

# Coupled Thermal-Electrical Transient Analysis of 3D Fuses and Interconnects



**VICTORY Device**

**3D Device Simulator**

Self Heating Effects of Resistive Metals



**SILVACO**

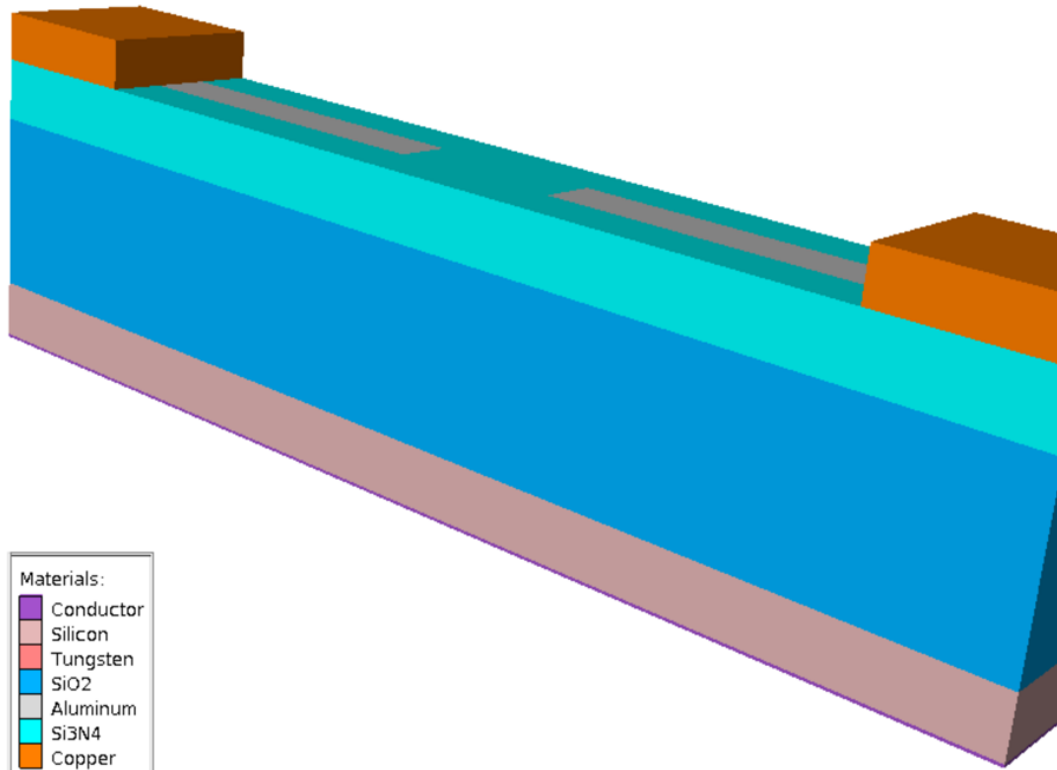


# Coupled Thermal-Electrical Transient Analysis of 3D Fuses and Interconnects

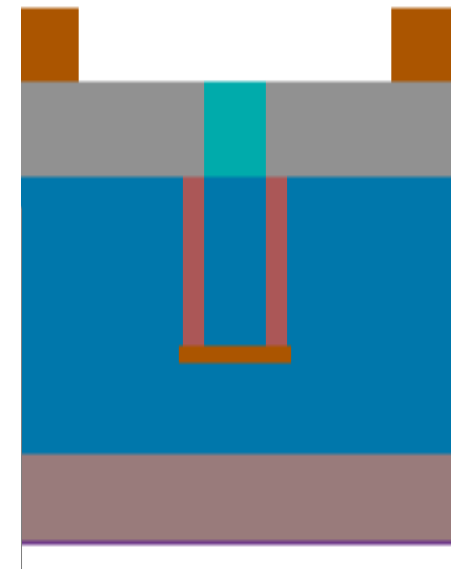
- This presentation covers:
  - Transient 3D thermal-electrical analysis in fuses and metal structures
  - Benefits are understanding heat generation inside metal structures and heat conduction flow



