EFFECTIVE OPTICAL PROPERTIES OF ABSORBING NANOCOMPOSITE THIN FILMS FOR TE AND TM POLARIZATION

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ABSTRACT. This paper investigates the possibility of tuning the optical properties of thin films by introducing nanopores with different film thickness, porosity, and pore size. The complex index of refraction of nanoporous thin films with isotropic morphology are determined for normally incident transverse magnetic (TM) and transverse electric (TE) electromagnetic waves. The transmittance and reflectance of nanoporous thin films are computed by solving the two-dimensional Maxwell's equations with the associated boundary conditions at all interfaces using finite element methods. The effective complex index of refraction of nanoporous thin films are computed by an inverse method. The numerical results are compared with predictions from widely used effective medium approximations. For thin films exposed to TM waves, good agreement is found between the retrieved optical properties and those predicted by the parallel model. This is in contrast with our previously reported results for TE waves where good agreement was found with the VAT model. These results can be used to guide the design of nanocomposite materials with tunable optical properties or to measure porosity.

NOMENCLATURE

A	dimensionless parameter, Eq. (7)	T	transmittance
B	dimensionless parameter, Eq. (7)	χ	size parameter
$\vec{E}$	electric field vector	δ	phase angle
$\vec{e}$	unit vector	ε	dielectric constant
$\vec{H}$	magnetic field vector	ϕ	porosity
i	index	μ	magnetic permeability
j	index	$\vec{\pi}$	Poynting vector
$\vec{n}$	normal vector	σ	electrical conductivity
N	number of wavelengths considered	τ	interface transmissivity
Q	efficiency factor	ψ	general property
R	reflectance	ζ	dimensionless parameter, Eq. (18)
r	interface reflectivity		

Subscript

0	refers to vacuum, or an incident wave	*eff*	refers to effective property