Using Doped Zno Pillar Array Structures for Spectral Control of Near-Field Radiation In Nanogap TPV Systems: an FDTD Simulation

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Pillar array surface structures fabricated with ZnO:Ga (GZO) and ZnO:Al (AZO) were proposed as the emitter for near-field thermophotovoltaic (TPV) systems. 2D square pillar array surface structures with critical sizes of hundred nanometer are able to manipulate near-field radiative transfer spectrum in the near-infrared range. Doped ZnO is used as the emitter material due to the resistance to high temperature and changeable optical properties by changing the doping ratio. The spectral control ability of doped ZnO pillar arrays was studied by the finite-difference time domain (FDTD) method, where the emission of thermal radiation was directly simulated using the Langevin approach to characterize the thermal fluctuations inside the high temperature emitter. The permittivity of AZO and GZO was fitted with Drude-Lorentz model from experimental data and taken into the FDTD simulation with piecewise linear recursive convolution (PLRC) algorithm. The spectral radiative flux was calculated between two doped ZnO pillar array surfaces and also from the doped ZnO emitter to the GaSb cell surface to explain the influence of pillar array size parameters and ZnO doping ratio on the radiative flux spectrum. In consideration for TPV output power, the heat flux in the GaSb bandgap spectrum is discussed with comparison between ZnO pillar array emitters and traditional metallic emitters.