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Advances and Methods of Electronics Cooling

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The ever increasing transistor density and processing speed of computer chips and central processor units (CPUs) pose continuous challenges for removing the dissipated heat at a reasonable junction temperature and for mitigating the effect of hot spots on shortening the service life and increasing the failure frequency of the chips. For high power computer chips, the temporal variation along the surface could be as much as 10 ^{o}C or higher, and the hot-spot local heat flux could be 2-3 times the surface average heat flux. Heat sinks or spreaders are typically used to increase the capability for removing the dissipated thermal power by the underlying computer chips or CPUs. The temperature budget for removing this heat from the surface of the speeder and that due to the interfacial resistance between the spreader and the underlying chip are major contributors to the junction temperature.

Methods for cooling the heat sinks or spreaders for electronics and computer chips are reviewed with emphases on the capability of removing the dissipated heat and the values of the corresponding surface temperatures. Methods reviewed include forced convection of air and liquids, impinging jets and sprays of dielectric liquids, and pool and flow boiling of dielectric liquids. The potential and limitation of each method are discussed and the operable ranges of surface temperatures are compared. Recent results on enhanced cooling of electronics using pool boiling of dielectric liquids on porous, micro-porous, and micro-structured surfaces are also presented and discussed. Also discussed are the use of thermoelectric coolers for mitigating the effect of the hot spots in high power computer chips and the different thermal interface materials for reducing the interface résistance between the heat spreaders and the underlying computer chips or CPUs.