

Effective optical responses above effective plasma frequency in metal-dielectric metamaterials

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Stratified metal-dielectric (MD) metamaterials show high-efficient transmission above effective plasma frequency ω_p . This is feature is described in view of effective refractive indexes, which are determined by two complex reflectivity method (TCRM) we have developed. TCRM analysis determines all the components of effective permittivity and permeability tensors.

The optical responses above effective ω_p are associated with effective refractive index n ($0 < \text{Re}(n) < 1$ and weak loss) in a visible range. Therefore, the phase velocity exceeds the speed of light in vacuum c . The electromagnetic distribution indicates that the wavelength is λ/n in the metamaterial. On the other hand, the group velocity is estimated to be less than c from the photonic band.

The MD metamaterials are thus characterized simply and concisely by the effective refractive index and turn out to be a new group of materials with the phase velocity larger than c . In noble metals, the ω_p are significantly affected by lossy interband transitions. Stratified MD metamaterials overcome the inevitable property in the metals.