Thermal integrity analysis for 2.5D/3D Process-in-Memory (PIM) heterogeneous package

Research highlights

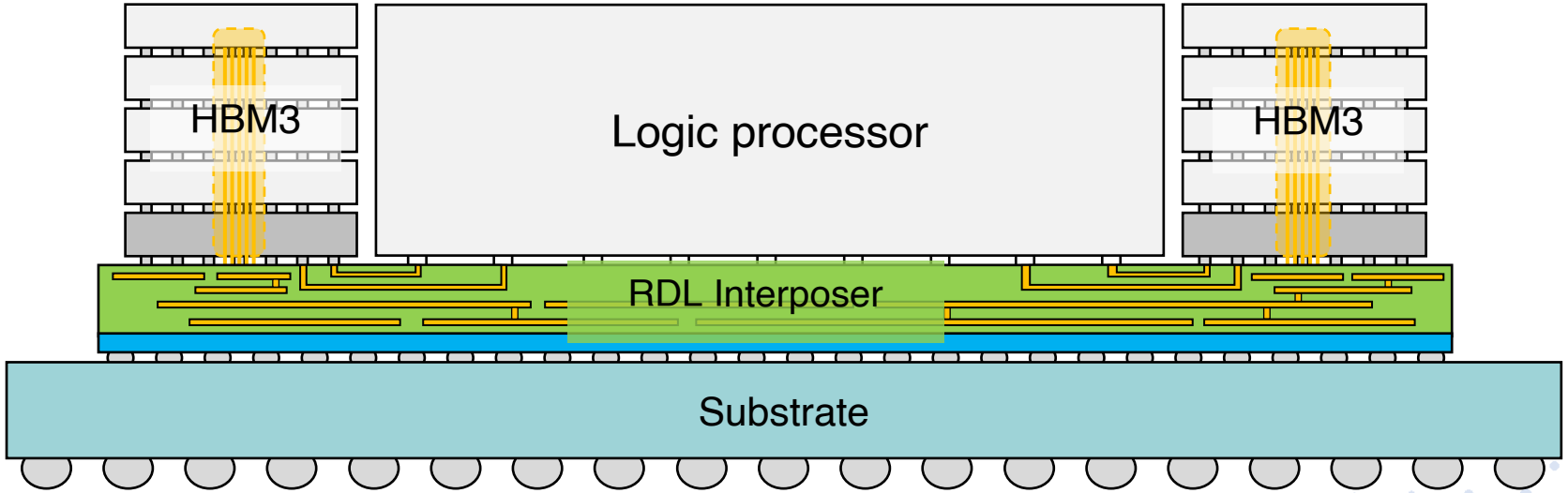
Thermal integrity analysis of PIM heterogeneous package (Project w/ ETRI)

Background

- **Processing-in-memory (PIM) technology has drawn attention as a promising solution for boosting speed of data processing** by bringing computation into or near the memory.

- **Thermal crosstalk between the logic processor and the HBMs leads to the package failure.**

Schematic of PIM heterogeneous package



Research highlights

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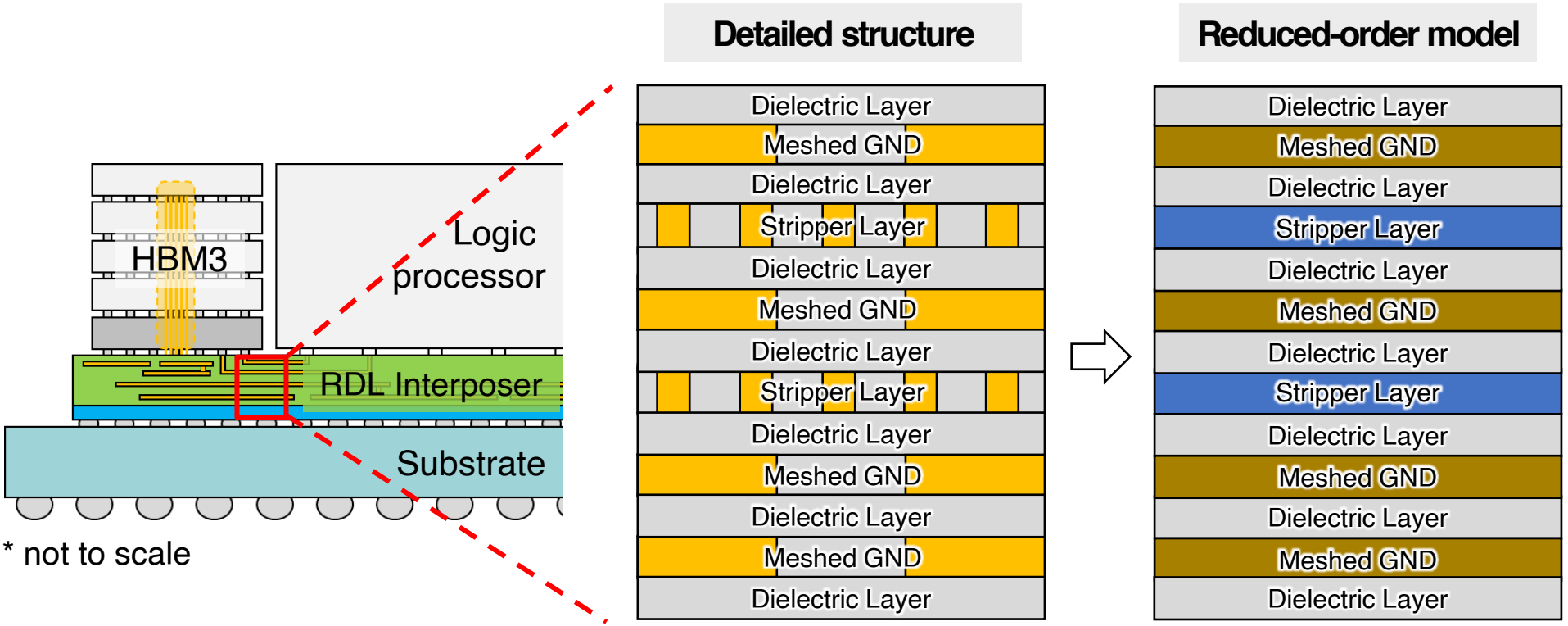
Approach