# Generation of a 3D Metal Structure for Thermal-Electrical Analysis



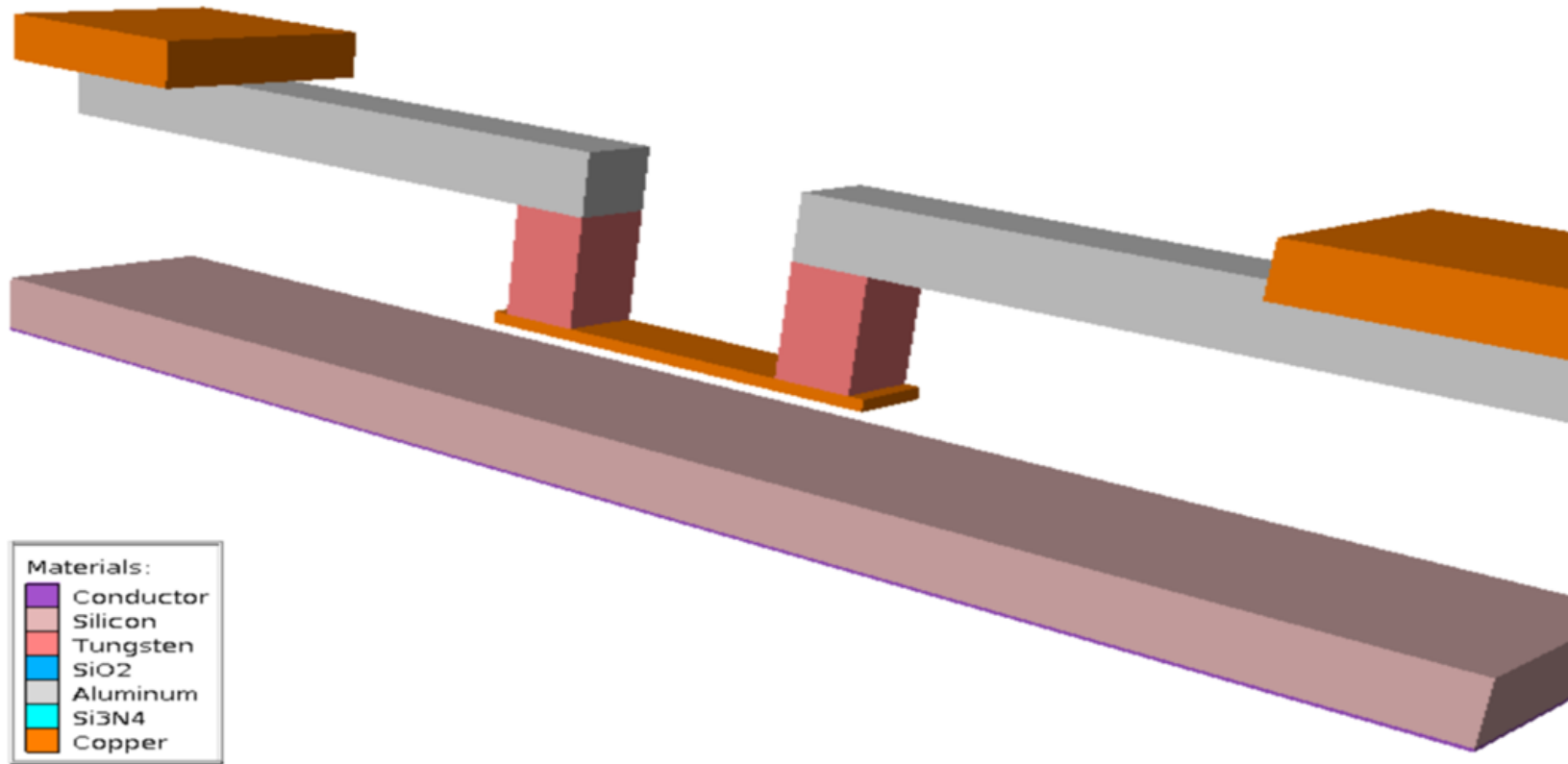
Wiring Structure



2-D cross sectional view



