ID: 12.3c

Title: Influence of the Heat Source Characteristics on Dimensionless Thermal Spreading Resistance

Name: Yan, Cui ping

Affiliation: Beihang University

The heat flow will be constrained to flow through the sparsely spaced actual contact spots when heat is transferred through a contact interface for the surface is rough. This phenomenon is known as thermal contact resistance including constriction and spreading resistances. In many instances, the constriction and spreading resistances may become greater than one-dimensional material resistance in a system, and represent an essential part of the total thermal resistance in predicting the overall thermal performance of the device. In order to research the influence of heat source shape on dimensionless thermal spreading resistance(DTSR), a series of numerical models, such as circle/circle flux tube, square/square channel, rectangular/square channel and rhombus/square channel which have the same heat source area with different perimeters were built in this paper. The analysis was performed using ANSYS software. The models assume a heat source in contact with a larger cold plate which is in turn cooled with a convective heat transfer coefficient specified over the sink surface. All edges are assumed to be adiabatic. Further, the region outside the heat source in the source plane is also assumed to be adiabatic. If heat is supplied to the channel for a sufficiently long time, the system will reach a steady-state situation. The total thermal resistance is composed of two terms: a uniform flow or one-dimensional resistance and a spreading or multi-dimensional resistance, which vanishes as the source area approaches the plate area, ie. $ A_s \rightarrow A_b $. These two components are combined as follows: $$ R_t=R_{1D}+R_s $$ the total resistance:$$ R_t=(T_{source}- \bar{T}_b)/Q $$ where $ T_source $ is temperature at heat source, $ \bar{T}_b $ is average temperature of the plate, $ Q $ is rate of heat transfer of the steady-state system. one-dimensional resistance:$$ R_{1D}=t/(k A_b) $$ where $ k $ is the thermal conductivity of the channel, $ t $ is the thickness of the channel. Nondimensionalization of $ R_s $ can be made by introducing a characteristic dimension with the units of length $ \sqrt{A_S} $, which is defined as: $$ R_S^*=k\sqrt{A_S}R_s $$. From the above formulas, we can get DTSR of the whole system. Now I get numerical results of circle/circle flux channel and square/square flux channel. The results are compared with published numerical data and the agreement is excellent over a wide range of parameters. DTSR is affected by the shape of the heat source which can be observed from the numerical results. Later more models with fractal heat source shape will be researched. The whole results will be presented in the full paper.