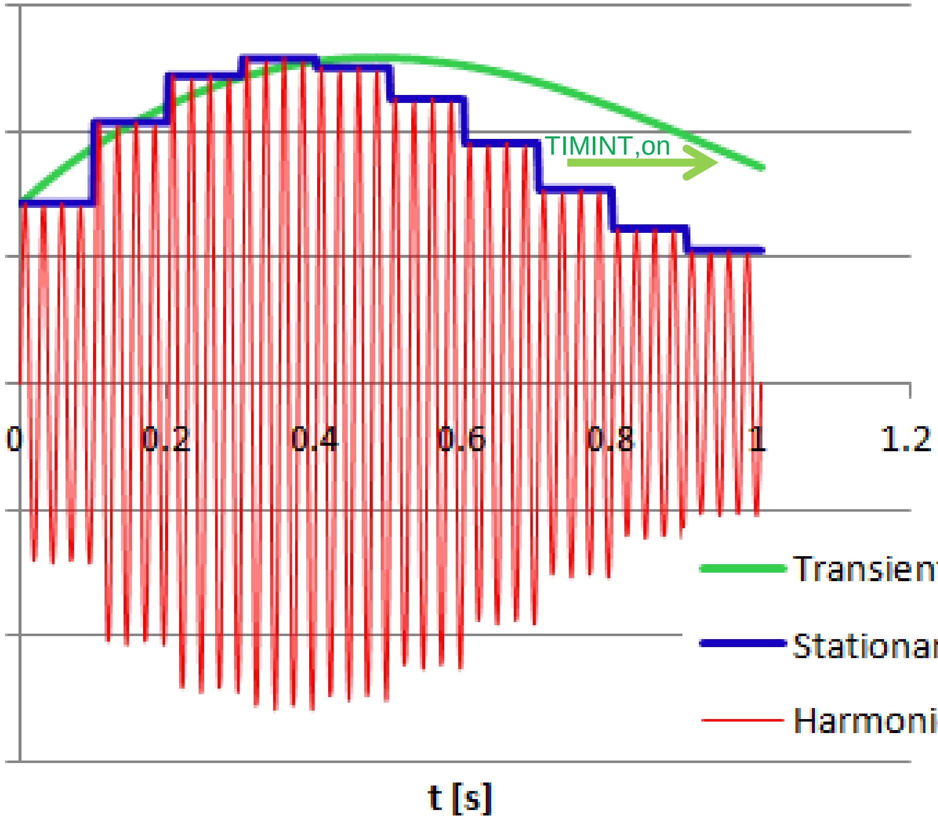
CADFEM

Multi-timescale

- Stationary: time scale t_1
- Harmonic: time scale t_2
- Transient (TIMINT, on): time scale t_3

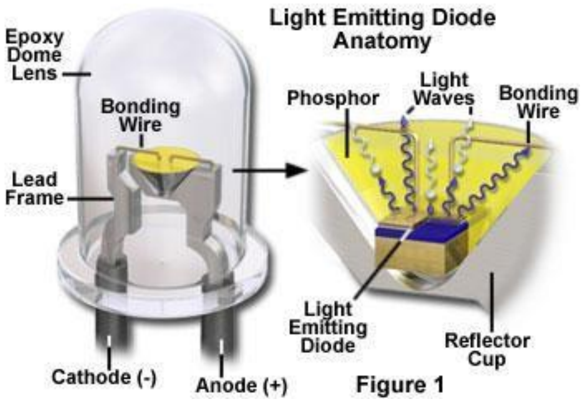
- For instance:

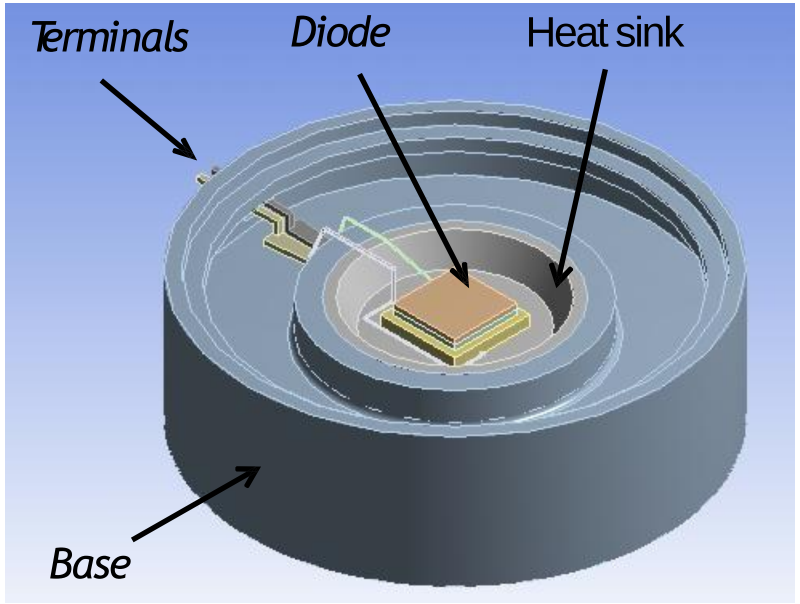
  $t_1 << t_2 << t_3$

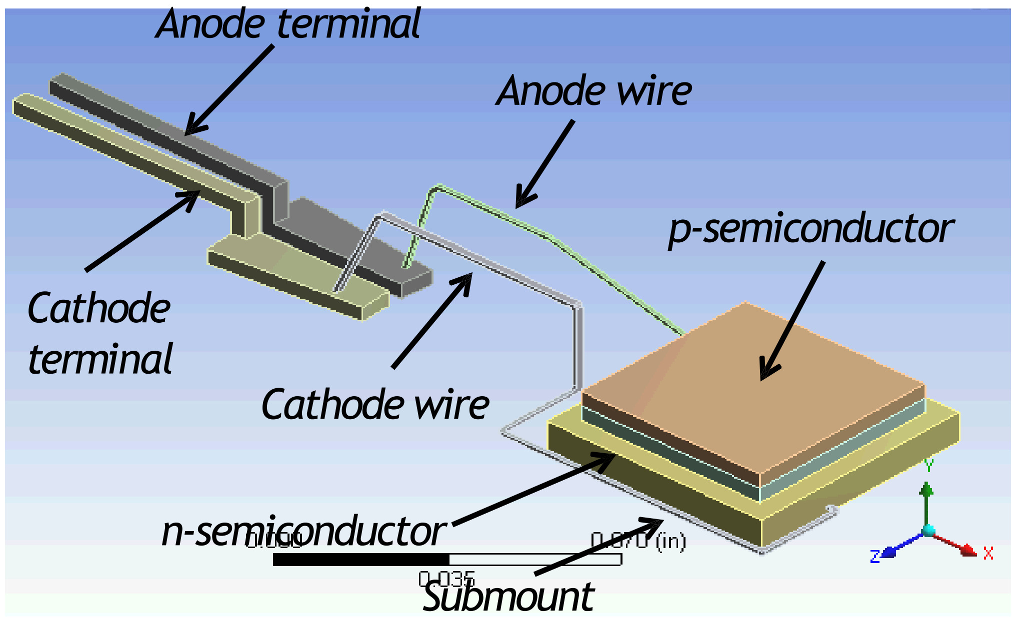


Transient, TIMINT	Temperature
Stationary	Power
Harmonic	Electrical current

Thermal-Electric analysis of a LED (Strong Coupling)



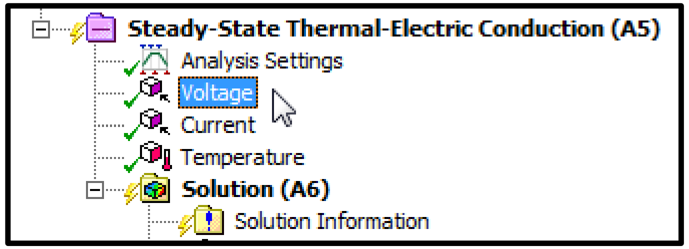


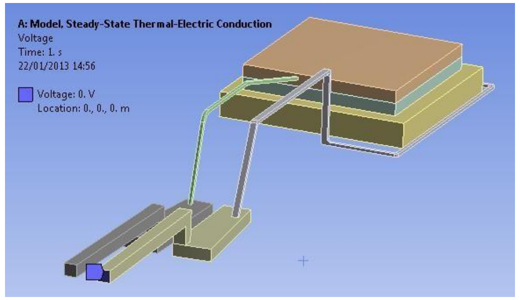


Material	Body	Thermal Conductivity λ (W.m-1.K-1)	Resistivity p (Ω.m-1)
Gold	Anode terminal / Cathode terminal / Anode wire / Cathode wire	301	2.2e-8
Silicon	Submount	124	0.0001
Gallium Nitride	n-semiconductor	125	0.118
Gallium Arsenide	p-semiconductor	46	0.079
Copper Alloy	Heat sink	401	1.724e-8
Nylon	Base	0.634	1000

