The Homogenization Method and its Application to Designing Frequency Selective Structures

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Thermo-photovoltaic (TPV) cell panels are increasingly used in production of small lightweight portable generators, hybrid electric vehicles and electric grid independent appliances. A need also exists to protect the TPV panels from broadband radiation by employing high efficiency spectral control filters. However, these filters often lack compactness, good bandpass behavior or the desired efficiency.

The goal of this paper to address the design issues of TPV spectral-control filters with specific operational characteristics. This is accomplished by applying a new design technique, the Homogenization Design Method (HDM). More specifically, the dielectric permittivity is homogenized and used as the design variable in a Sequential Linear Programming (SLP) based optimization algorithm. The main attempt is to optimize the material distribution of the dielectric layers in a Frequency Selective Volume configuration with cascaded planar periodic structures. The HDM methodology is demonstrated in developing a sharp transition TPV filter that becomes reflective at 2.4 μm, which is the onset of inter-band absorption in the TPV device in a working band of 1-10 μm. An additional design requirement is that the filter transmits more than 90% up to 2.4 μm and less than 10% beyond that range.