Finite-size passive narrow bandpass filters for shortwave infrared (SWIR) region

Umar Hasni[(1)], Ümit Özgür [(1)], Erdem Topsakal [(1)],

(1) Department of Electrical and Computer Engineering, Virginia Commonwealth University, Richmond, Virginia, USA

Applications in the infra-red frequency region such as medical imaging, spectroscopy, material analyzers and trace-particle detection have seen major development in past years which are attributed to advancements in materials and fabrication capabilities. However, at the very fundamental level they all rely on filter design which determines the frequency response and resolution of any given device employing these technologies. Also, avoiding joule losses in high frequency Infra-Red applications require dielectric structures hence, need for high-gain optical dielectric filters with greater spatial resolution, particularly in the case of weak intensities, is evident. Particularly in the applications of trace particle detection and medical imaging.

In this study, we investigate passive narrow (~ 10 nm) bandpass thin film dielectric filters in the short wave infra-red (SWIR) region, with lateral device dimensions limited to 'N' wavelengths (where N = 1, 2, ..., n), that replicate the frequency response of the infinite size structure. We focus on two types of filter topologies; sub-wavelength patterned guided-mode resonance (GMR) filter offering high peak and low sideband transmission, and Fabry-Perot filter due to its relatively easier fabrication procedure. The filters are optimized based on their transmission capabilities by introducing a cavity underneath the grating structure in GMR filters (see figure 1), and between subsequent stacks of Fabry-Perot filters (see figure 2). Both filter types, terminated with conductive side-walls (see figure 3), are simulated in HFSS and tested for peak/sideband transmission, tunability and incidence angle dependence for varying lateral dimensions. These are then compared to their infinite size counterparts. This paper will outline the design process for finite-size SWIR filter structures and present a comparative analysis.

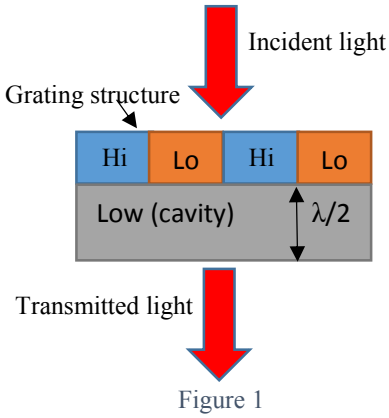

Figure 1

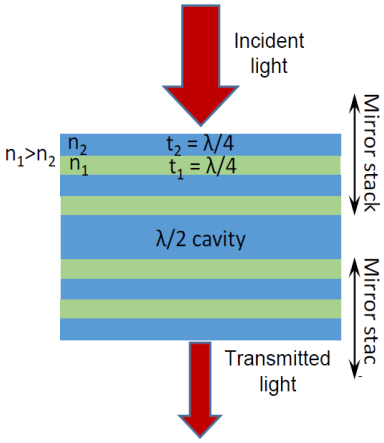

Figure 2

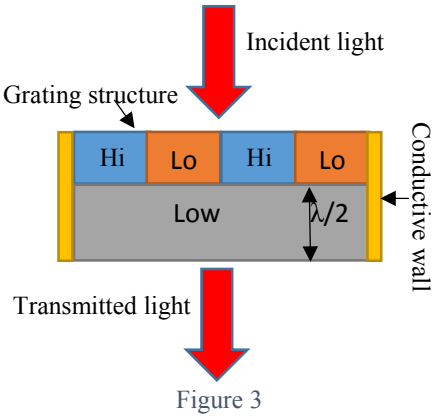

Figure 3

Figures: **(1)** Guided mode resonance transmission filter with High-Low refractive index materials. **(2)** Fabry-Perot filter with High-Low refractive index materials. **(3)** Finite GMR filter of size 5*Wavelength