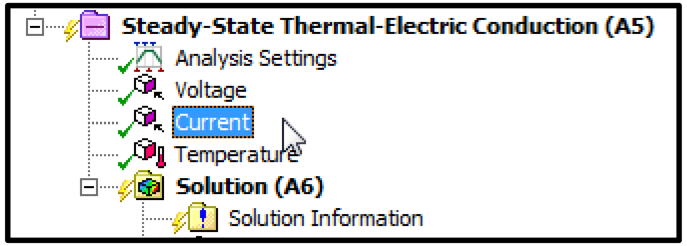
Thermal-Electric analysis of a LED : Setting boundary conditions

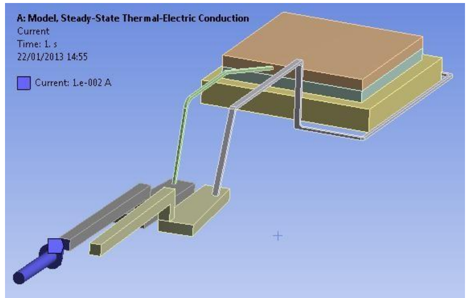
Apply 0 V to the end of Anode terminal:



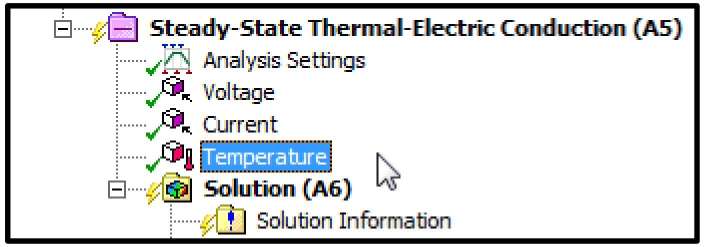


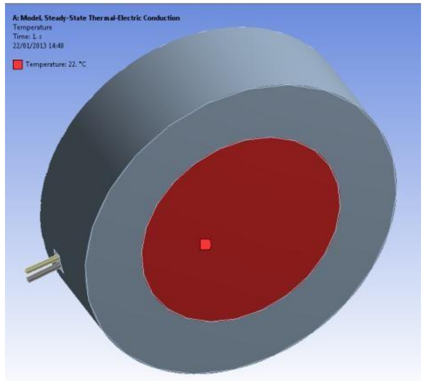
Apply 10mA to the end of Cathode terminal:





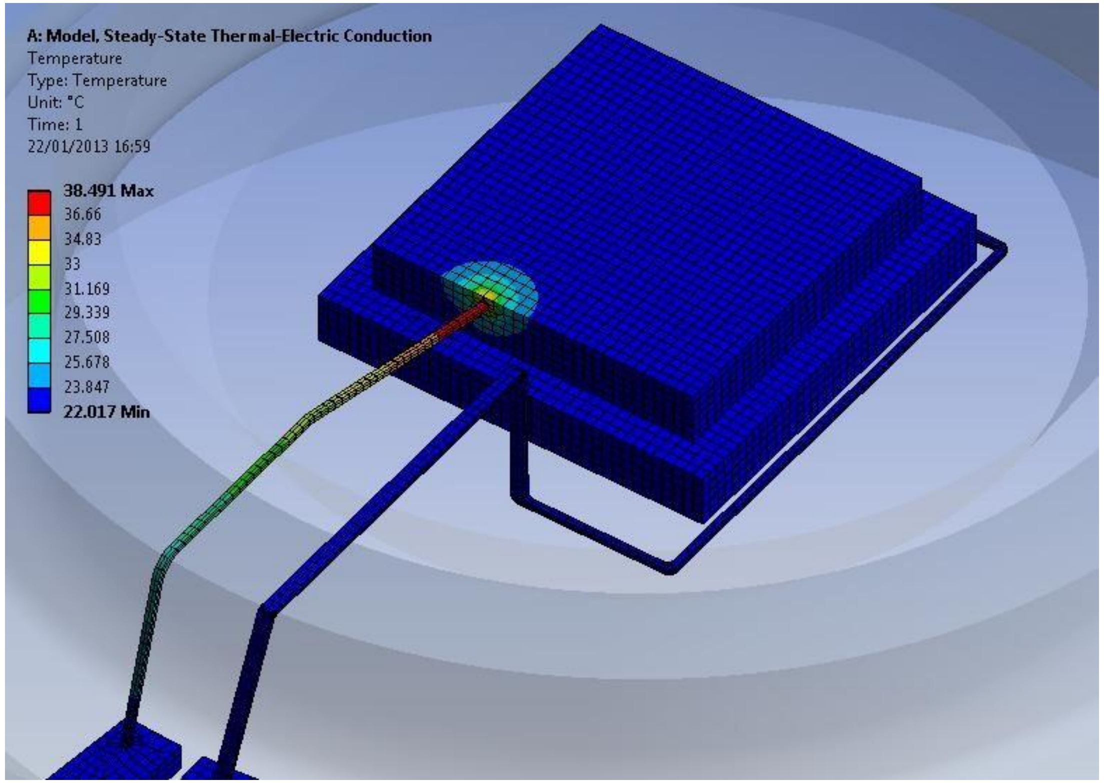
Apply 22°C to the bottom of the Heat sink:



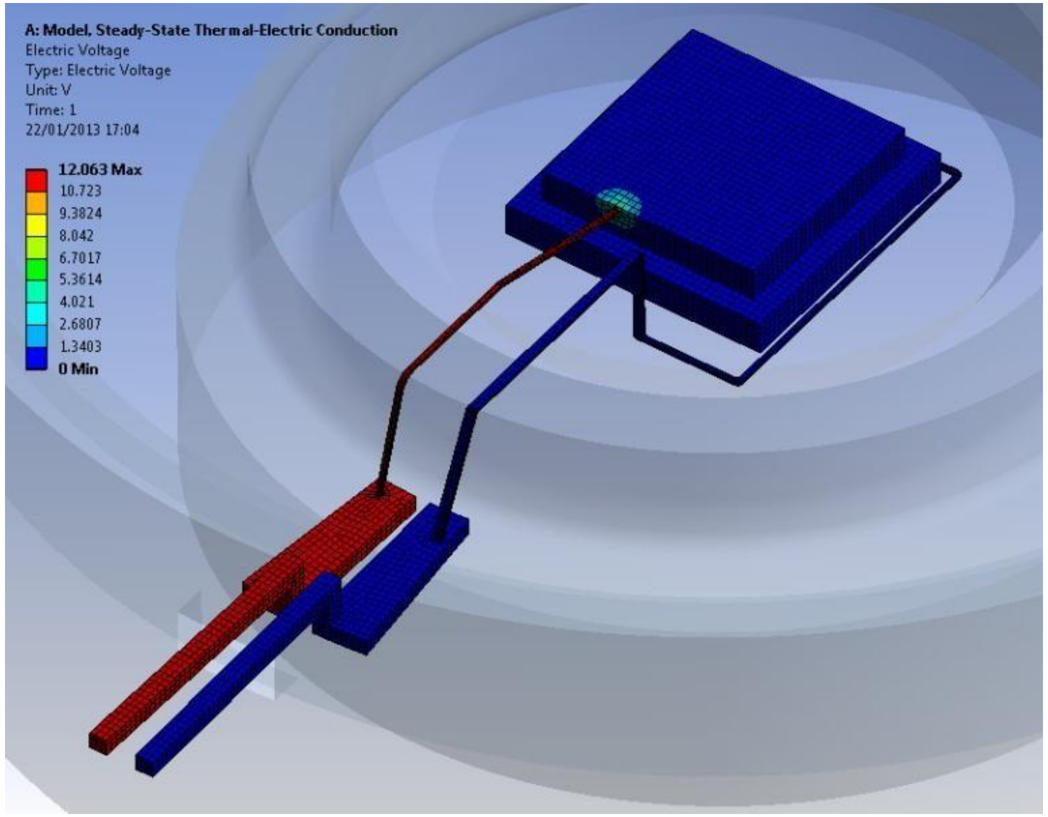


Thermal-Electric analysis of a LED : Results

- Temperature

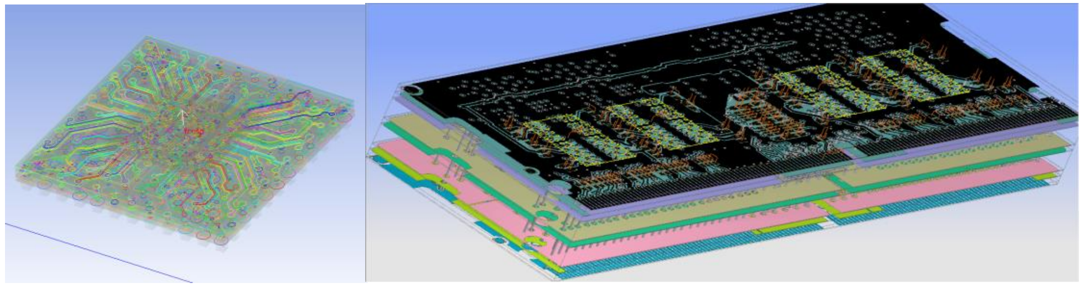


- Voltage

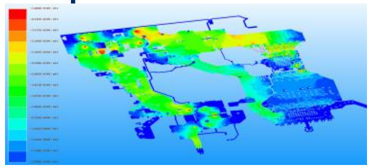


ECAD & Equivalent Circuit extraction

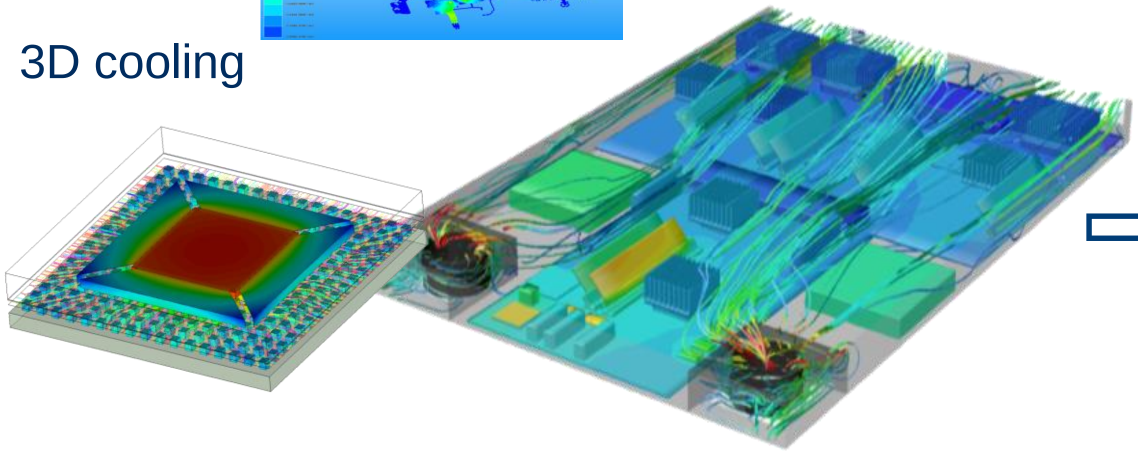
- ECAD import:



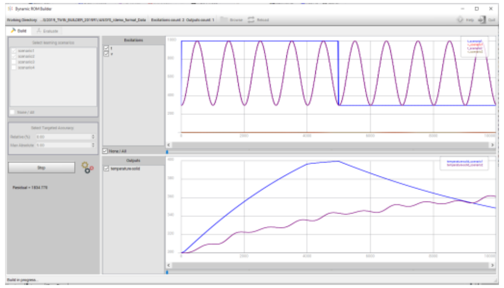
- 2.5D loss computation

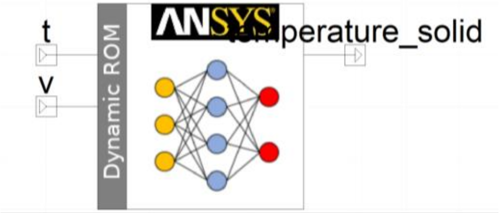


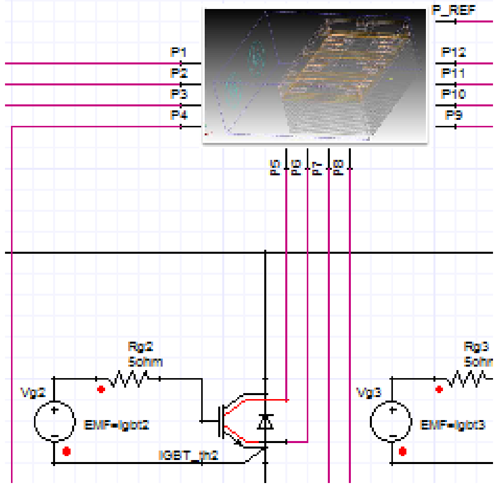
- 3D cooling

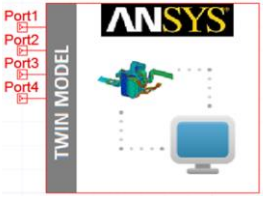


- 0D Circuit extraction



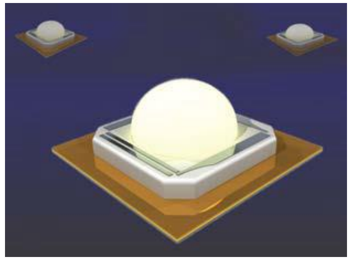


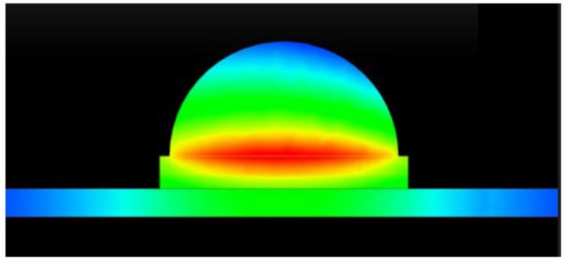




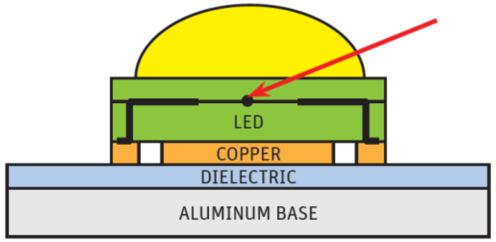
DuPont : CooLam Substrate

“…supply lighting manufacturers with thermal substrates that ensure high LED performance, reduced power consumption and long life.”

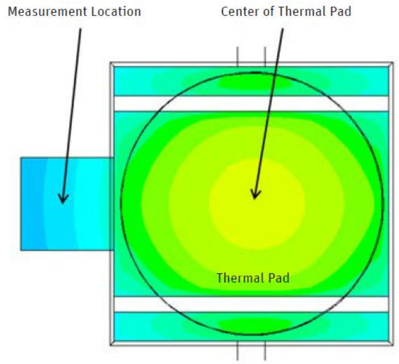




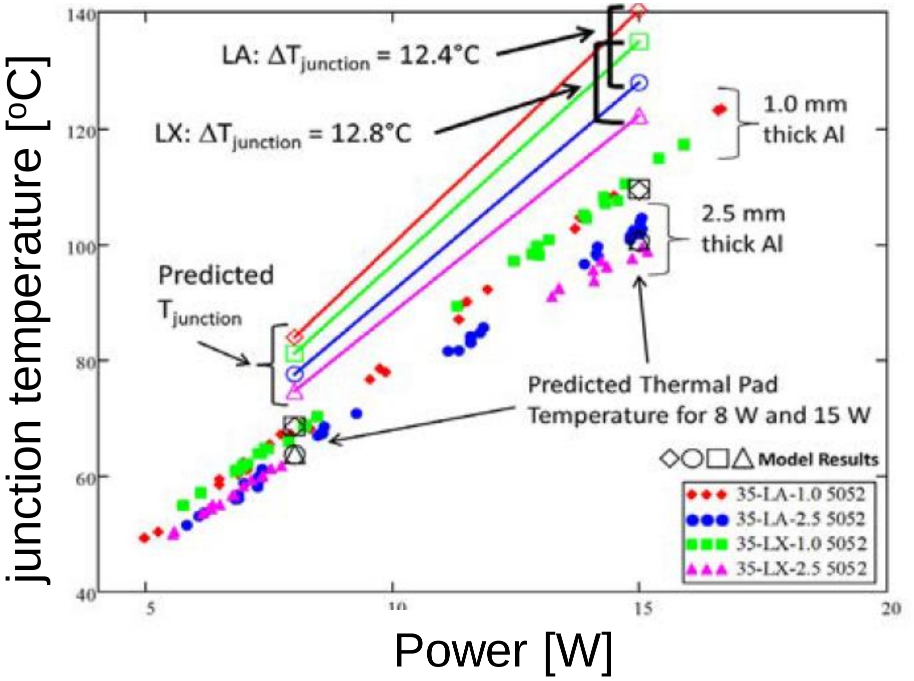
▲ Simulation results show temperature plotted on LED, thermal substrate and board.



