HotSpot Extension 1.2 Test Cases

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Computing Joint Parallel Resistivity

Let $A_{\%w/oTSVs}$ = % area of block without TSVs

$A_{\%withTSVs}$ = % area of block with TSVs

R_{Layer} = Resistivity of the Layer (TIM or Silicon)

R_{Cu} = Resistivity of TSVs (Copper) = $0.0025\,\frac{m*K}{W}$

$$R_{Joint} = \frac{1}{\left(A_{\%w/oTSVs} * \frac{1}{R_{Layer}}\right) + \left(A_{\%withTSVs} * \frac{1}{R_{Cu}}\right)}$$

In order to calculate the percent area of block with TSVs you can model the TSVs with diameter 50µm[1] as square blocks, i.e. occupying a space of 50µm x 50µm.

Test Case Parameters

Sampling Interval = 0.0001 seconds

# of Row = 64

# of Cols = 64

Resistivity of Silicon = $0.01\,\frac{m*K}{W}$

Resistivity of Interface Material = $0.25\,\frac{m*K}{W}$

Length/Width of one layer = 2mm x 2mm

Other parameters are listed in the HotSpot Configuration File/Layer Configuration File

Default3D

Base case with one unit in each layer and default parameters.

Layer #	Floorplan File	Resistivity $\frac{(m*K)}{W}$)
0	layer0.flp	0.01
1	TIM.flp	0.25
2	layer2.flp	0.01
3	TIM.flp	0.25

[1] Mohamed M. Sabry, Ayse K. Coskun, David Atienza, Tajana Simunic Rosing, Thomas Brunschwiler. **Energy-efficient Multi-objective Thermal Control for Liquid-Cooled 3D Stacked Architectures**. In *IEEE Transactions on Computer Aided Design, vol. 30 no. 12, pp. 1883-1896*, Dec. 2011.

3D_10Percent

This test case consists of four layers with each containing only one unit in each layer. The 3D_10percent_TIM.flp layer has a TSVs density of ten percent and the joint resistivity is calculated based on the equation in the above section.

Layer #	Floorplan File	Resistivity $\frac{(m*K)}{W})$
0	layer0.flp	0.01
1	10percent_TIM.flp	0.02294
2	layer2.flp	0.01
3	TIM.flp	0.25

3D_2Percent

This test case consists of four layers with each containing only one unit in each layer. The 3D_2percent_TIM.flp layer has a TSVs density of two percent.

Layer #	Floorplan File	Resistivity $\frac{(m*K)}{W})$
0	layer0.flp	0.01
1	2percent_TIM.flp	0.08389
2	layer2.flp	0.01
3	TIM.flp	0.25

3D_2Percent_v2

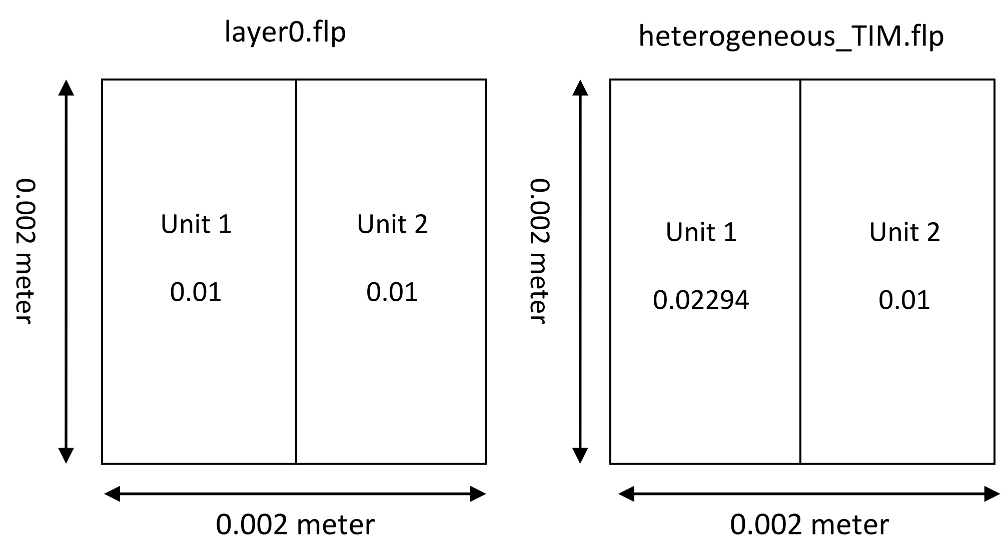
TSVs may connect the active layers of each Si layer; therefore some of the Si layers may have TSVs in the bulk Si. We adjusted the resistivity in layer zero to model this case with the same two percent TSVs density.

Layer #	Floorplan File	Resistivity $\frac{(m*K)}{W})$
0	2percent_layer0.flp	0.0094
1	2percent_TIM.flp	0.08389
2	layer2.flp	0.01
3	TIM.flp	0.25

3D_heterogenous

This test case consists of four layers with each 3D_TIM.flp and default3D_layer0.flp contains two equally sized units. All other layers contain one unit.

Layer #	Floorplan File	Resistivity $(\frac{(m*K)}{W})$
0	layer0.flp	$Unit_1$ = 0.01
		$Unit_2$ = 0.01
1	heterogeneous_TIM.flp	$Unit_1$ = 0.02294
		$Unit_2$ = 0.01
2	layer2.flp	0.01
3	TIM.flp	0.25



Note: We do not modify the specific heat capacity of the layers in these experiments. The change in specific heat capacity is expected to have lower impact compared to that of the thermal resistivity. Capacity values, however, can also be modified in this tool if needed.

Debugging

We added a debugging flag to print out the thermal resistances in the x, y and z direction for each grid in a .csv type format. This will disable the dumping of steady state temperatures to stdout.

Usage:

```
make DEBUG3D=1
```

When running HotSpot it output the relevant data starting from layer zero to the last layer specified in the layer configuration file.

Output:

row #, column #, R_x, R_y, R_z