New frontier for plasmonics and metamaterials: Thermophotovoltaics


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Plasmonics and metamaterials have been used for a multitude of applications ranging from sensing, thermal cancer therapy, sub-diffraction imaging to cloaking. Recently a new frontier of applications for plasmonics and metamaterials was proposed by us: high temperature selective thermal emission for thermophotovoltaics[1]. We will present a detailed description and initial experimental results of engineering thermally excited far field electromagnetic radiation through the use of epsilon-near-zero (plasmonic) metamaterial coatings. We also introduce the concept of high temperature plasmonics using metals like Titanium Nitride to replace conventional metamaterial building blocks (silver and gold) with low thermal stability. Using the approaches presented here, the angular nature, spectral position, and width of the thermal emission can be finely tuned for a variety of heat transfer applications. Our calculations show that these metamaterial emitters near 1500 K can be used as part of thermophotovoltaic devices to surpass the Shockley-Queisser conversion efficiency limit of 41%. Our work paves the way for a new direction of application for plasmonics and metamaterials: high temperature nanophotonics.