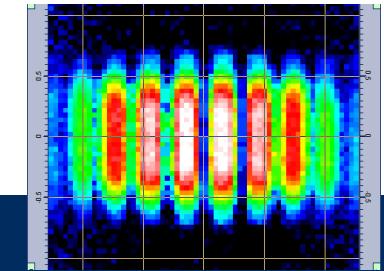
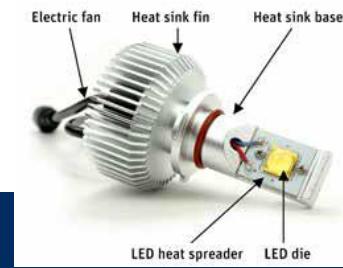
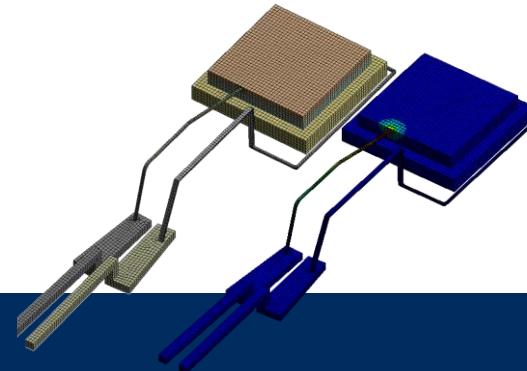




Simulation is more than Software®



Multiphysics numerical simulation for photonics packaging

Joël Grognuz



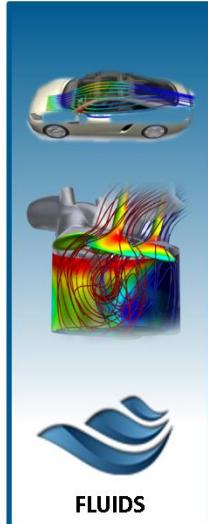
Cyber Physical System Portfolio

Model Based Engineering

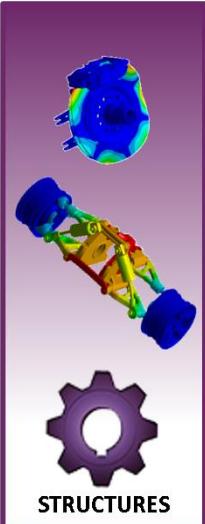


Robust Design
Optimization

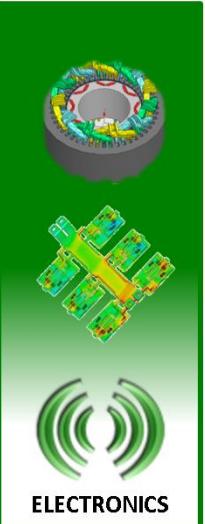
Metamodels, MOR, Co-simulation, Strong Matrix coupling, Parameters



