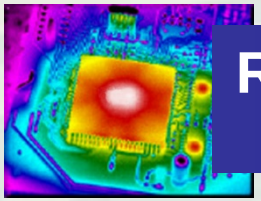


Reverse-engineered Microstructures for Optimal Thin-Films

Faculty: S. V. Garimella, J. Y. Murthy Student: Ram Ranjan

Objective

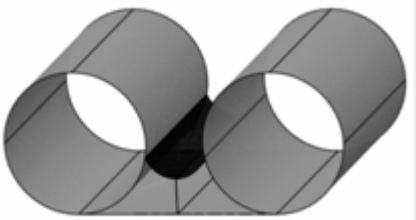
Develop physics-based models to analyze wicking, permeability, thermal conductivity and thin-film evaporation characteristics of microstructures

Impact

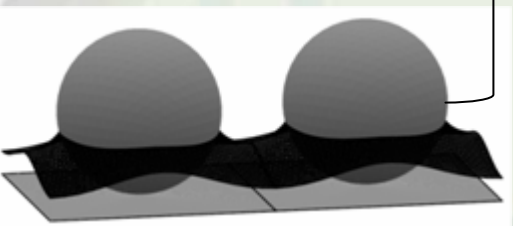
- Optimization of the performance of evaporator in a two-phase cooling device
- Capability to remove ultra-high heat flux in electronics by optimizing the microstructure based on developed models

Approach

Compute liquid meniscus shapes in microstructures



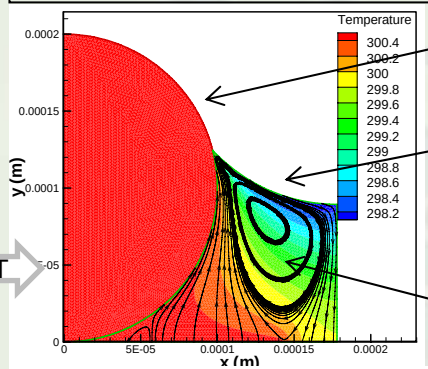
Horizontal wires (wire mesh)



Packed bed of spheres (sintered particles)

To FLUENT model

Model evaporation from liquid meniscus in microstructures

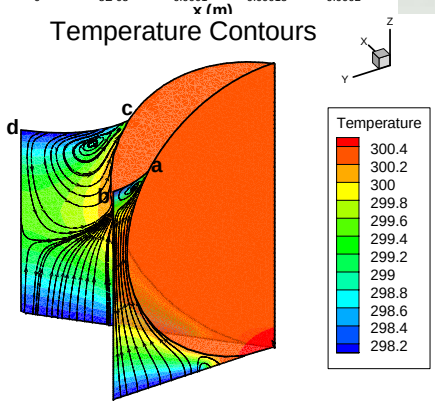


Superheated solid wall

Liquid-vapor interface

Marangoni Convection

Temperature Contours



Selected Publications

- R. Ranjan, J. Y. Murthy and S. V. Garimella, ASME IMECE 2009, Paper no. IMECE09-11326.
- R. Ranjan, J. Y. Murthy and S. V. Garimella, ASME JHT, 2009, vol. 131, 101001.
- R. Ranjan, J. Y. Murthy and S. V. Garimella, ASME 2008 Summer Heat Transfer Conference, Paper no. HT2008-56170.
- H. Wang, J. Y. Murthy, S V. Garimella, IJHMT, 2007, vol. 50, pp. 3933-3942

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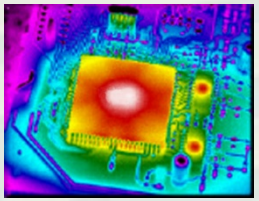


Numerical Modeling of 3D Vapor Chambers

Faculty: J. Y. Murthy, S. V. Garimella **Student: Ram Ranjan**

Objective

Develop physics-based numerical models to determine the dry-out of vapor chamber heat spreaders for different wick structures.

Impact

- Micro-level effects (thin-film evaporation, Marangoni convection) are captured in the vapor chamber model.
- Vapor chamber performance with different wick structures can be predicted using the coupled model.

Approach

Couple Evaporation Micromodel with Vapor Chamber 3D Model

Macromodel[1]

Compute pressure gradient across interface in the device

Surface Evolver Model[2]

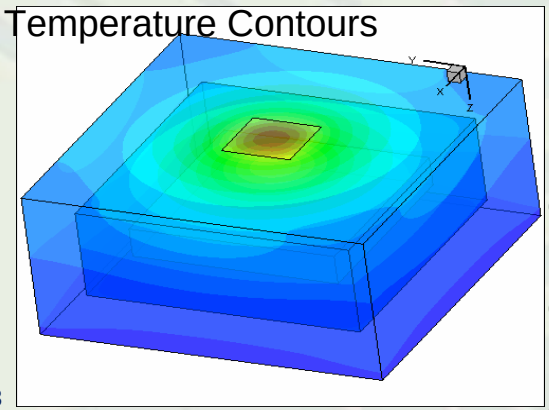
Get corresponding contact angle from Surface Evolver model

Evaporation Micromodel[3]

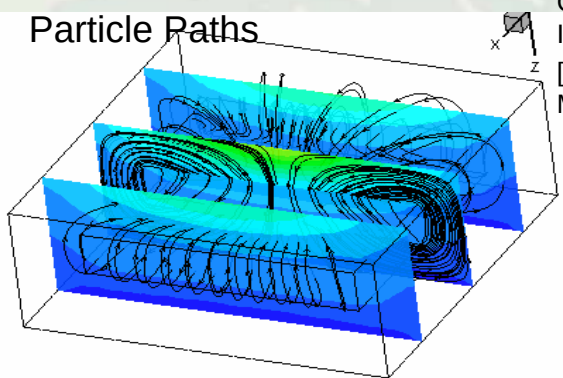
Compute interfacial mass transfer coefficient including thin-film evaporation and Marangoni effects

3D Vapor Chamber Simulation Results

Temperature Contours



Particle Paths



Selected Publications

[1] R. Ranjan, J. Y. Murthy and S. V. Garimella, 2010 ITHERM Conference, Paper no. ITHERM10-2586..

[2] R. Ranjan, J. Y. Murthy and S. V. Garimella, ASME JHT, 2009, vol. 131, 101001.

[3] R. Ranjan, J. Y. Murthy and S. V. Garimella, ASME IMECE 2009, Paper no. IMECE09-11326.

[4] U. Vadakkan, S. V. Garimella and J. Y. Murthy, ASME JHT, 2004, vol. 126, 347-354.

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