▲ CooLam® thermal substrates consist of copper foil, polyimide dielectric and aluminum base. The arrow shows the center of the thermal pad, which cannot be measured under operating conditions.



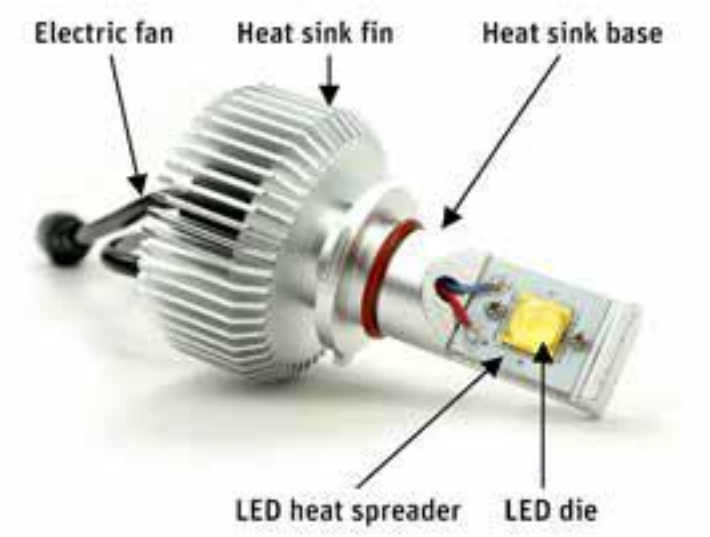
▲ Simulation showed a 15 C temperature difference between the solder pad and the center of the thermal pad.

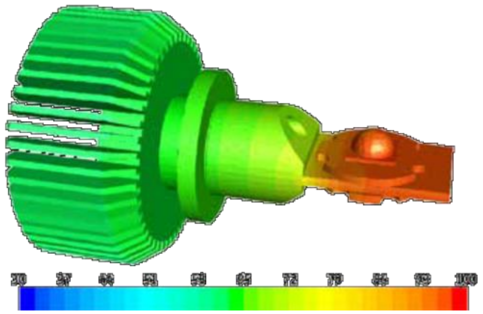


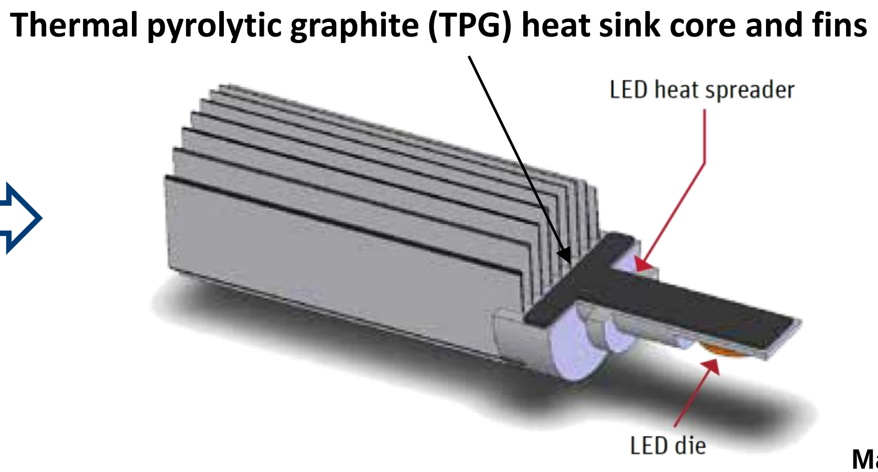
▲ Effect of aluminum thickness on junction temperature for two power levels and two types of dielectric material (LA and LX)

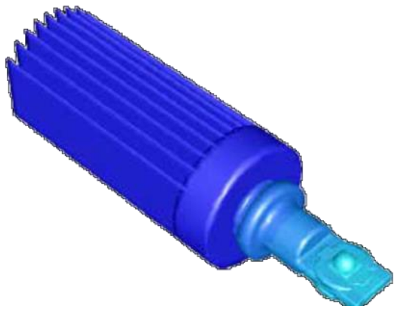
By Kevin Allred, **Stacy Hamlet**, **Winston Fan** and **Lei Zhao**, DuPont Engineering,
E. I. DuPont de Nemours and Company, Wilmington, USA, ANSYS Advantage, Volume X, Issue 1, 2016

2 fold power increase at equal temperatures (which matched physical measurement)



