Abstract:

It is commonly believed that the significant advantages are belonged to the logic circuits which operate at low temperature. Also, nanoscale thermal management, efficient energy usage in nanoscale and especially thermal optimization are the most challenging issues, while dealing with the new generation of transistors as the miniaturizing unlimitedly the silicon channels of the transistors has resulted in an increase in the energy consumption of computers and the leakage currents. In this paper, the non-Fourier thermal attitudes of well-known two-dimensional crystalline materials of graphene, blue phosphorene, germanene, silicene and molybdenum disulfide as the silicon channels replacements are studied by using the phonon Monte-Carlo method. We show that graphene and blue phosphorene have the least maximum temperature among the all five investigated nano-channels during the Monte-Carlo simulation. The established hotspots of these two materials are always cooler, not reaching the temperature threshold level, and they lose the heat much faster as the heat generation zone is switched off. The obtained results considered along with the electrical disadvantages of the graphene layer, suggests the blue phosphorene as the more thermally appropriate and optimal choice for the silicon channel replacement in new designed field effect transistors. That is to say that the limit of the energy and economic cost of the producing the advanced blue phosphorene chips meets the value of the product for the computing enterprise.