Wide-band Infrared (IR) Absorber Design Based on Multi-sized Co-centric Circular Rings

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High absorption level and wide absorption band are the main characteristics of broadband absorbers. These characteristics are highly desired in various applications, such as thermal imaging, photovoltaics, solar cells and light harvesting. The proposed metamaterial (MTM) based absorber design possesses a wide absorption band over the midrange Infrared (IR) wavelength regime. The bandwidth has been extended by utilizing multiple sized resonant elements distributed within the unit cell. Those elements are designed to produce multiple resonances that are brought together in close proximity to form one continuous wideband. The resonant elements in the proposed absorber are composed of double co-centric rings (CDRs). Full-wave simulations were used to optimize the dimensions of four metallic CDRs contained in the single cell. Each CDRs resonator generates two resonances, therefore, total of eight adjacent resonances are carefully distributed over 3-5 μm band. This arrangement offers wide absorption characteristics with better than 60% of full width of half maximum (FWHM).

Moreover, an effective medium approximation model was extracted. The effective permeability was modeled by a Lorentz oscillator and the effective permittivity modeled by Drude-Lorentz oscillator. The model shows very good agreement with the numerically simulated results obtained by the full-wave simulations. Due to the highly symmetrical structure, this design is insensitive to the incident light polarization and it exhibits good absorption performance for a wide range of incident angles. In addition, the bandwidth is almost unaffected at higher incident angles. Consequently, the proposed design show excellent performance in terms of absorption level and bandwidth making it appealing for various applications.