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Semiconductor-Based Selective Emitter with Sharp Cutoff for Thermophotovoltaic Energy Conversion

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-Background Thermophotovoltaic (TPV) devices convert thermal radiation from a high-temperature emitter to electricity via a narrow-bandgap photovoltaic (PV) cell. Since the emitter can be heated by any kind of heat source (e.g., combustible fuel, solar energy, waste heat), the TPV technique has a wide range of applications. However, due to the mismatch between the thermal radiation spectrum of the emitter and the absorption spectrum of the cell, TPV systems exhibit low electrical power output and poor efficiency. To overcome this problem, much work has been carried out on spectrally selective emitters that emit photons with energy just above the bandgap of the PV cell. An ideal selective emitter should have an emissivity of one over a certain bandwidth just above the bandgap of the PV cell, and an emissivity of zero elsewhere. Despite some research efforts reporting desirable spectral selectivity and temperature stability, the bandgap cutoff lacks the sharpness needed for higher efficiency. Invention Description Researchers at Arizona State University have developed a multi-layered semiconductor-based spectral emitter with:

•   A germanium (Ge) semiconductor layer; •   A tungsten (W) reflective bottom layer to ensure opaqueness of the structure and high reflectivity below the Ge bandgap; •   An anti-reflective Si_3N_4 top layer for reducing in-band reflection and enhancing absorption or emission.

The semiconductor itself provides a near-ideal sharp cutoff at the bandgap edge. In some embodiments, the emitter system exhibits a nearly two-fold increase in TPV efficiency compared to a black emitter control. Potential Applications •   Solar cells •   Power generation Related Publication: Semiconductor-based selective emitter with sharp cutoff for thermophotovoltaic energy conversion (PDF)Research Homepage of Professor Liping Wang