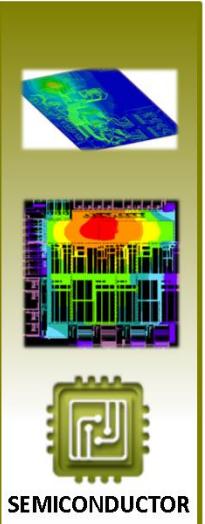
FLUIDS



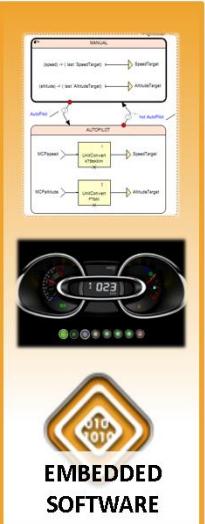
STRUCTURES



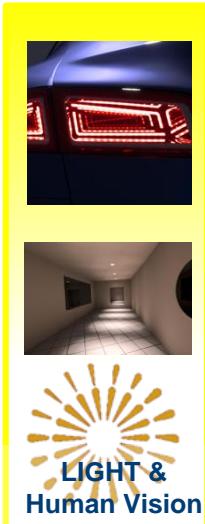
ELECTRONICS



SEMICONDUCTOR



EMBEDDED
SOFTWARE



LIGHT &
Human Vision

Integrated (I)IoT Assets

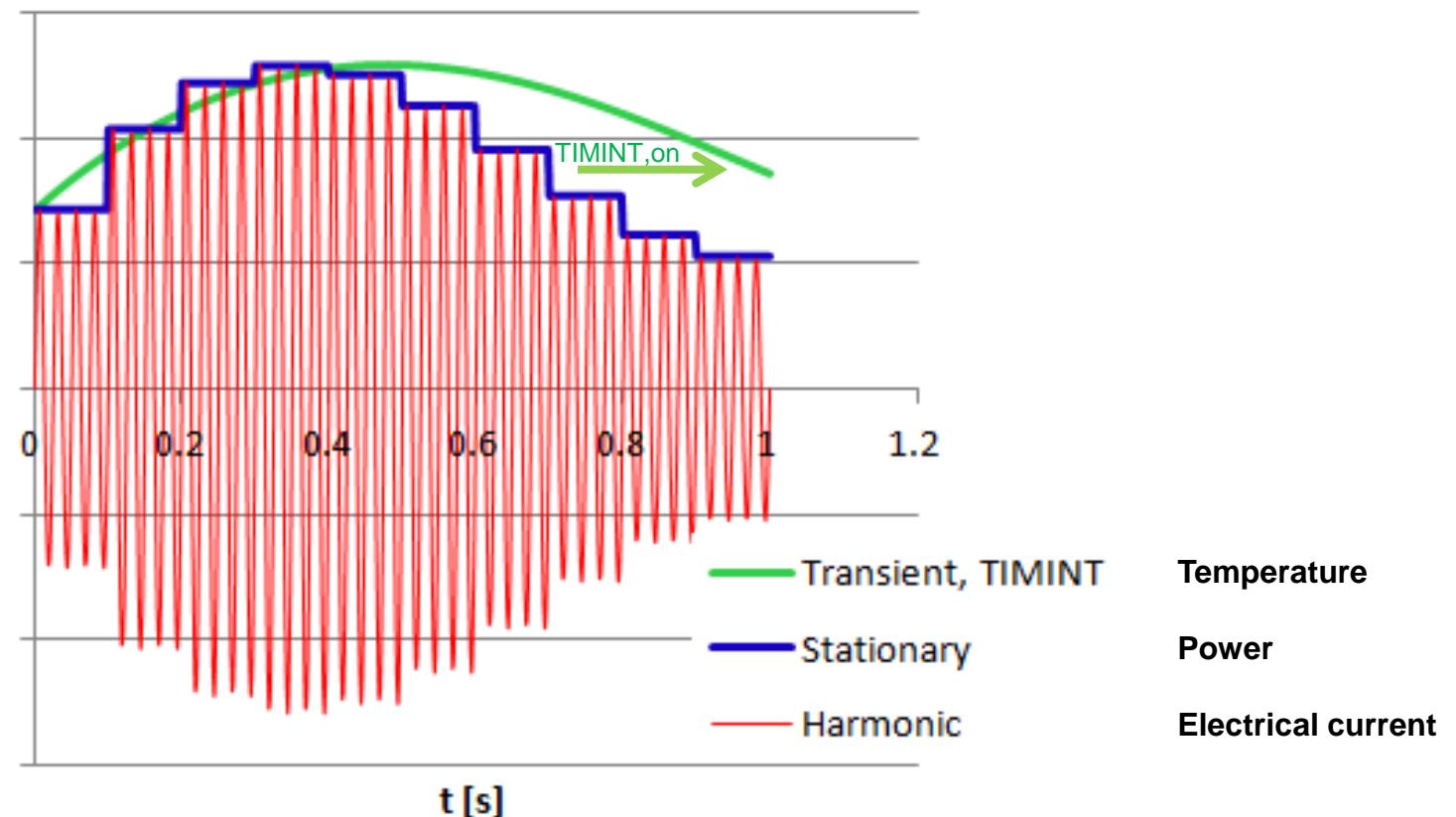


Rendered with ANSYS SPEOS

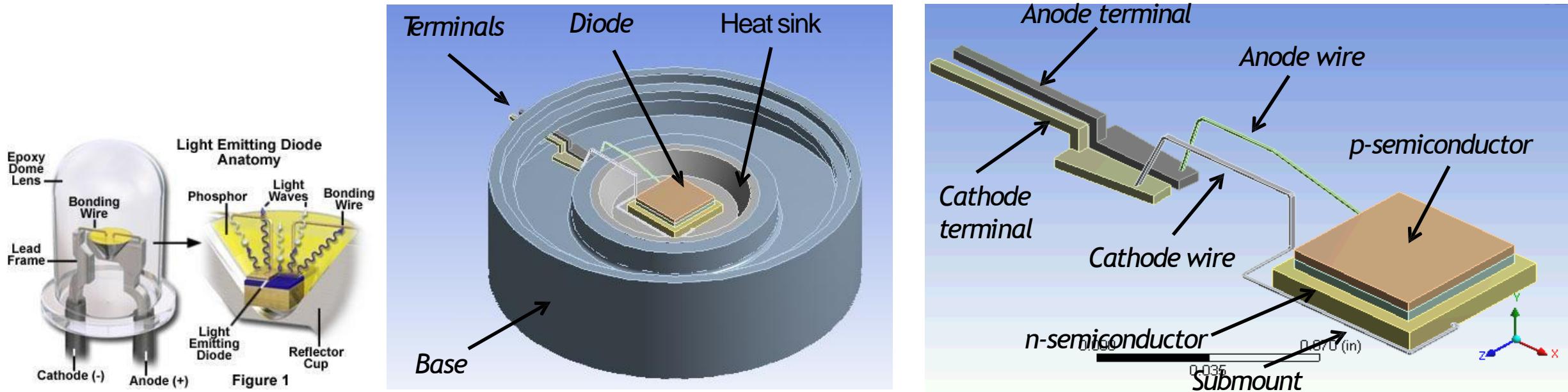
Multi-timescale

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

- For instance:
 $t_1 \ll t_2 \ll t_3$



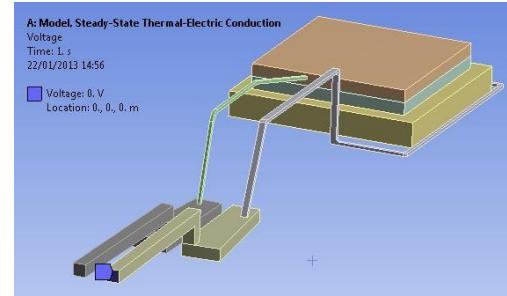
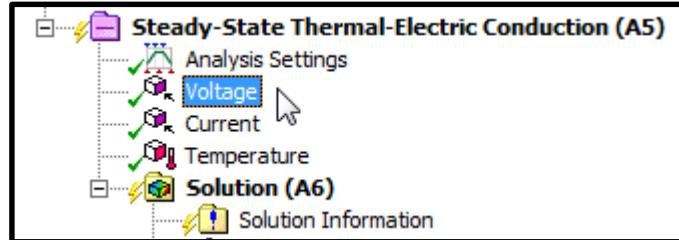
Thermal-Electric analysis of a LED (Strong Coupling)



