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Local Cooling Engineered by Asymmetric Electrodes in Nanoscale Junctions. YU-CHANG CHEN, BAILEY C. HSU, Department of Electrophysics, National Chiao Tung University, Taiwan — Searching for a solution to prevent electronic components from overheating has been a constant concern for the electronics industry. Local heating is caused by inelastic electron-phonon scattering. The mechanism corresponds to the electron incidence from the right or left electrode that relaxes (cools) or excites (heats) the energy level of normal–mode vibrations in the device region. Much research has been conducted on local heating. However, quite few studies have discussed local-cooling phenomena. Local cooling refers to the decrease in local temperature with increased applied voltage. Such an unusual phenomenon is possible when the rate of energy in cooling exceeds that in heating. Here, we propose an engineer-able local-cooling mechanism which utilizes asymmetric electrodes, e.g., one electrode is made of metal, whereas the other is made of bad metal. Substantial local cooling can be achieved at room temperature when the bandwidth of the bad-metal electrode is comparable to the energy of the phonon in inelastic e-p scatterings. The local cooling is caused by the narrowed bandwidth which obstructs certain inelastic heating scattering processes, i.e., the Pauli exclusion principle prohibits certain heating processes, where electrons heat up the device, lose energy via inelastic scattering, and being scattered to the forbidden region below the bottom of the narrowed band. Local-cooling phenomenon is meritorious to stability and performance of electronic devices.

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