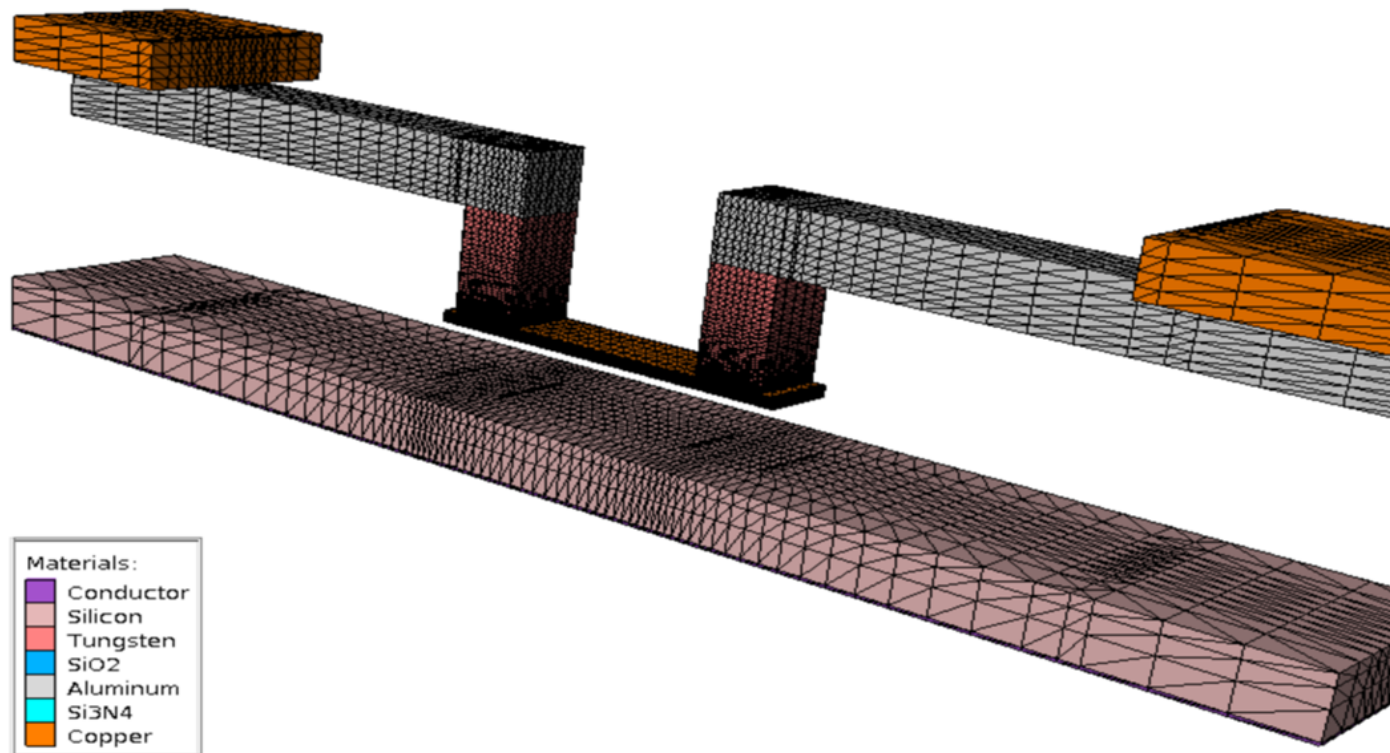
## Generation of a 3D Metal Structure for Thermal-Electrical Analysis



VICTORY Cell is used to create the 3D structure.