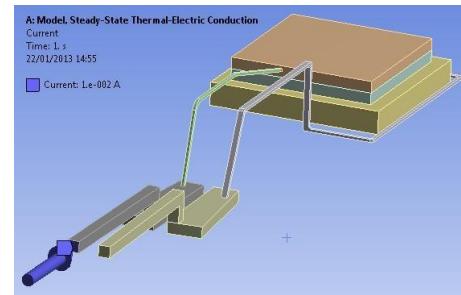
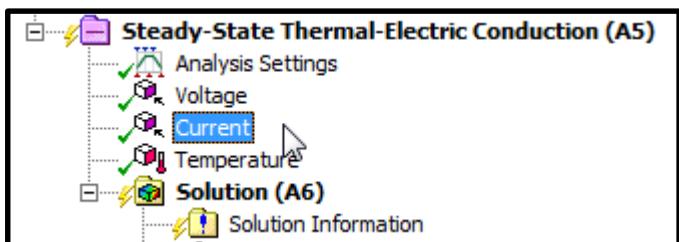
Material	Body	Thermal Conductivity λ (W.m ⁻¹ .K ⁻¹)	Resistivity ρ (Ω.m ⁻¹)
Gold	Anode terminal / Cathode terminal / Anode wire / Cathode wire	301	2.2e-8
Silicon	Submount	124	0.0001
Gallium Nitride	n-semiconductor	125	0.118
Gallium Arsenide	p-semiconductor	46	0.079
Copper Alloy	Heat sink	401	1.724e-8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

Thermal-Electric analysis of a LED : Setting boundary conditions

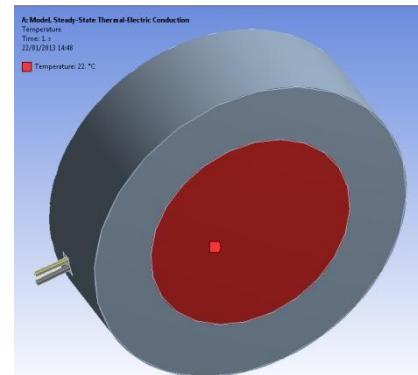
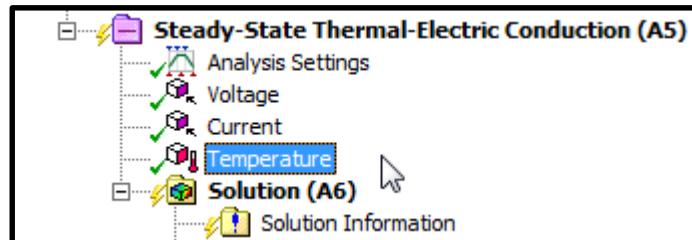
Apply 0 V to the end of Anodeterminal:



Apply 10mA to the end of Cathode terminal:

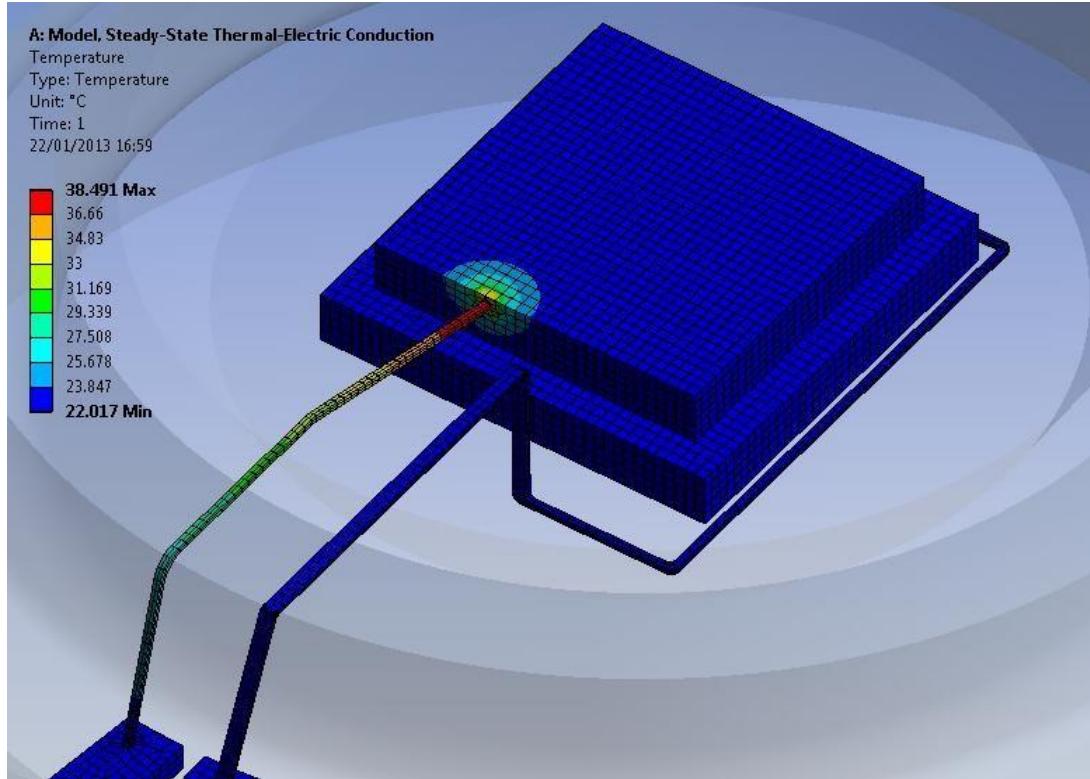


Apply 22°C to the bottom of the Heat sink:

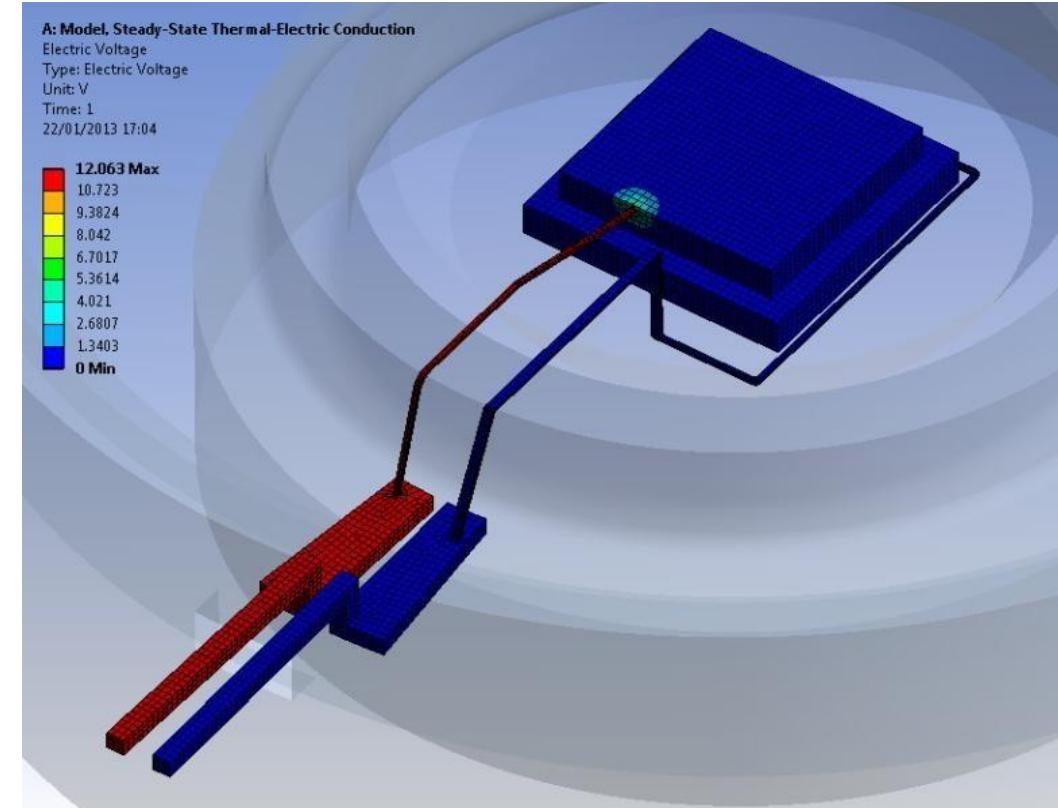


Thermal-Electric analysis of a LED : Results

- Temperature

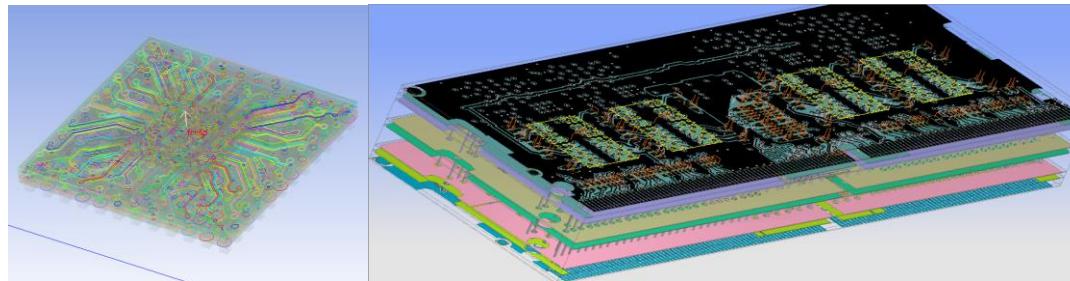


- Voltage

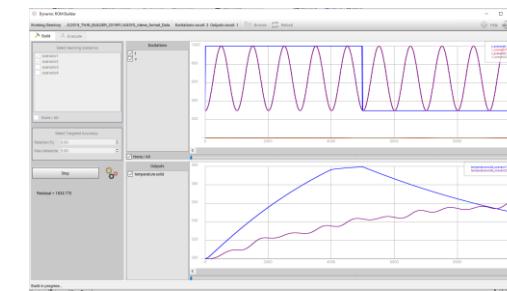


ECAD & Equivalent Circuit extraction

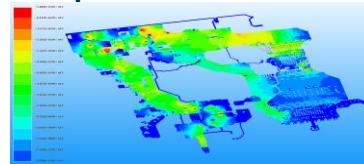
- ECAD import:



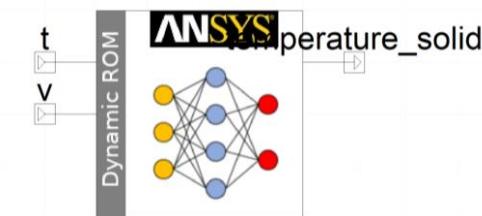
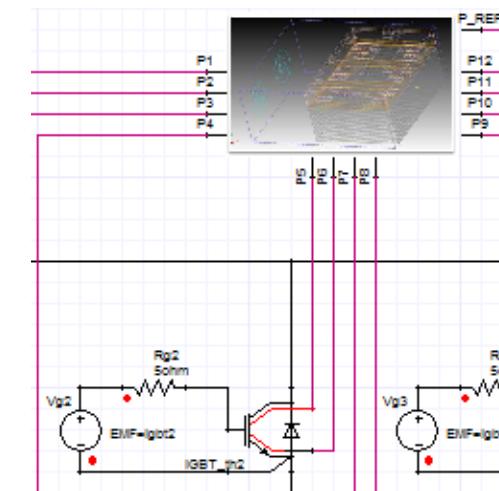
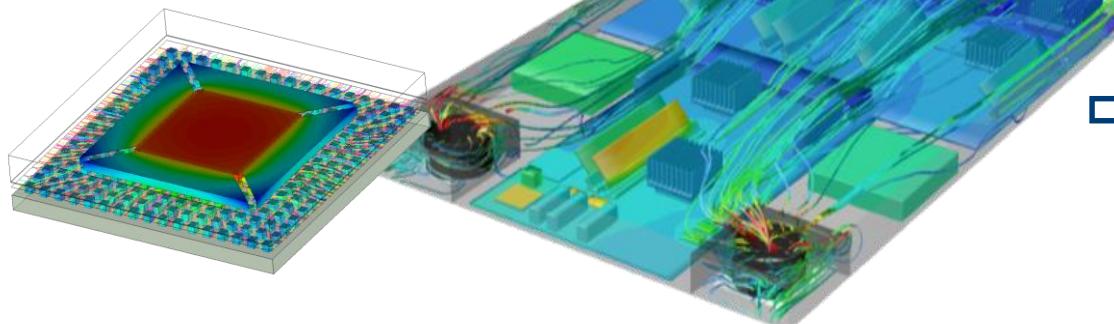
- 0D Circuit extraction



- 2.5D loss computation

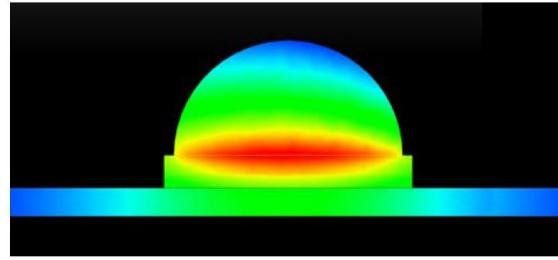
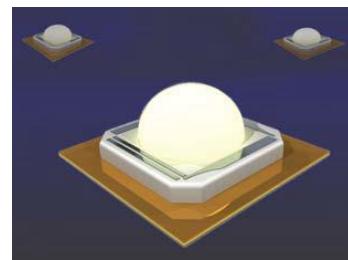


- 3D cooling

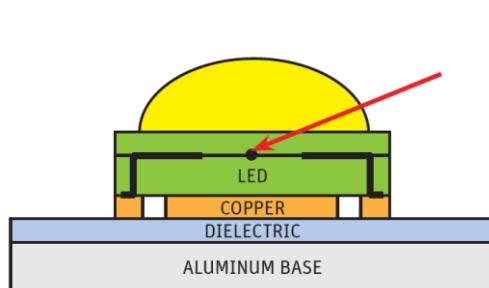


DuPont : CooLam Substrate

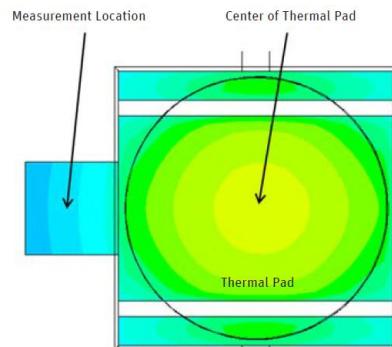
“...supply lighting manufacturers with thermal substrates that ensure high LED performance, reduced power consumption and long life.”



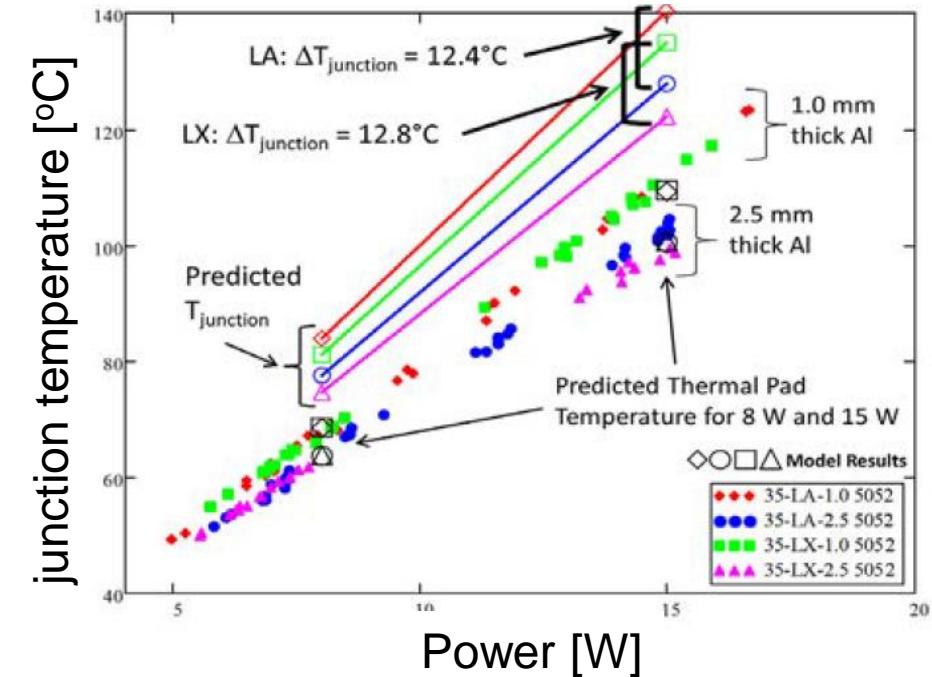
▲ Simulation results show temperature plotted on LED, thermal substrate and board.



