A Novel Concept of Dummy Heat Sources for Heat Transfer Enhancement in a Vertical Channel

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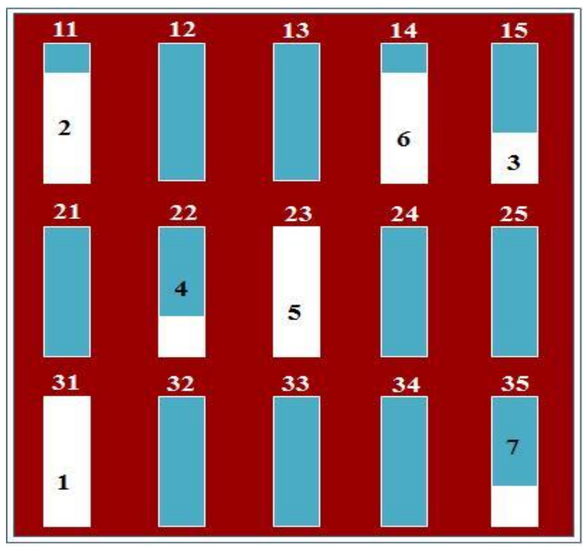
Introduction: Miniaturization of electronic equipment has resulted in high heat flux density at chip level and creating challenges in heat dissipation. Thus efficient thermal management of electronics become important. Cooling of discrete heat sources by forced convection air cooling using dummy heat sources is presented.



Heat source No.	Size
1	42x15x5
2	30x15x5
3	20x15x5
4	15x15x5
5	10x15x5

Figure 1. Arrangement of heat sources on substrate board

Computational Methods: 3D steady, incompressible, Laminar flow forced convection conjugate heat transfer equations for solids, and fluid are solved using COMSOL Multiphysics 4.3b.

$$\rho c_p u \nabla T = \nabla(k \nabla T) + Q \quad (1)$$

$$\rho(u \,.\nabla)u = \nabla \,.[\, pl + \mu(\nabla u + (\nabla u)^T - \frac{2}{3}\mu\,(\nabla \,.\, u)l] + F \quad (2)$$

$$\nabla \,.\,(\rho\, u) = 0 \quad (3)$$

$$\rho c_p \,\mathrm{u}\,.\,\nabla T = \nabla \,.\,(k\,\nabla\, T) + Q + Q_{vh} + W_p \quad (4)$$