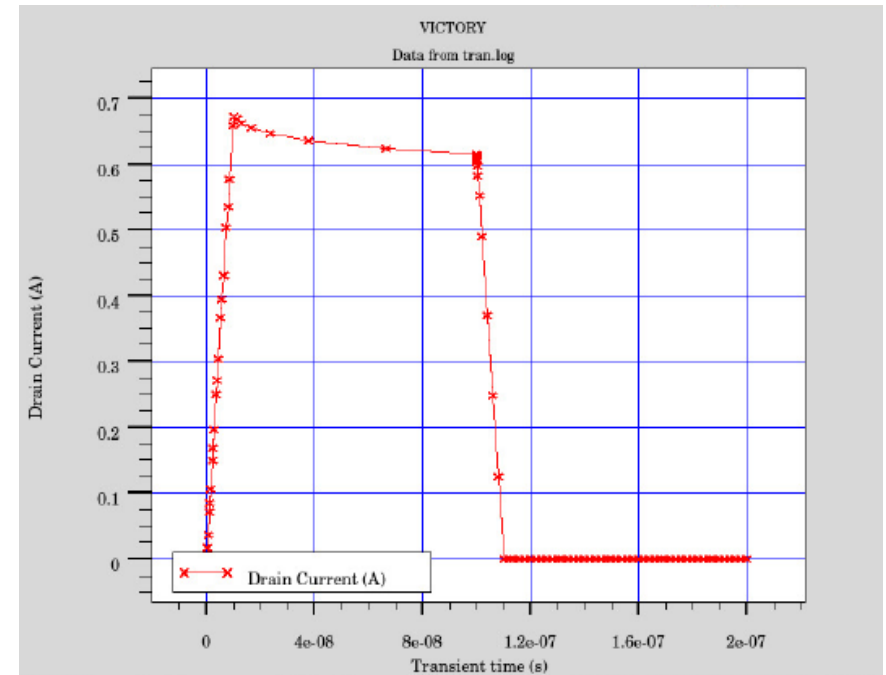
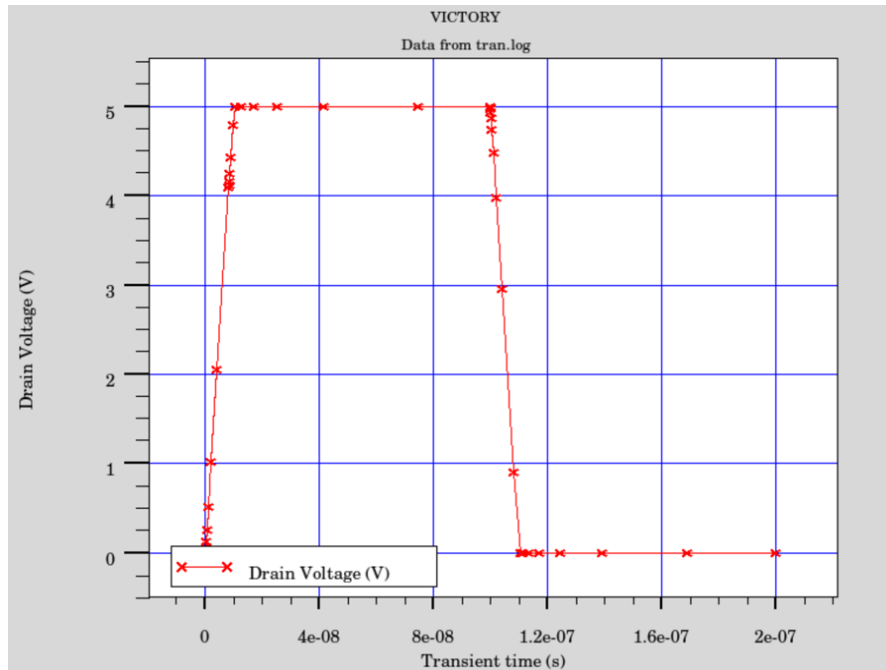
## Generation of a 3D Metal Structure for Thermal-Electrical Analysis



VICTORY Cell is used to generate the 3D tetrahedral mesh generation.



