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Design of Multilayer Stacks for Use as a Selective Emitter in a Thermophotovoltaic System

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In a thermophotovoltaic (TPV) system, the photons radiated from a thermal emitter are converted into electrical power with the help of a photovoltaic cell. These systems are good for remote power generation, deep-sea applications, in space, and in utilizing solar heat, or heat wasted from other power generation plants, for example. A selective emitter is the best choice for the thermal emitter, as it restricts the emission of photons below the bandgap energy of the photovoltaic cell material. In this work, we simulate the emission of metal/insulator multilayers by calculating their absorption. If the absorption is known, the emission can be well predicted as stated by the Kirchhoff's law where the amount of emission from a material is the same as the amount of absorption under equilibrium conditions. We thus studied the absorption spectra of Metal Insulator Metal (MIM) and Metal Insulator Metal Insulator Metal (MIMIM) multilayers made of six different metals each-TiN, Au, Ag, Al, W, Cu- and Silica or Hafnia as the insulators. It was shown that the broadness of the absorption peak could be varied by varying the metal, and by varying the thicknesses, the absorption intensity and position of the absorption peak can be tuned. The multilayers were tuned to the bandgap wavelength of Si, Ge and GaAs as photovoltaic cell references. An ideal selective emitter emits photons only around the bandgap wavelength of the photovoltaic cell, so the narrower the absorption peak, the better. In this regard, the best response was found for Ag, Au, Al and Cu as the metals in the multilayers. These absorption peaks were simulated using the transfer matrix method (TMM). In some of the simulations in this work, the absorption peak was greater than 85%, which is very well desired for this application.

Category

Other

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