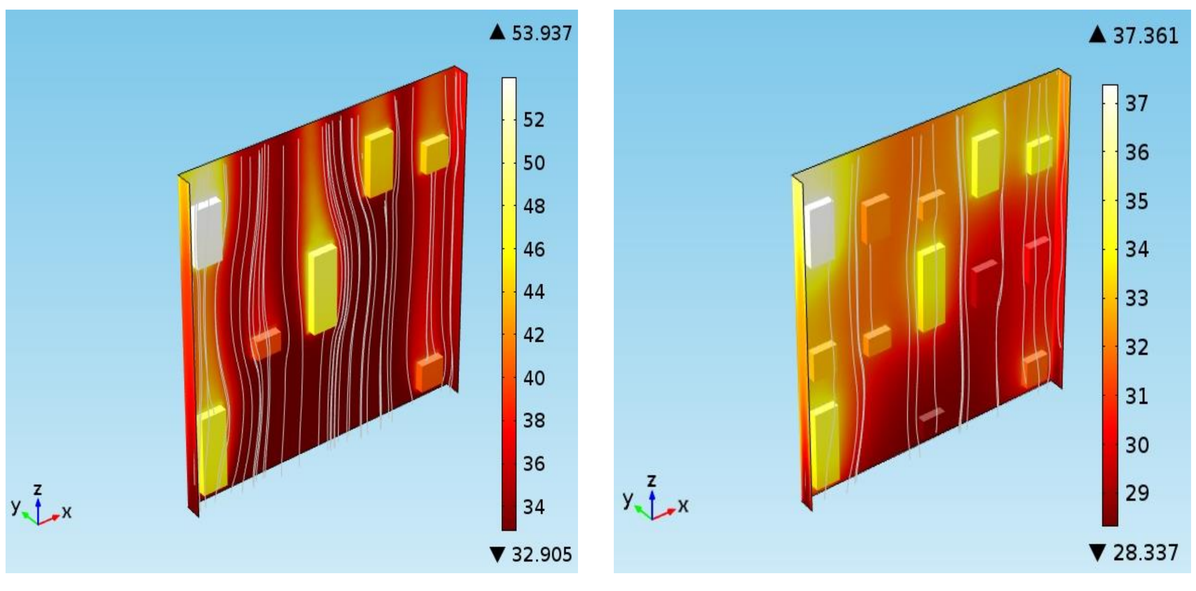


Figure 2. Temperature plot (a) bakelite without dummy and (b) Copper clad board with six dummy

Results: Fig.2 shows temperature plot for bakelite and copper clad board. Fig.3 is temperature contours. Table 1 gives the comparison of temperature using bakelite and copper clad board as substrate materials for same heat input.

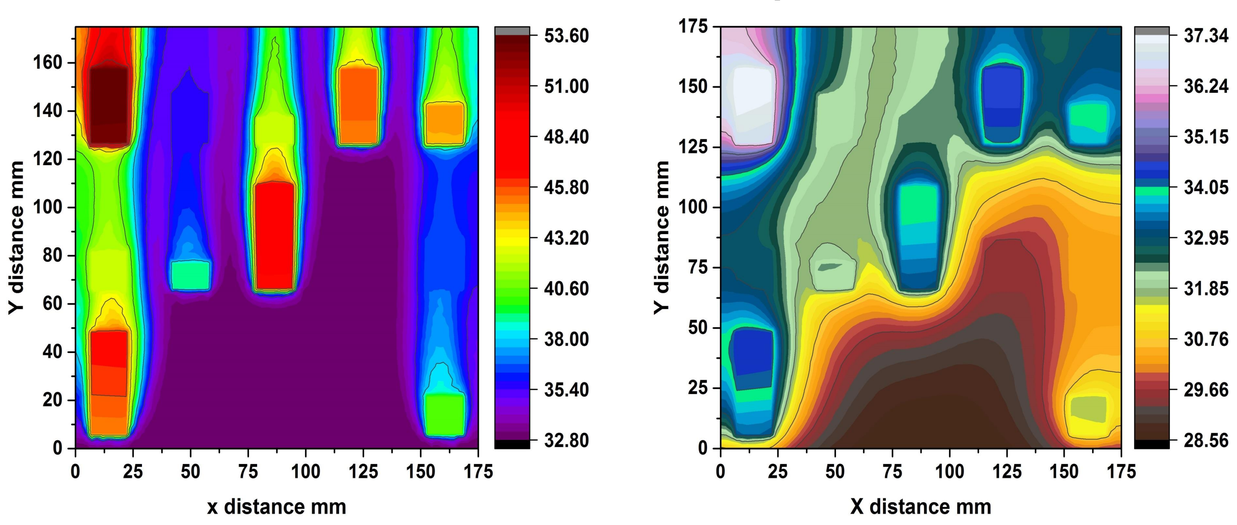


Figure 3. Temperature contour plots six dummies

Substrate board material	7 heaters without dummy			7 heaters with 6 dummy			7 heaters with 8 dummy		
	Temperature °C								
	0.6 m/s	1.0 m/s	1.4m/s	0.6 m/s	1.0 m/s	1.4 m/s	0.6 m/s	1.0 m/s	1.2 m/s
Bakelite	70.4	60.9	53.9	66.7	54.1	51.7	67.7	55.4	52.1
CCB	49.2	44	40.3	43.4	41.9	37.3	48.2	43.2	39.1

Table 1. comparison of temperature °C

Conclusions: Temperatures for seven heat sources i.e. without dummy are higher compared to seven heat sources with 6 and 8 dummy heat sources. In a typical arrangement of seven heat sources with six dummy, results in a lowest temperature. It gives some guidelines for cooling of printed circuit boards used in electronic devices.

References:

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2. Shankar Durgam., Venkateshan S. P., Sundararajan, T. A Numerical and Experimental Study of Optimal Distribution of Rectangular Discrete Heat Sources under Laminar Forced Convection, Proceedings of 1st ISHMT_ASTFE International Conference, ISRO, Trivandrum, Kerala - India (2015).

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