# Transient Analysis of Metal Self Heating



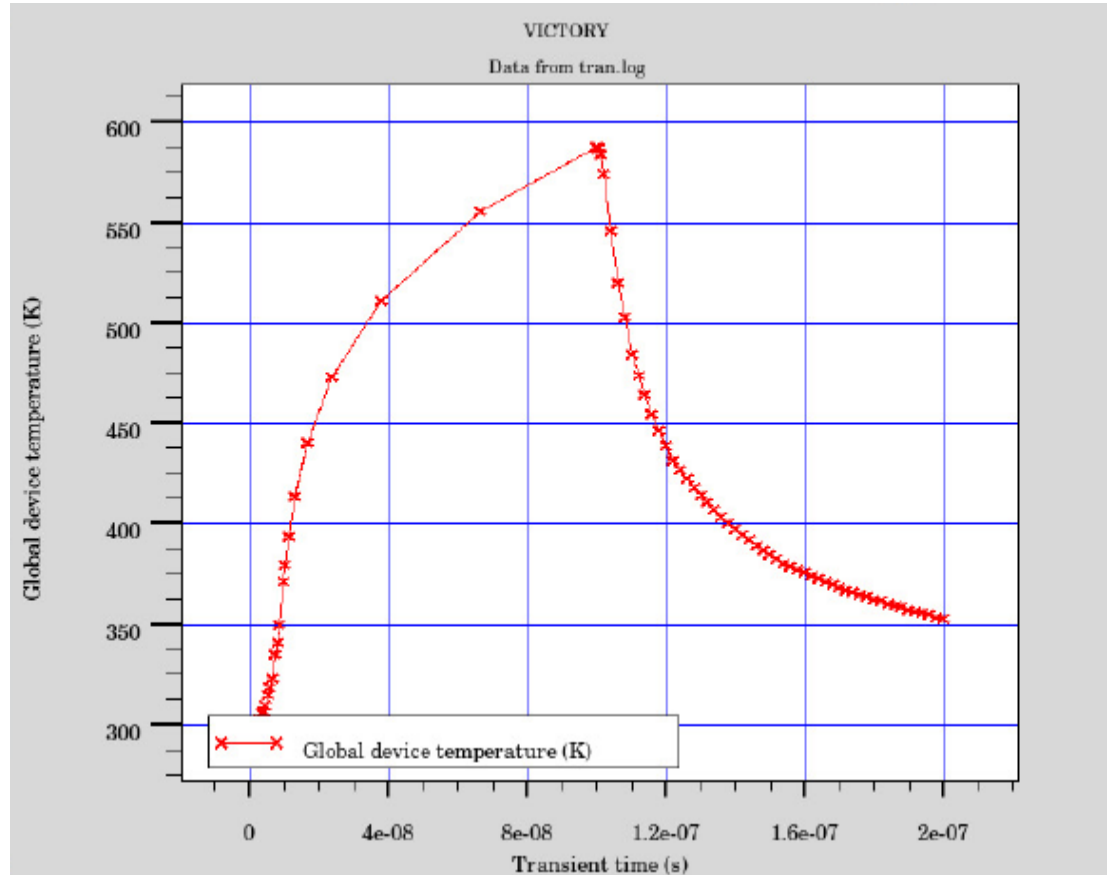
Drain Voltage

Drain Current

Time-dependence of drain voltage and current.



# Transient Analysis of Metal Self Heating

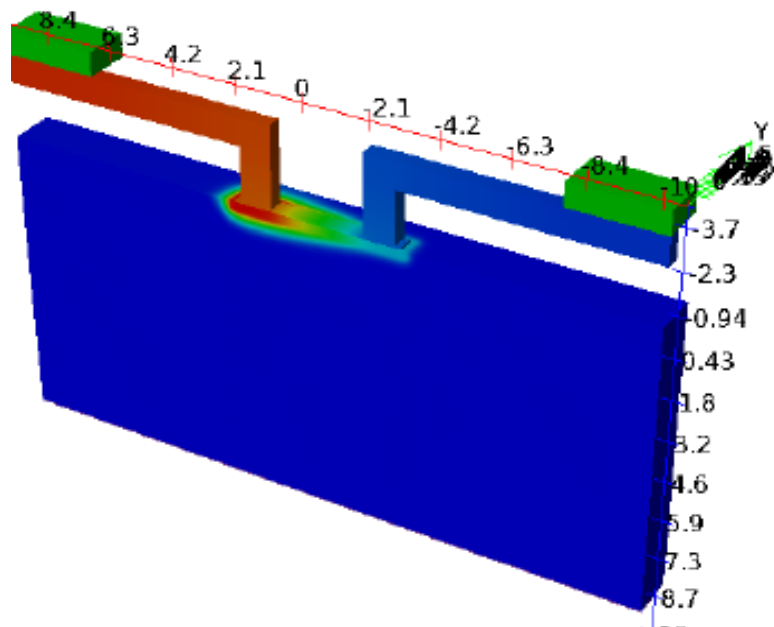


VICTORY Device solves the 3D coupled thermal-electrical transient analysis.

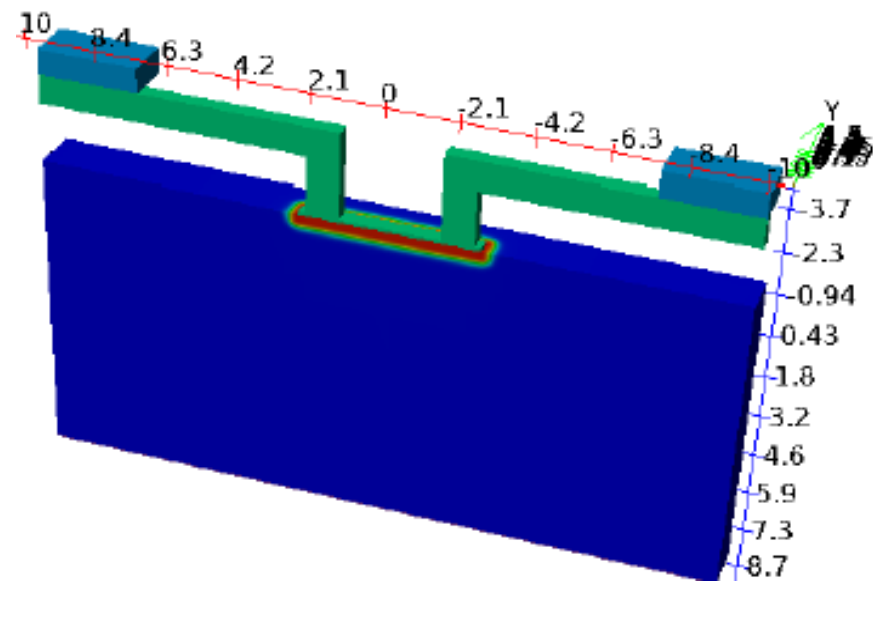
Lattice Temperature versus Transient Time