▲ CoolLam® 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.

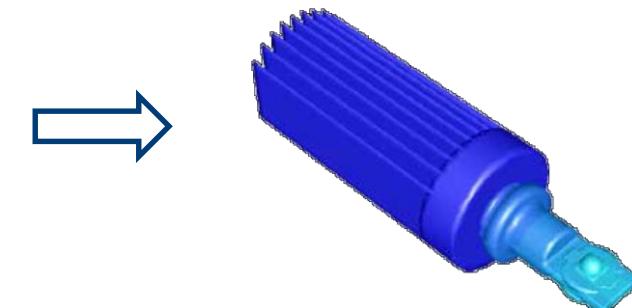
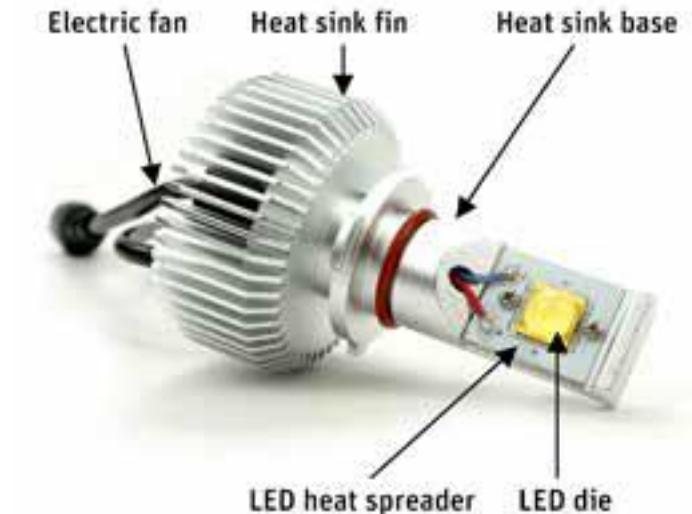
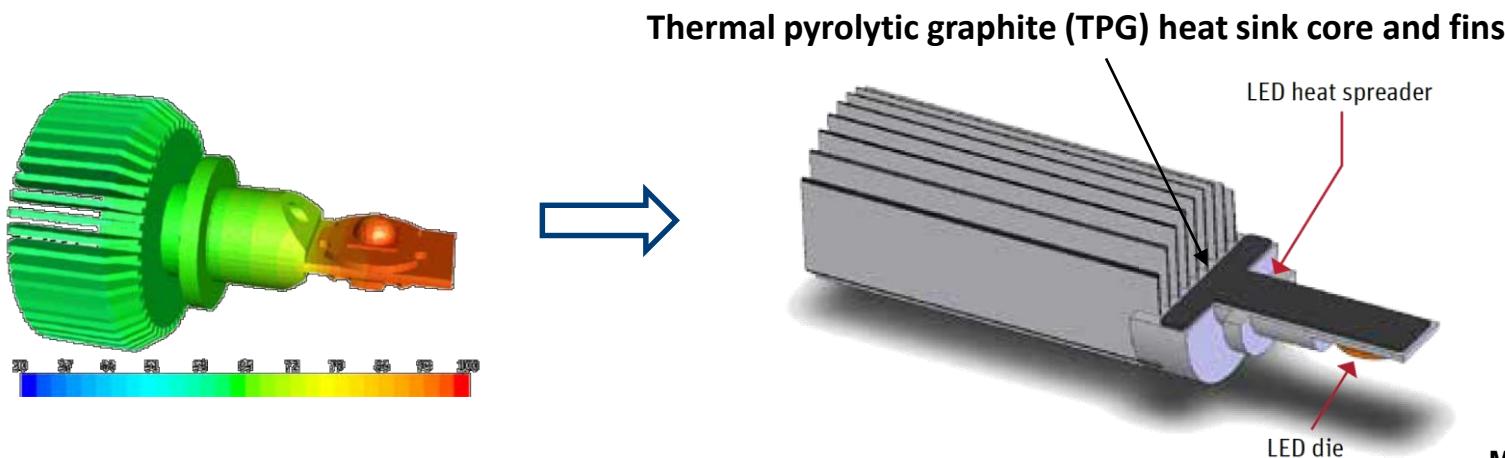


▲ Effect of aluminum thickness on junction temperature for two power levels and two types of dielectric material (LA and LX)

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

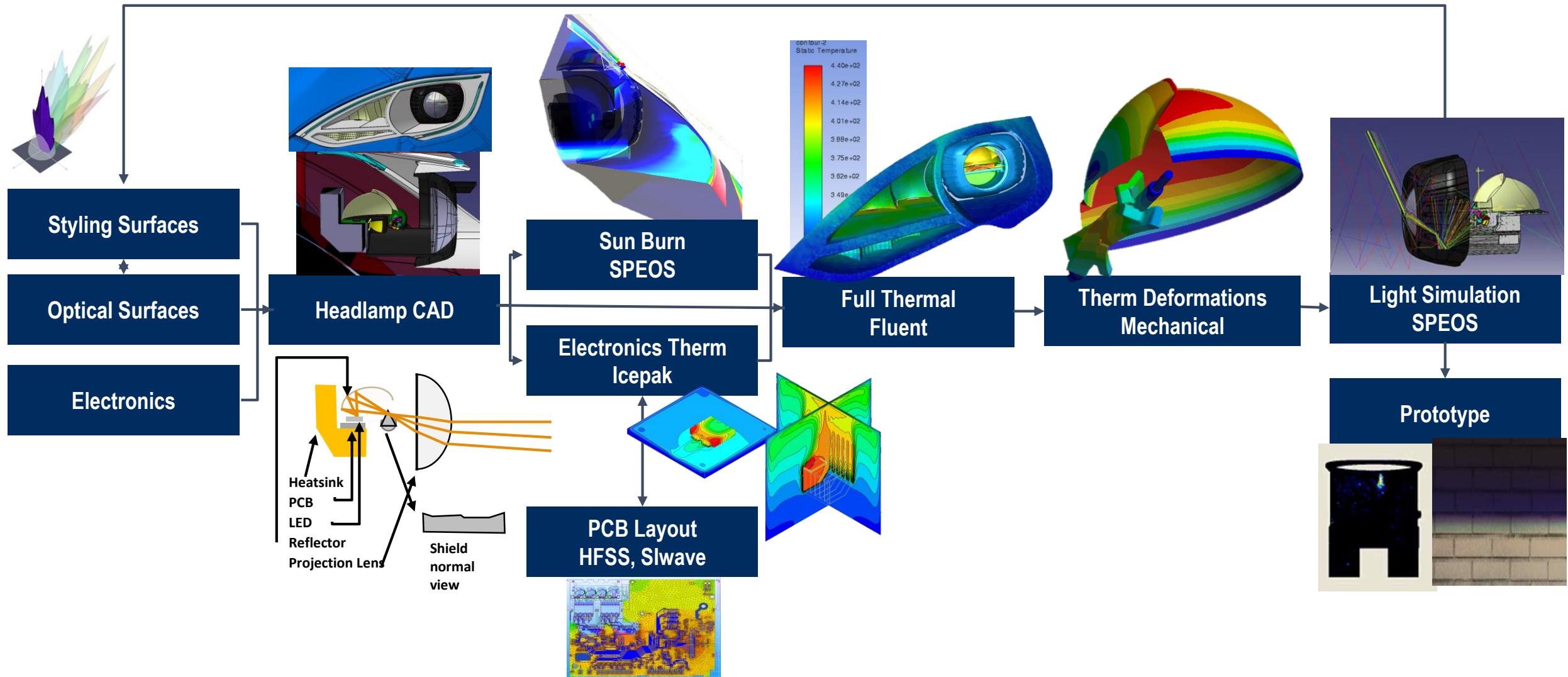
Momentive Performance Materials : Automotive Headlight LED

