Thermal Emission by Dielectric Particles

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Spectral control of thermal emission can be achieved with metamaterials made of subwavelength dielectric particles, such as spheres and cylinders, embedded in a dielectric host medium (e.g., Fenollosa et al., *ACS Photonics* **6**, 3174, 2019). Typically, thermal emission by dielectric-based metamaterials is predicted via the effective medium theory in which the impacts of particle shape, size, and spacing are greatly simplified. Thermal emission by solitary particles has been modeled via the thermal discrete dipole approximation (Ekeroth et al., *Phys. Rev. B* **95**, 235428, 2017) and an extension of Mie theory (Nguyen et al., *Appl. Phys. Lett.* **112**, 111906, 2018). Particle shapes have been developed through machine learning techniques to optimize the emissivity of a single particle (Elzouka et al., *Cell Rep.* **1**, 100259, 2020). Thermal emission by clusters of particles modeled as dipoles has been reported (Dong et al., *J. Quant. Spectrosc. Ra.* **255**, 107279, 2020). To date, however, no comprehensive analysis quantifies the impacts of particle shape, size, and spacing on thermal emission. Therefore, the objective of this work is to analyze the spectral, hemispherical emissivity of two or more dielectric particles supporting localized surface phonons, such as SiC and SiO_2. In particular, we study the impacts of material, size, shape, and spacing on the emissivity of dielectric particles. Numerically exact, fluctuational electrodynamics-based calculations of spectral, hemispherical emissivity are performed via the discrete system Green's function method (Walter et al., *Phys. Rev. B* **106**, 195417, 2022). Our preliminary results reveal tunable spectral emissivity of two 100-nm-diameter SiC spherical particles when the spacing d is smaller than 100 nm. In contrast, SiO_2's spectral emissivity remains unchanged, even when d is smaller than the particle size. Our work paves the way to designing spectrally selective metamaterials that have the potential to impact various energy conversion devices.