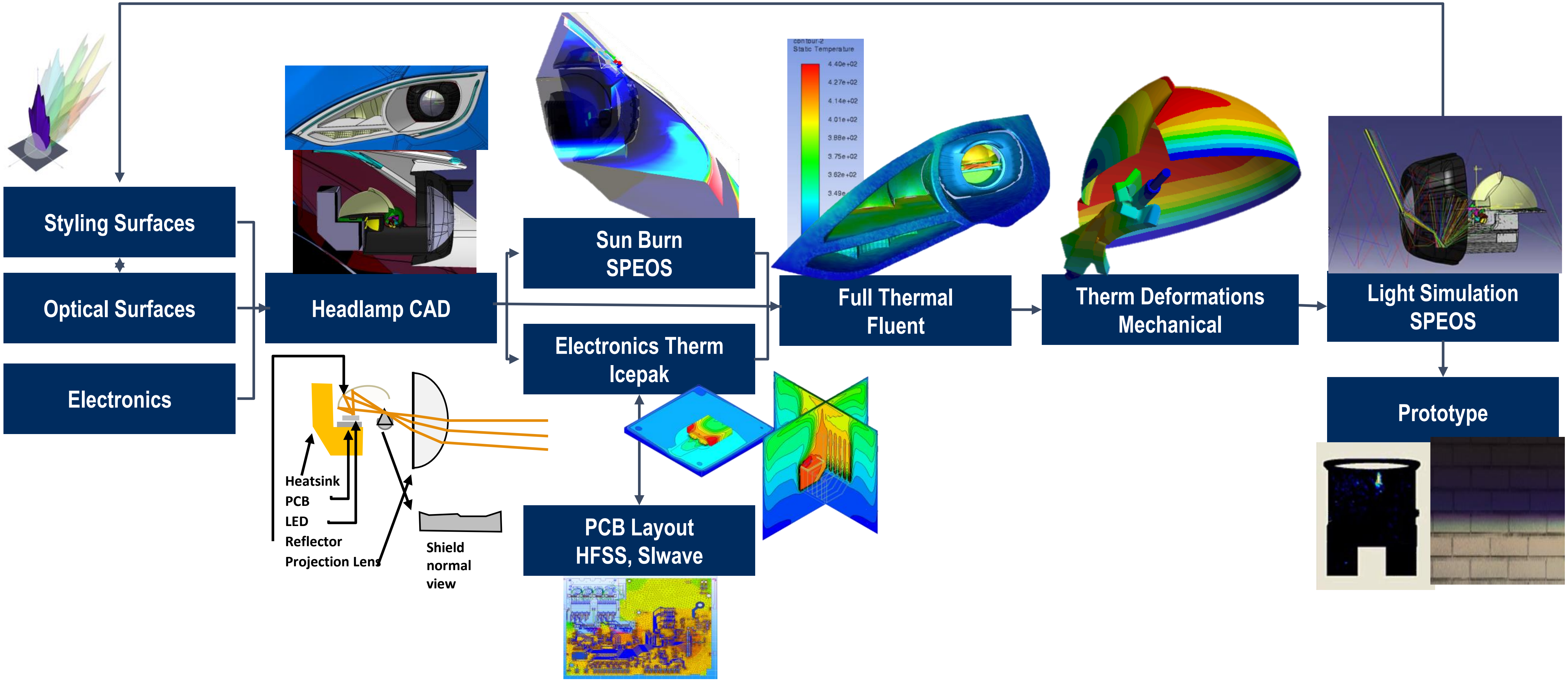






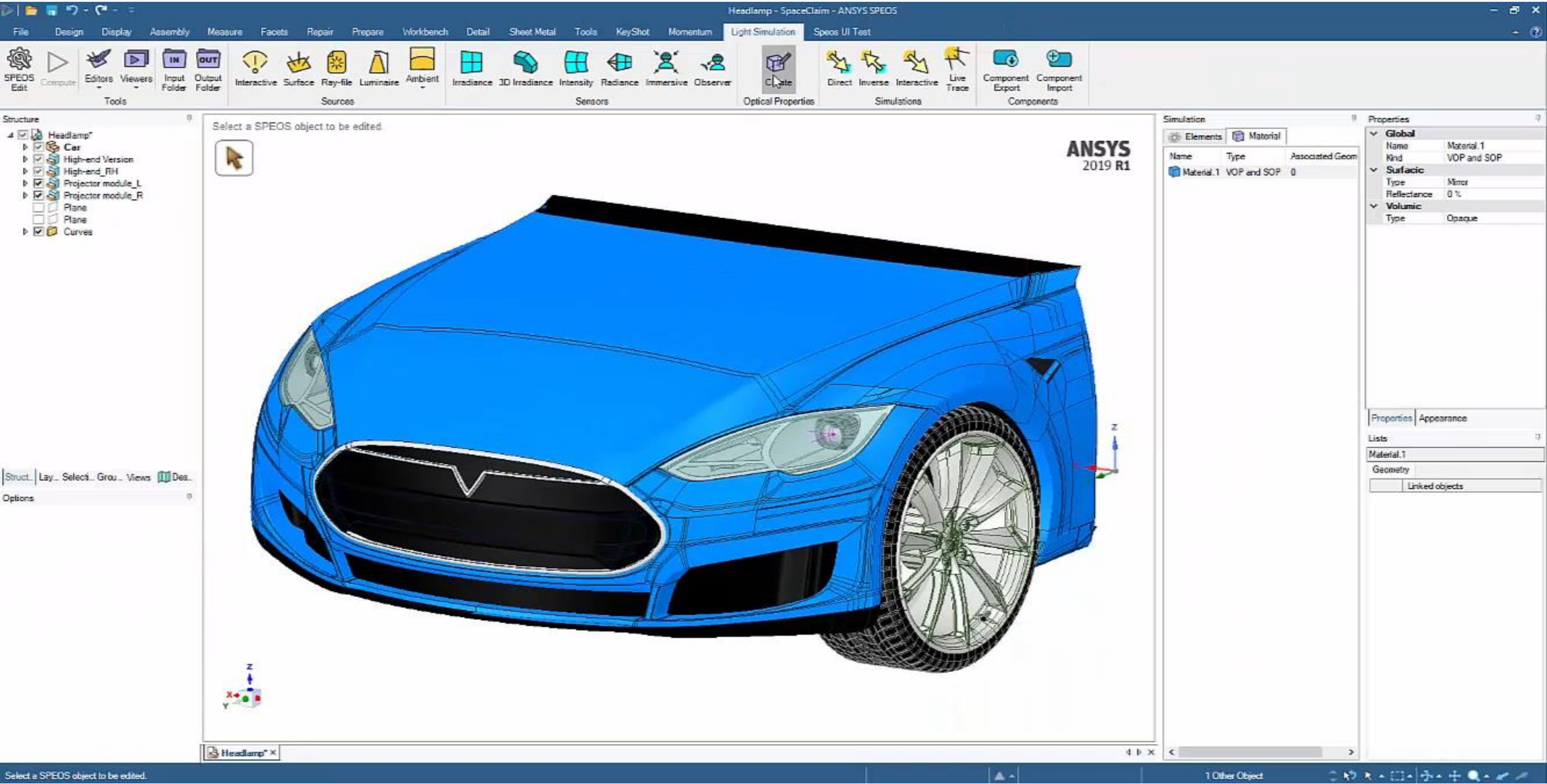
Manjunath Subbanna, **Eelco Galestien**, **Creighton Tomek**, **Wei Fan**,
Momentive Performance Materials,
Strongsville, USA, **ANSYS Advantage, Issue 2 2017**

Effects of Thermal Deformation of Car Headlamp Parts on Lighting Performance



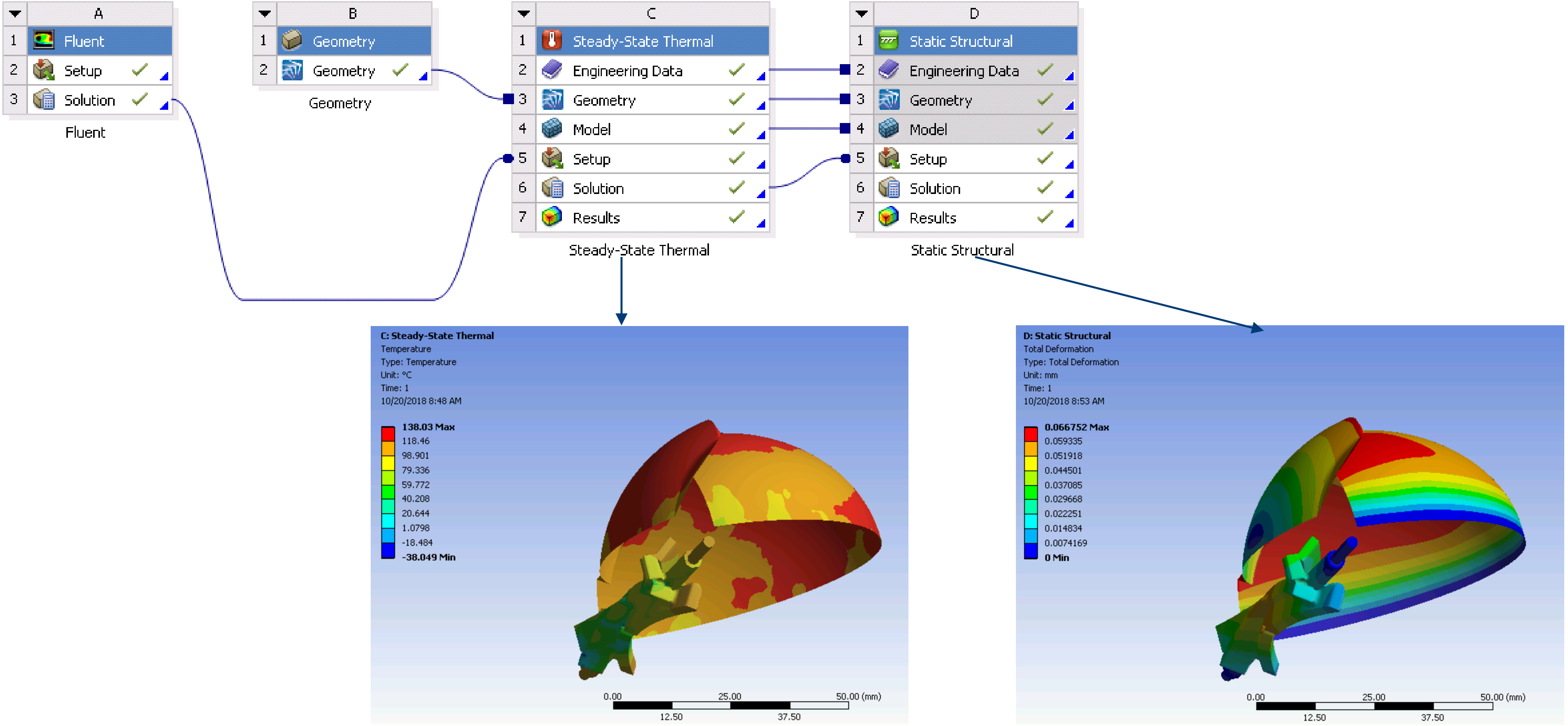
CADFEM

ANSYS



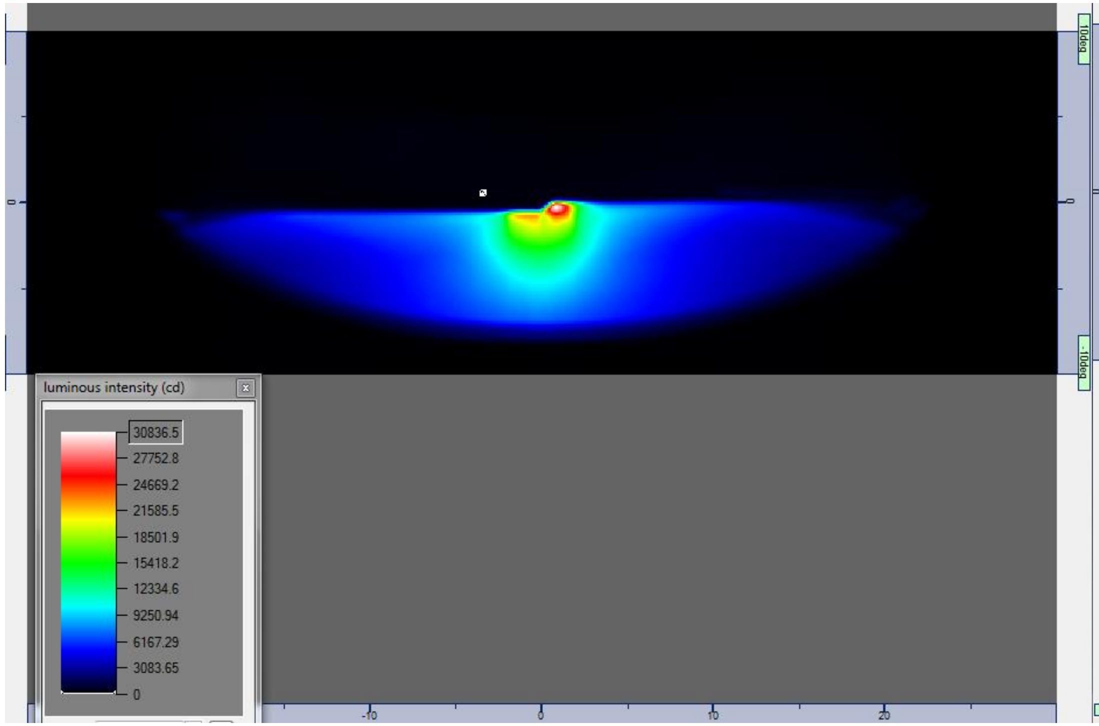
Effects of Thermal Deformation of Car Headlamp Parts on Lighting Performance