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



File Design Display Assembly Measure Facets Repair Prepare Workbench Detail Sheet Metal Tools KeyShot Momentum Light Simulation Speos UI Test

SPEOS Edit Compute Editors Viewers Input Folder Output Folder Sources Irradiance 3D Irradiance Intensity Radiance Immersive Observer Optical Properties Create Direct Inverse Interactive Live Trace Component Export Component Import Components

Structure

- Headlamp*
- Car
- High-end Version
- High-end_RH
- Projector module_L
- Projector module_R
- Plane
- Plane
- Curves

Select a SPEOS object to be edited.

ANSYS 2019 R1

Properties

Name	Type	Associated Geom
Material.1	VOP and SOP	0

Elements Material

Properties Appearance

Lists

Material.1

Geometry

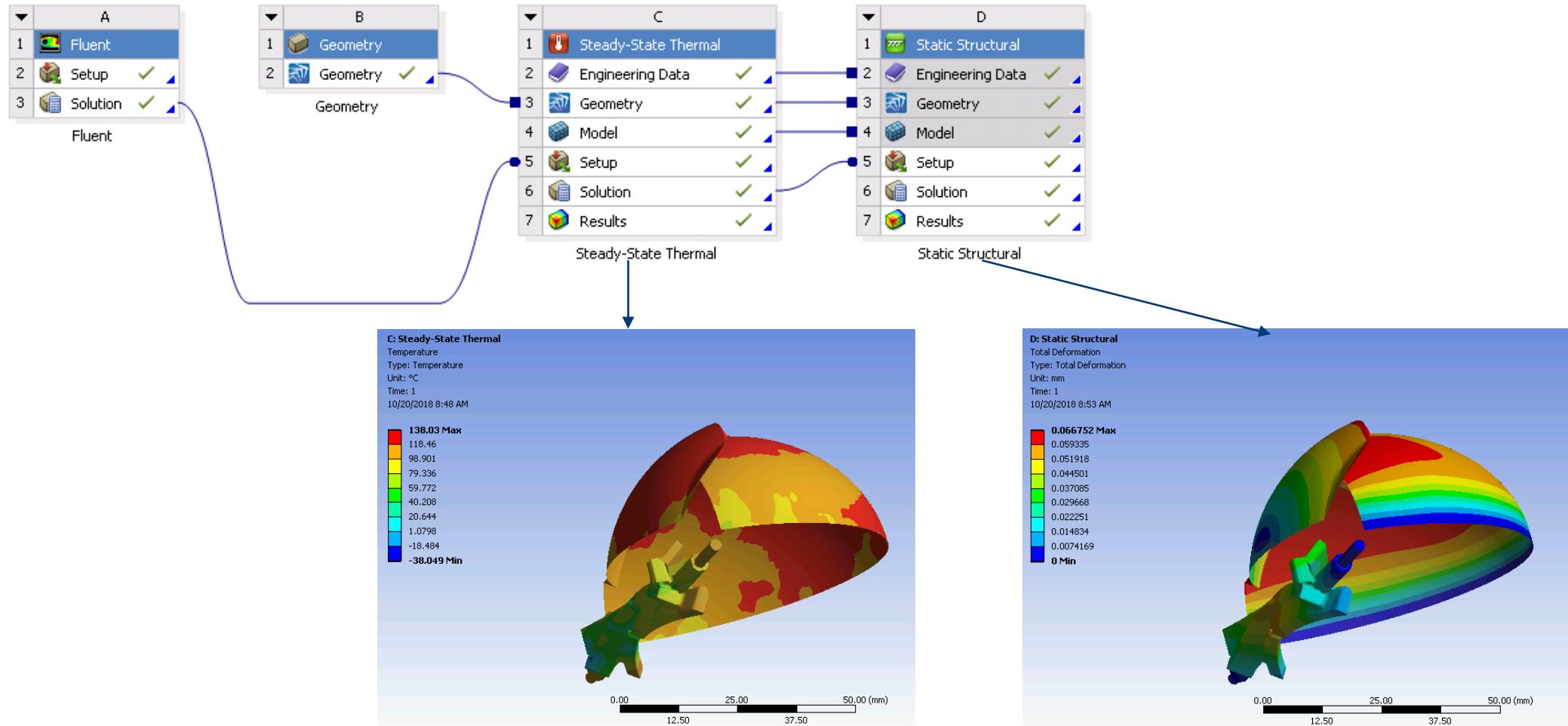
Linked objects

Headlamp*

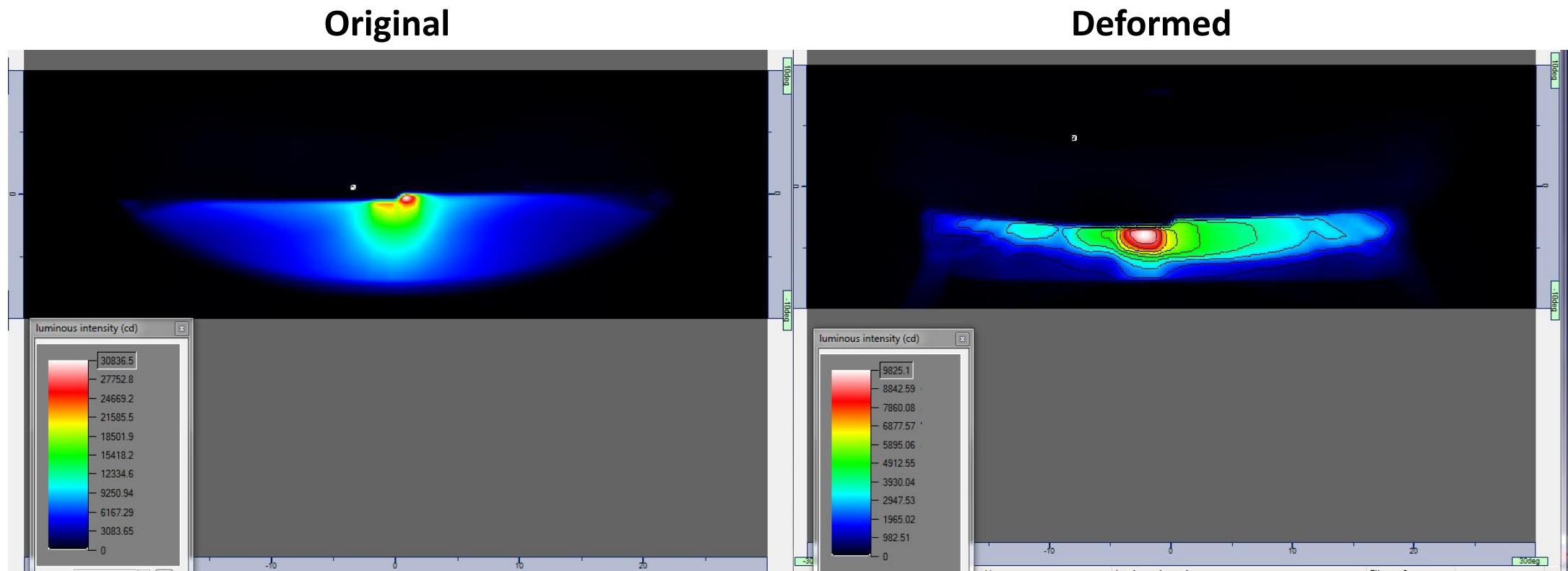
Select a SPEOS object to be edited.

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



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 Interactive Surface Ray-file Luminaire Ambient Sources Sensors Optical Properties Create Direct Inverse Interactive Live Trace Component Export Component Import Components

Structure

DEMOLightGuide_TabletPC

- lightguide_lma_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
- diffuser

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.

Properties

Struct. Layers Select. Group Views Des.

Options - Move

General

Create patterns

Maintain orientation

Detach first

Maintain sketch connectivity

Remember orientation Default

Appearance

Background Color Wh Environment Default

Properties Lists DEMOLightGuide_TabletPC*

ANSYS R19.2

Demo_TabletPC - SpaceClaim - ANSYS SPEOS

File Design Display Assembly Measure Facets Repair Prepare Workbench Detail Sheet Metal Tools KeyShot Momentum Light Simulation Specs UI Test Light Simulation Beta

Preview Disconnected Update Renderer Direct Simulation Rebalancing Color Scale Morphological AA Depth of Field Illuminance IsoLines Ambient Occlusion Motion Blur Auto-Resolution Luminance IsoArea HDR Toning Depth of Field Generate Display AO

Structure Demo_TabletPC+ TabletPC Button_Camera Button_Phone Button_Home Button_Power Button_Networks Button_Mail Button_Stocks Button_Travels Lightguide Lib_LED_Osram_MiniTOPLED_Lx_M670 Lib_ATR-GARR

ANSYS R19.2

Ready

640 Width
400 Height
1280 Horizontal Location
 3D View Only
 Windowed

Properties

Analysis Share Topology None
Document Document Name Demo_TabletPC
Display Name Demo_TabletPC
Document Path C:\Users\duchenel\Desktop\Datas\Demo_TabletPC
Locked False
Use File Name True
File Category
Content Status
Content Type
Created 12/01/2019 17:14
Creator
Description
Identifier

