MULTI-LAYER FREQUENCY SELECTIVE VOLUMES FOR THERMOPHOTOVOLTAIC FILTERS

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Compared to traditional photovoltaic (PV) converters which use the extreme heat of the sun to generate electricity, thermophotovoltaic (TPV) systems provide a method for the direct conversion of secondary thermal radiation from a heat source of relatively low temperature into electricity. A TPV consists of three basic components: a heat emitter, a spectral filter, and a sheet of PV cells. Maximum conversion efficiency occurs at the wavelength of the secondary radiation, but the heat from the emitter contains many frequency components other than that of the secondary radiation, which leads to poor overall performance. With a properly designed spectral filter, all undesirable frequencies may be reflected before reaching the PV cells to dramatically improve system performance. Frequency selective volumes (FSVs), screens that exhibit frequency selective properties, are good candidates for the band-pass, band-stop infrared filter required by TPV converters.

The overall efficiency of a TPV depends on the performance of the spectral filter. The filter should only allow those frequencies with the wavelength of the secondary radiation to pass while rejecting all others. The performance requirements of the spectral-control filter are high reflection ($> 90\%$) for $\lambda > 2.4\mu m$, high transmission ($> 90\%$) for $1 < \lambda < 2.4\mu m$, insensitivity to large $\Delta\theta$, insensitivity to polarization, and broadband operation ($1-10\mu m$).

In [1], several FSV geometries were explored including commensurate multi-layer designs; wire loop configurations were tested using both one and two layers. It was shown that single layer wire loop FSVs generally utilized approximately 89% of the desired spectrum while two layer configurations of equivalent depth only offered about 85% utilization. Our new results found that non-commensurate multi-layer designs may offer upwards of 90% spectral utilization with dimensions similar to the commensurate layouts of the previous work. In this paper, we present results regarding non-commensurate multi-layered FSV structures and compare those with the single layer configurations given in [1].

[1] E. Topsakal and A.Z. Hood, "*A Near Infrared Optical Thermo-photovoltaic Filter Design Using Frequency Selective Volumes*", IEEE Antennas and Propagation Society International Symposium, Monterey, California June 20-26, 2004.

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