# Transient Analysis of Metal Self Heating



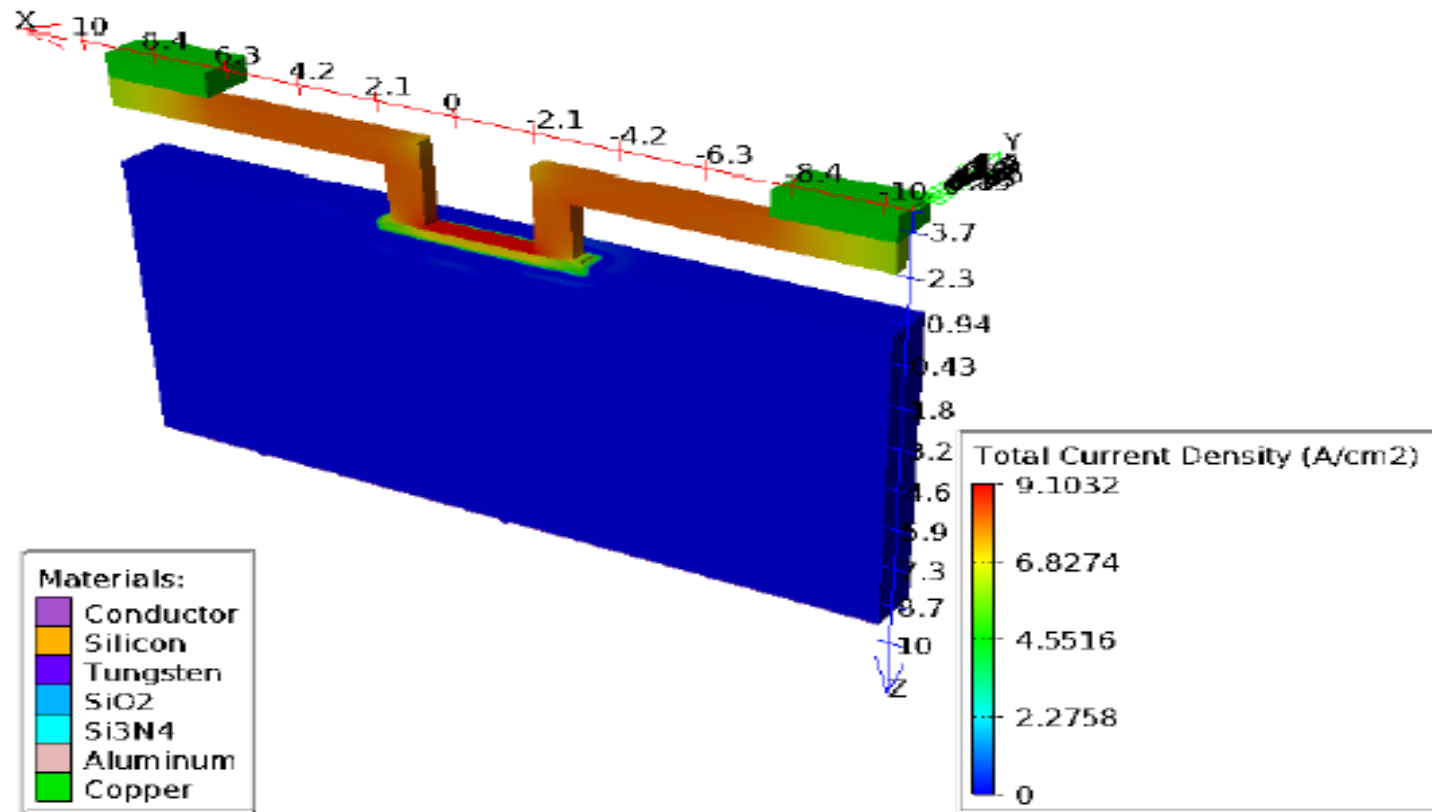
Potential at  $t = 100\text{ns}$