Properties Appearance Lists

Demo_TabletPC DEMO_LightGuide_TabletPC

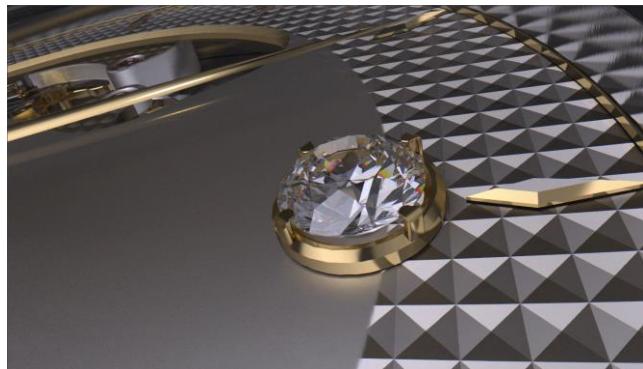
Ready 1 Part

Physically Accurate Light Simulation

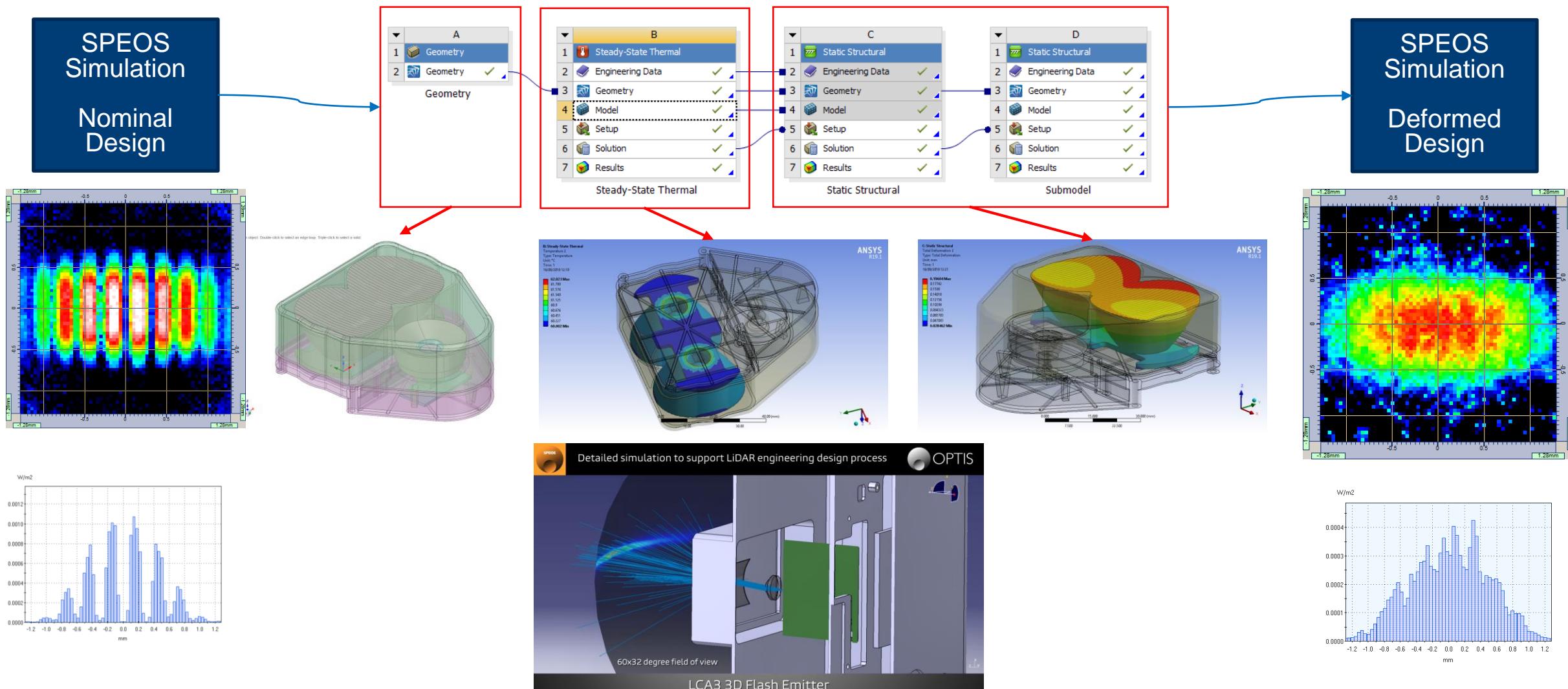


Real

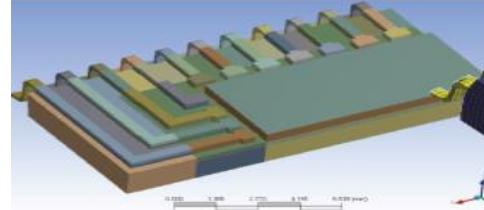
Virtual



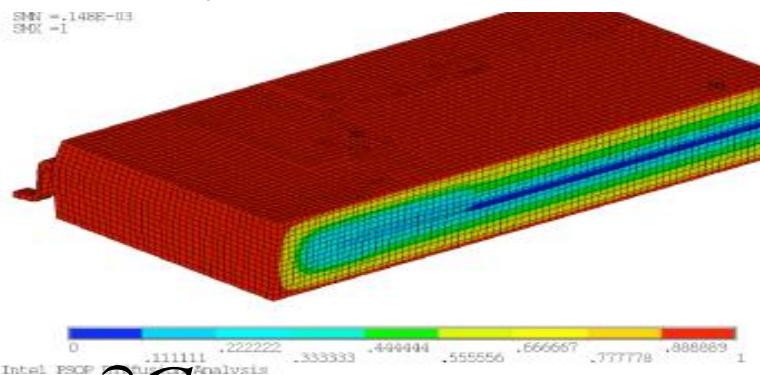
Flash Lidar: Multiphysics coupling



Temperature-dependent moisture migration and hygrothermal strains in electronic packages



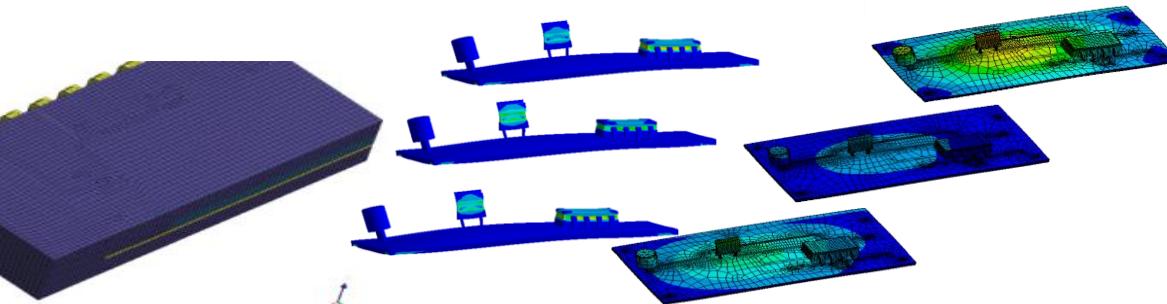
Humidity after 168h



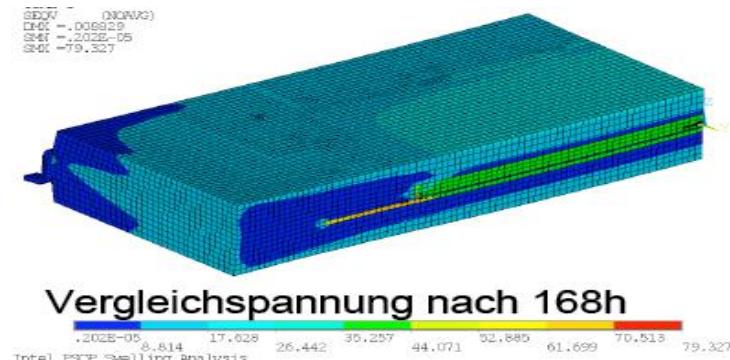
$$\frac{\partial C}{\partial t} = D \cdot \nabla^2 C$$

↑

Diffusion Constant [m²/s]



Stress after 168h



Vergleichsspannung nach 168h

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

↑

Diffusion expansion ([m³/kg])

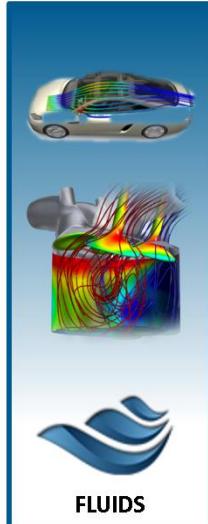
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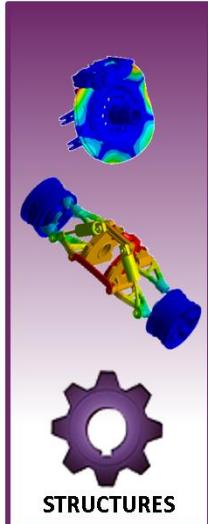


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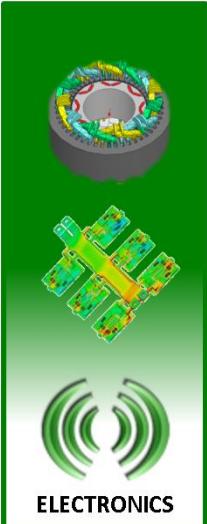
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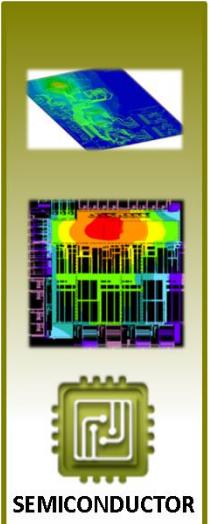
FLUIDS



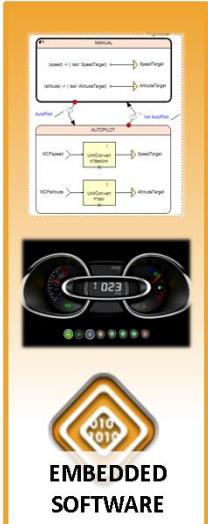
STRUCTURES



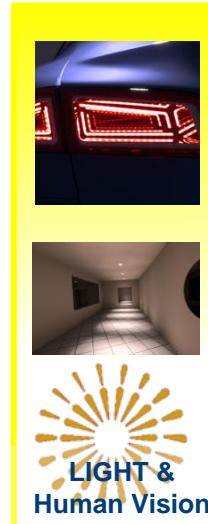
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