Drag & Drop Multiphysics :

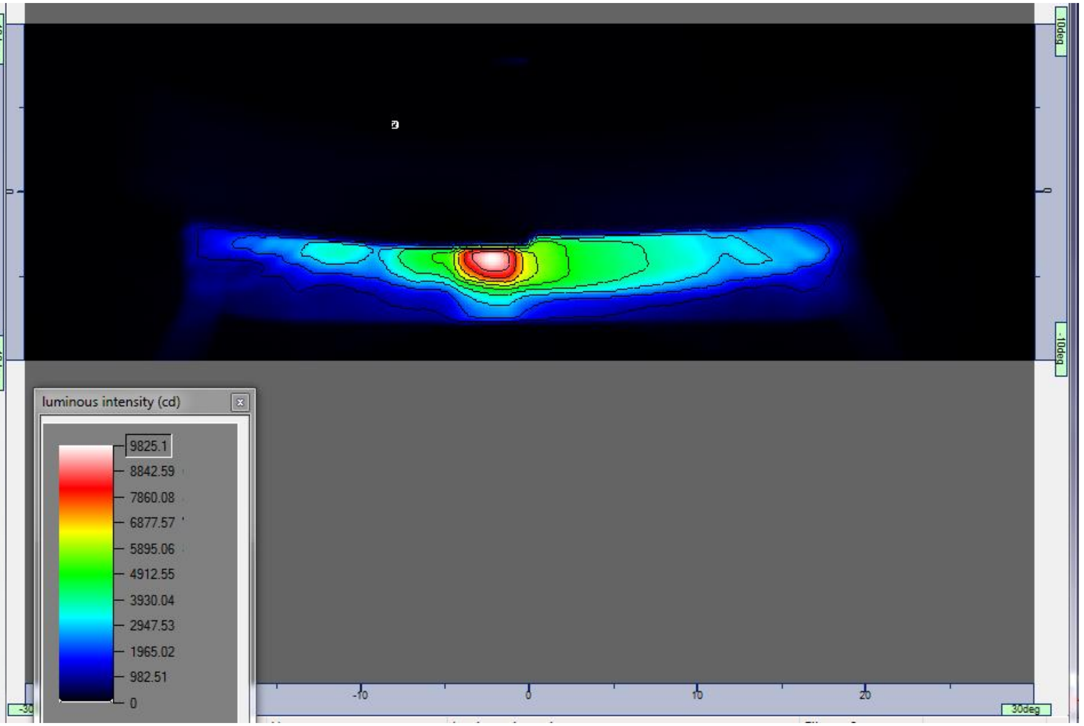


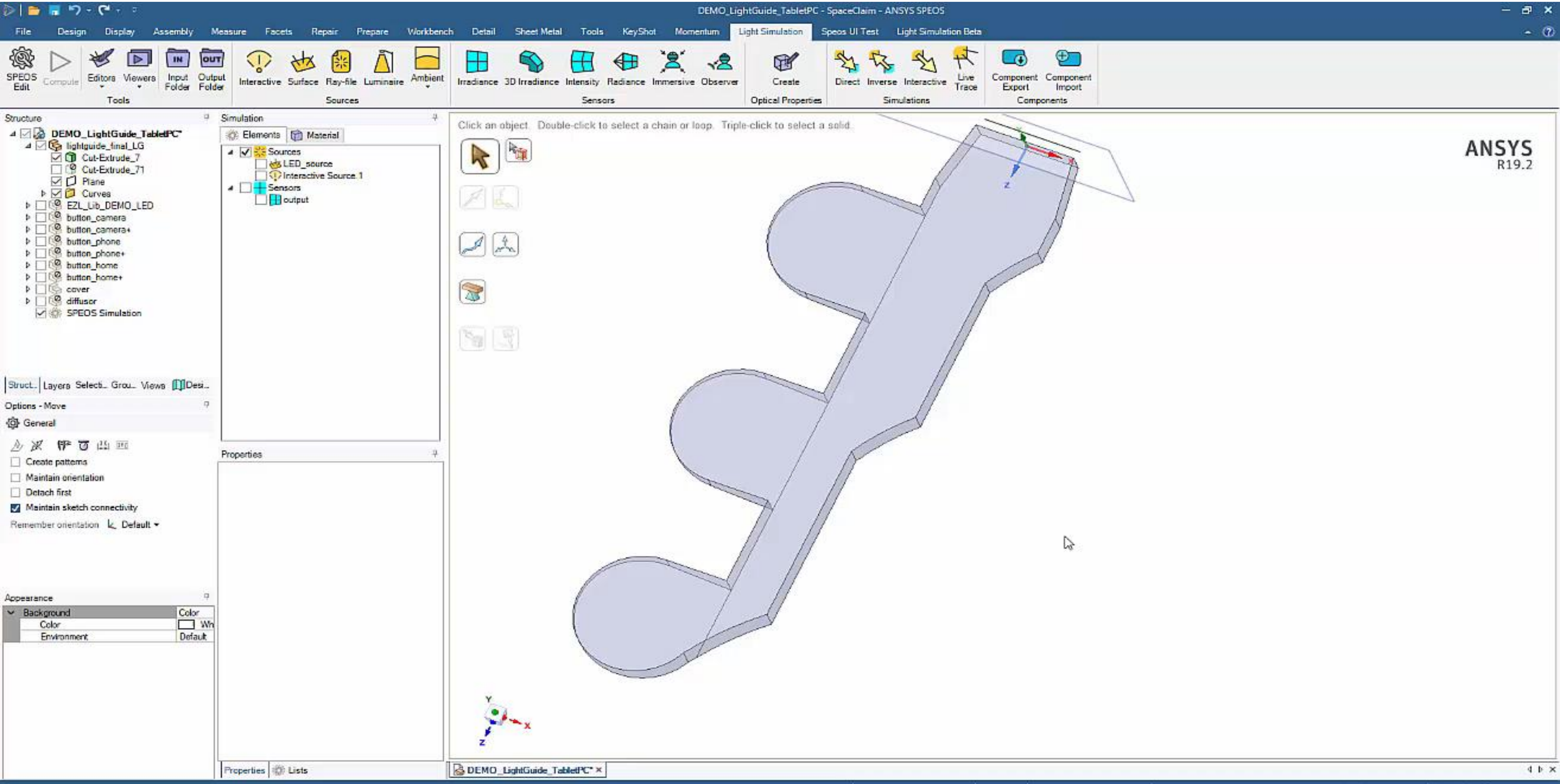
Effects of Thermal Deformation of Car Headlamp Parts on Lighting Performance