Potential at  $t = 200\text{ns}$



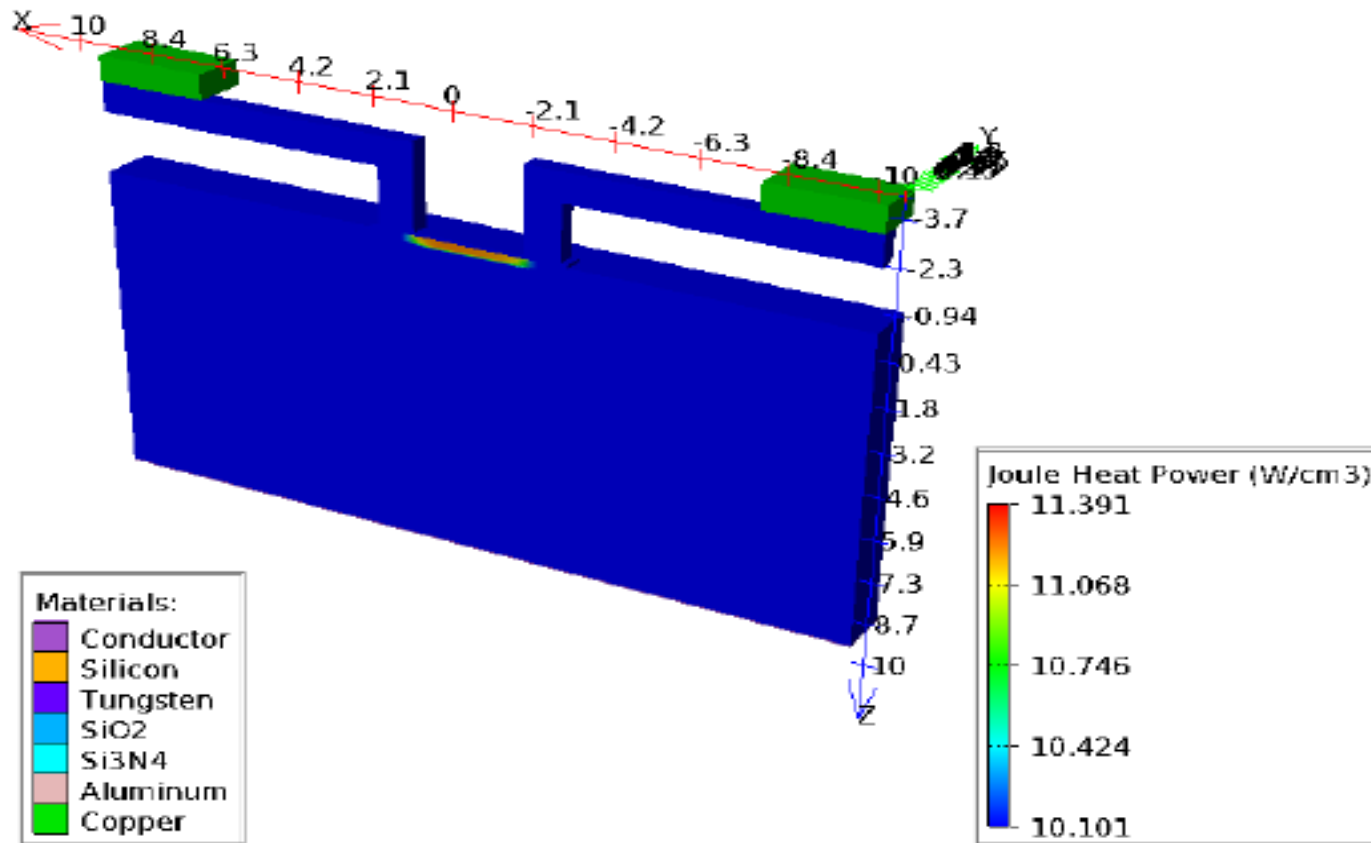
# Transient Analysis of Metal Self Heating