- **To predict the temperatures within the logic processor and HBMs, a reduced-order model is built based on compact modeling approach using the rule of mixtures.**



Rule of mixtures

$$\rho c_{\mathrm{p,\,eq}} = \sum_i r_i \left(\rho c_{\mathrm{p}}\right)_i, \qquad k_{\mathrm{eq,\,series}} = L_{\mathrm{tot}} \left(\sum_i \frac{L_i}{k_i}\right)^{-1}, \qquad k_{\mathrm{eq,\,parallel}} = L_{\mathrm{tot}} \sum_i \frac{k_i}{L_i}$$

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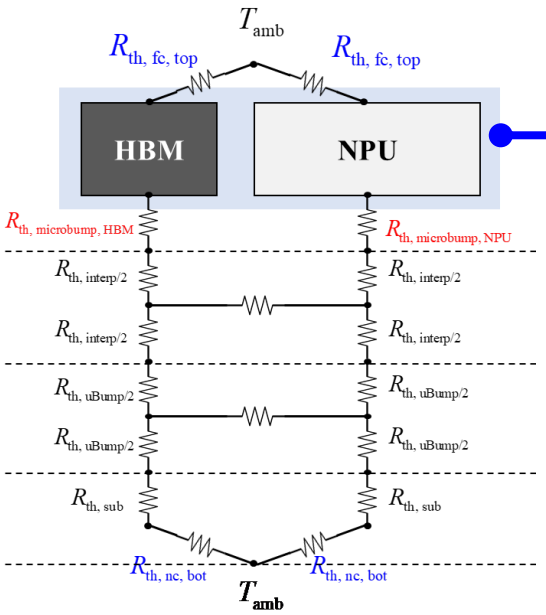
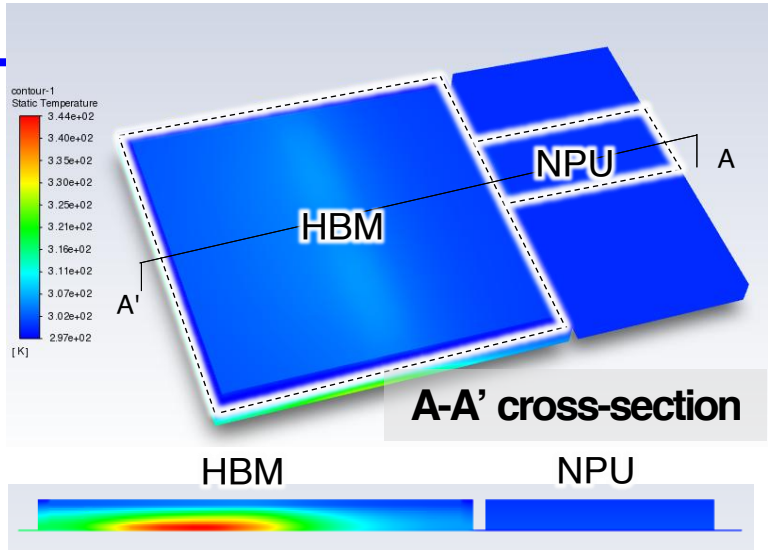
Results

- **The developed reduced-order model successfully predicts the temperatures within the PIM heterogeneous package.**

Thermal Resistance Analysis



Temperature distribution within PIM heterogeneous package



	3-D numerical simulation		Reduced-order model	
	HBM	NPU	HBM	NPU
$T_{top, avg}$	29.7°C	27.4°C	29.0°C	27.3°C
$T_{bot, avg}$	49.3°C	29.0°C	47.0°C	25.4°C
T_{max}	74.2°C	29.4°C	71.3°C	28.6°C