RAD-13-NS4

NEAR-FIELD THERMAL EMISSION BY METAMATERIALS

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ABSTRACT. Near-field thermal emission by metamaterials is analyzed. For this purpose, a closed form expression for the local density of electromagnetic states (LDOS) due to a bulk of arbitrary permittivity and permeability is derived from Maxwell's equations and fluctuational electrodynamics. The final form is identical to that for nonmagnetic materials, where the influence of permeability is in the Fresnel reflection coefficients. Results reveal that spectral distributions of LDOS are dominated by surface polaritons (SPs) in both polarizations. The necessary conditions for exciting SPs via a dispersion relation analysis that accounts for losses are discussed. Beyond the conventional conditions for SP excitation, the lossy dispersion relation analysis demonstrates that SPs exist when the imaginary parts of the permittivity or permeability, as well as the product of the real and imaginary parts of the refractive index, are near zero. Finally, it is shown that SP resonance in the near infrared can be activated at temperatures as low as 400 K at a distance of 50 nm from Mie resonance-based metamaterials made of silicon particles. The results obtained in this paper will assist in assessing electromagnetic properties of metamaterials in energy harvesting applications.