Original

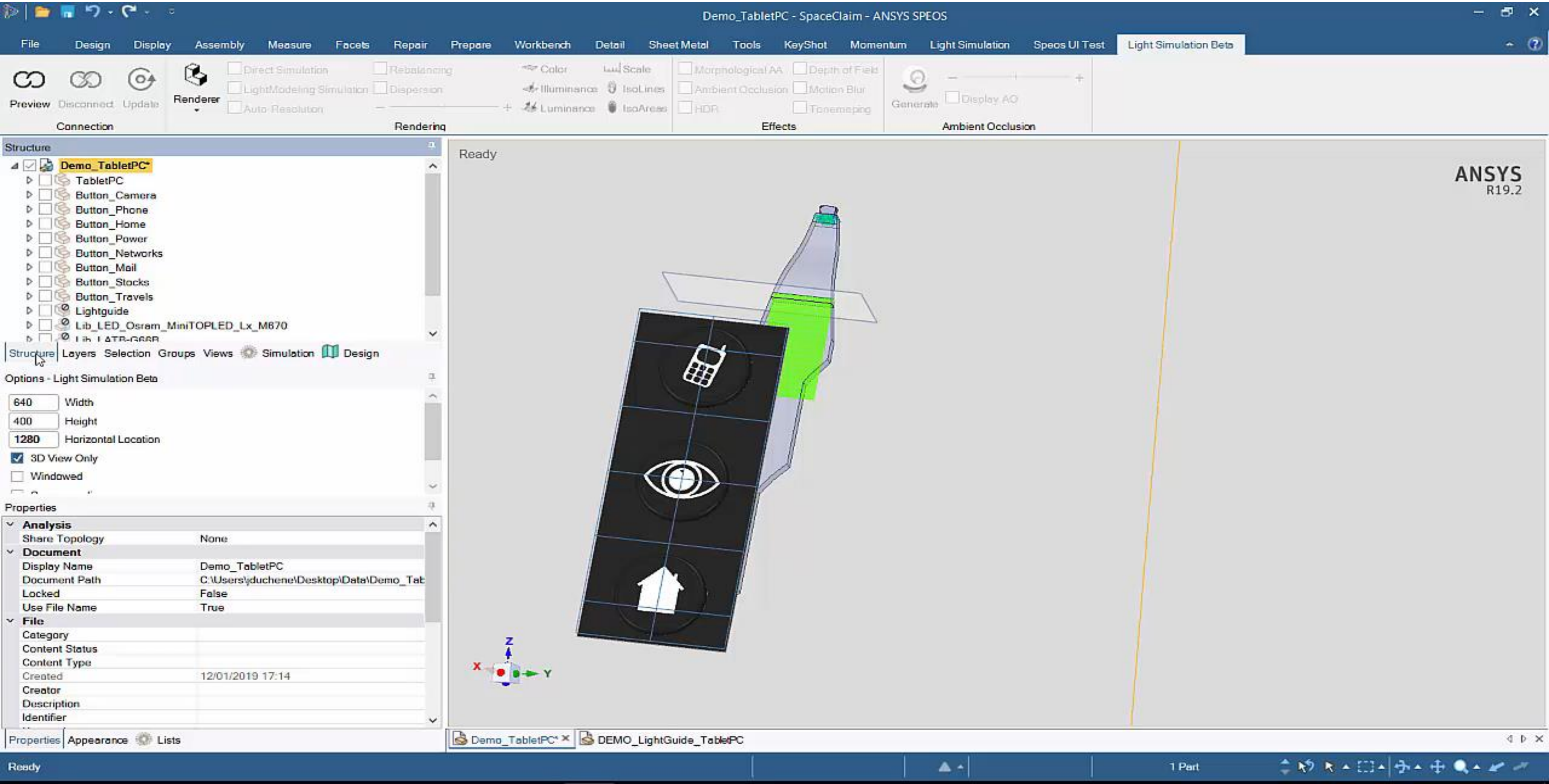


Deformed




DEMO_LightGuide_TabletPC - SpaceClaim - ANSYS SPEOS
File
Design
Display
Assembly
Measure
Facets
Repair
Prepare
Workbench
Detail
Sheet Metal
Tools
KeyShot
Momentum
Light Simulation
Speos UI Test
Light Simulation Beta
SPEOS Edit
Compute
Editors
Viewers
Input Folder
Output Folder
Tools
Interactive
Surface
Ray-file
Luminaire
Ambient
Sources
Irradiance
3D Irradiance
Intensity
Radiance
Immersive
Observer
Sensors
Create
Optical Properties
Direct
Inverse
Interactive
Live Trace
Simulations
Component Export
Component Import
Components
Structure
DEMO_LightGuide_TabletPC*
lightguide_final_LG
Cut-Extrude_7
Cut-Extrude_71
Plane
Curves
EZL_Lib_DEMO_LED
button_camera
button_camera+
button_phone
button_phone+
button_home
button_home+
cover
diffusor
SPEOS Simulation
Simulation
Elements
Material
Sources
LED_source
Interactive Source.1
Sensors
output
Click an object. Double-click to select a chain or loop. Triple-click to select a solid.
ANSYS
R19.2
Options - Move
General
Create patterns
Maintain orientation
Detach first
Maintain sketch connectivity
Remember orientation
Default
Properties
Appearance
Background
Color
Environment
Default
Lists
DEMO_LightGuide_TabletPC*