Log(10) of Current Density at T = 100ns



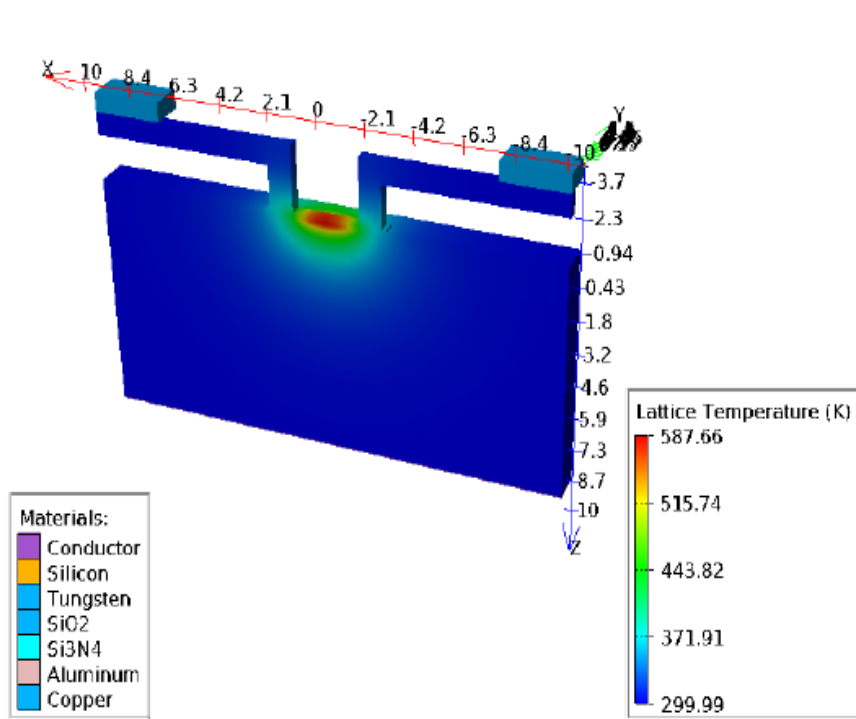
# Transient Analysis of Metal Self Heating



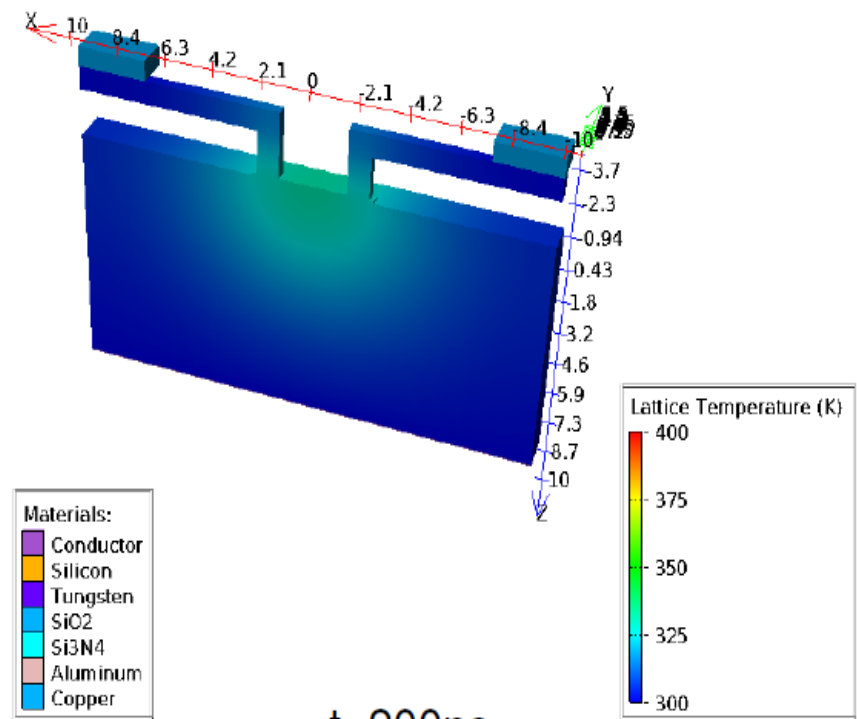
Joule Heating Power at  $t = 100\text{ns}$



# Transient Analysis of Metal Self Heating



Lattice Temperature at  $t=100\text{ns}$ .  
Power turns off at this point.



$t=200\text{ns}$

Thermal conduction continues even  
beyond this 200ns.



## Summary

- This presentation demonstrates:
  - Creation of a 3D wiring structure using VICTORY Cell
  - Tetrahedral mesh generation required for arbitrary shaped 3D structures
  - Self heating simulation capability for metals as well as semiconductors using VICTORY Device
  - Coupled 3D Thermal-Electrical transient analysis using VICTORY Device