Controlling the spectral and spatial properties of thermal radiation from hot surfaces is extremely important for many applications including energy harvesting, sensing and novel light sources [1]–[3]. For example, the spectral selectivity of thermal radiation from a hot emitter directly relates to the efficiency of thermophotovoltaic energy conversion [1]. High brightness, high spectral contrast, directional emission and polarization preference are a few desired properties of such selective thermal emitters. Since many of these characteristics are related to one another through geometry and materials, a single selective emitter can hardly meet all the requirements. Here, we show two ways to relax the trade-off between these desired properties of thermal emitters by employing (i) asymmetric geometry and (ii) extremely anisotropic materials.

**Asymmetric geometry:** Spectrally selective emitters exhibit a trade-off between their peak emissivity and spectral contrast. If the emitter is made from lossless materials, there is no net absorption and hence no thermal emission. But, their spectral contrast or resonant quality factor can be very high. On the other hand, too high losses lead to low quality factor or poor spectral contrast, but high peak emissivity. This trade-off between the brightness or peak emissivity and spectral contrast may be relaxed if the thermal emitter is built using two coupled resonators, one with high loss and the other nearly lossless. Such extreme asymmetry leads to the best of both worlds or a possibility of high spectral contrast arising from the lossless resonator and high brightness arising from the high loss resonator. Here, we demonstrate a selective emitter consisting of a semiconductor resonator coupled to a plasmonic resonator operating at 1200 K and resulting in near unity emissivity around 3 μm wavelength and an adjustable quality factor between those of the isolated resonators.

**Anisotropic materials:** Extreme anisotropy such as metallic property in one direction and dielectric in the other gives rise to hyperbolic dispersion [4]. Hyperbolic materials support light waves with very high momenta and hence support photonic-like resonances in deep sub-wavelength cavities [5]. Such resonators allow polarized selective thermal emission with relaxed trade-off between the geometry and polarization contrast. Here, we demonstrate aligned carbon nanotubes as high temperature (900-1200 K) hyperbolic materials and show their polarized, spectrally selective thermal emission in the 3-5 μm wavelength range.

**References**