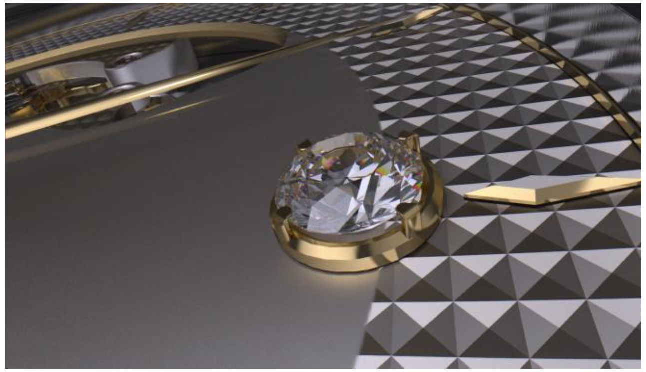
CADFEM ANSYS



Physically Accurate Light Simulation

Real

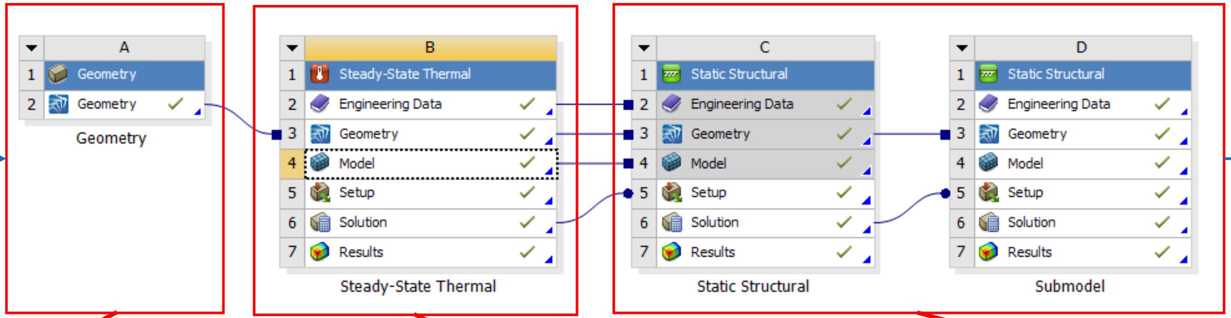
Virtual



Flash Lidar: Multiphysics coupling

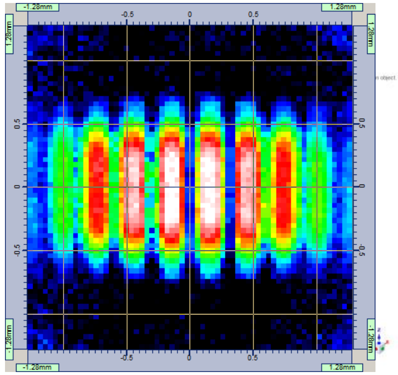
SPEOS Simulation

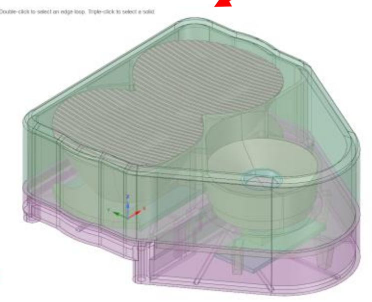
Nominal Design

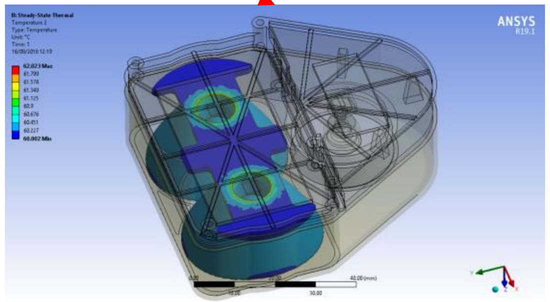


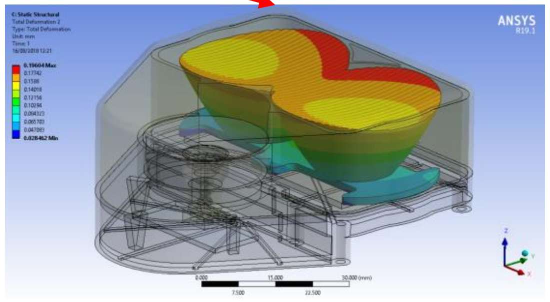
SPEOS Simulation

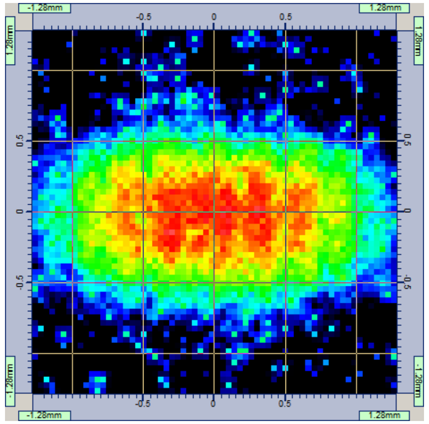
Deformed Design

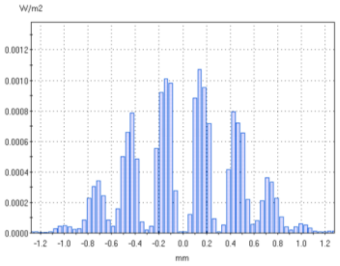


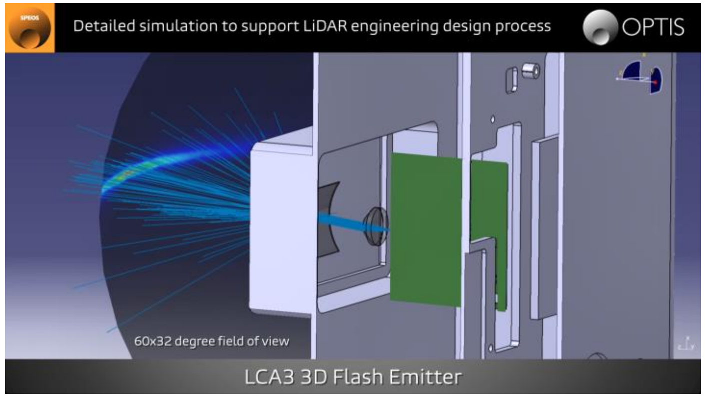


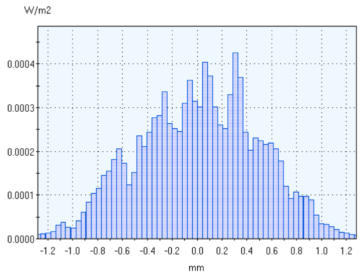






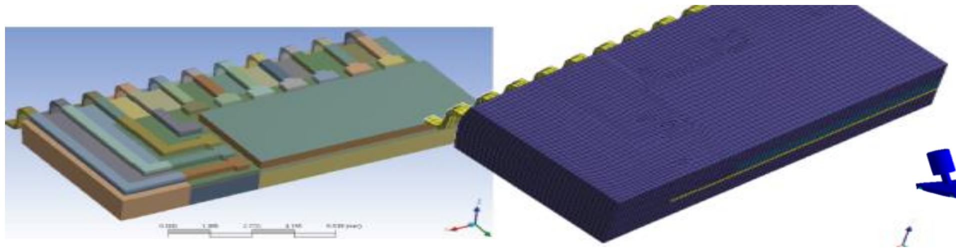


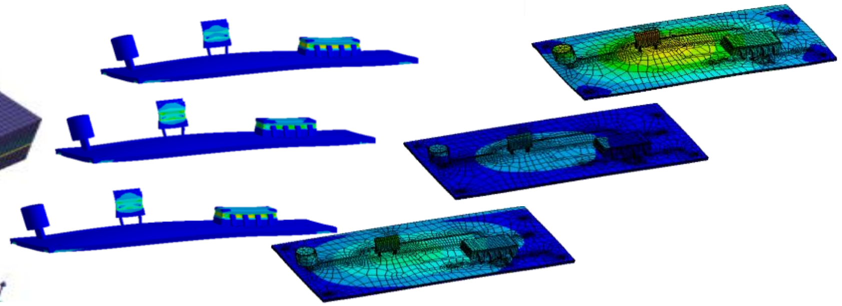




CADFEM

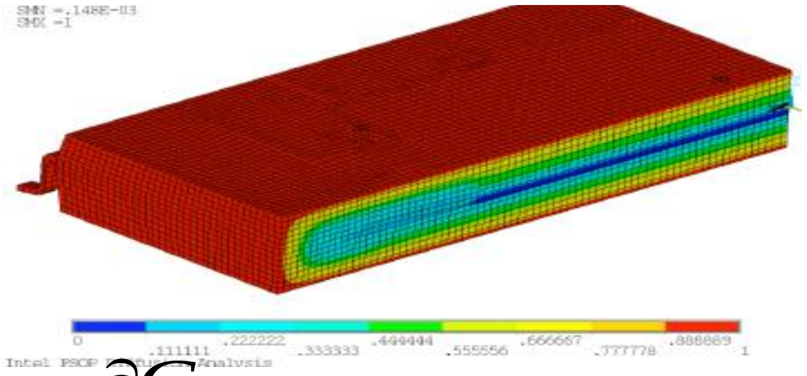
Temperature-dependent moisture migration and hygrothermal strains in electronic packages

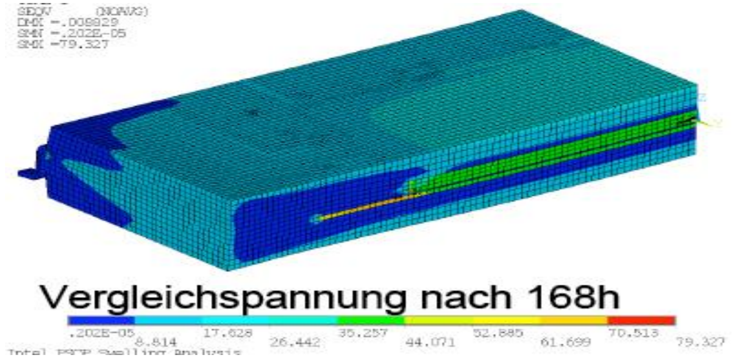




Humidity after 168h

Stress after 168h





$$\frac{\partial C}{\partial t} = D\cdot\nabla^2 C$$

$$\varepsilon = \varepsilon_{el} + \varepsilon_{di} = \varepsilon_{el} + C_{sat}\bullet\beta\bullet(\bar{C}-\bar{C}_{ref})$$

Diffusion Constant [m^2/s]

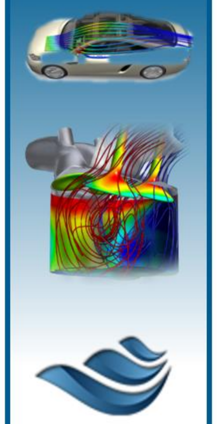
Diffusion expansion ([m^3/kg])

Cyber Physical System Portfolio

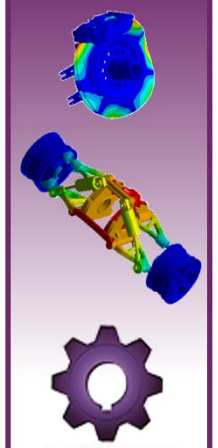
Model Based Engineering

Systems ⇔ Robust Design Optimization RDO

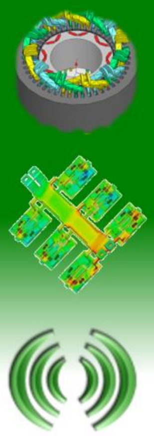
Metamodels, MOR, Co-simulation, Strong Matrix coupling, Parameters



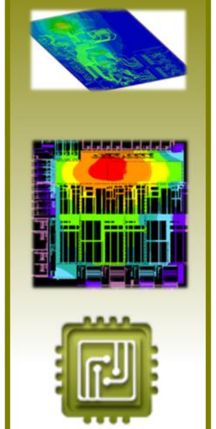
FLUIDS



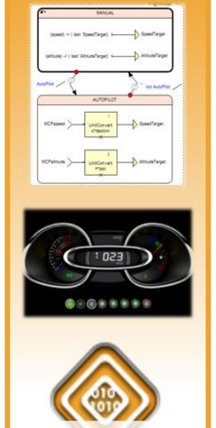
STRUCTURES



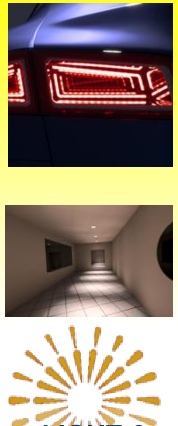
ELECTRONICS



SEMICONDUCTOR



EMBEDDED SOFTWARE



LIGHT & Human Vision

Integrated (I)IoT Assets

Rendered with ANSYS SPEOS