

1. TENSORIAL ASPECTS OF PHYSICAL PROPERTIES

$$\Delta\eta_6 = p_{66}S_6 \sin(\omega t - k\xi) = p_{44}S_6 \sin(\omega t - k\xi) \quad (1.6.7.14)$$

since all other components are zero. This means that the original spherical indicatrix of the cubic crystal has been distorted to form a biaxial indicatrix whose axes oscillate in length according to

$$\begin{aligned} n_1 &= n_{\text{cub}} + \frac{n_{\text{cub}}^3}{2} p_{44} S_6 \sin(\omega t - k\xi) \\ n_2 &= n_{\text{cub}} - \frac{n_{\text{cub}}^3}{2} p_{44} S_6 \sin(\omega t - k\xi) \\ n_3 &= n_{\text{cub}}, \end{aligned} \quad (1.6.7.15)$$

thus forming an optical grating of spatial periodicity given by the $k\xi$ term. In gallium arsenide, at a wavelength of light equal to 1.15 μm , $p_{11} = -0.165$, $p_{12} = -0.140$ and $p_{44} = -0.072$. It is convenient to define a figure of merit for acousto-optic materials (Yariv & Yeh, 1983) given by

$$M = \frac{n^6 p^2}{d v^3}, \quad (1.6.7.16)$$

where v is the velocity of the sound wave and d is the density of the solid. For gallium arsenide, $d = 5340 \text{ kg m}^{-3}$, and for a sound wave propagating as above $v = 5.15 \text{ m s}^{-1}$. At the wavelength $\lambda = 1.15 \mu\text{m}$, $n = 3.37$, and so it is found that $M = 104$. In practice, figures of merits can range from less than 0.001 up to as high as 4400 in the case of Te, and so the value for gallium arsenide makes it potentially useful as an acousto-optic material for infrared signals.

1.6.8. Glossary

α, β, γ	refractive indices of biaxial indicatrix, $\alpha < \beta < \gamma$
$\hat{\alpha}$	polarizability operator
B_i	i th component of magnetic induction
c	velocity of light
c_{klmn}	$klmn$ th component of elastic stiffness tensor
$\chi_{ijk\dots}$	$ijk\dots$ th component of generalized susceptibility
d	density
D_i	i th component of dielectric displacement
Δ	phase difference of light
\hat{e}_{ijm}	unit antisymmetric pseudotensor of rank 3
E_i	i th component of electric field
g_{ij}, G_{ij}	ij th component of gyration tensor
\mathbf{G}	gyration vector
$\gamma_{ij\ell}$	third-rank optical gyration susceptibility
\mathbf{H}	magnetic field intensity
η_{ij}	ij th component of dielectric impermeability tensor
ϵ_o	permittivity of free space
ϵ_{ij}	ij th component of dielectric tensor
κ	ellipticity of wave
\mathbf{k}	wavevector of light propagating in crystal ($ k = 2\pi/\lambda$)
λ	wavelength of light
μ_o	vacuum magnetic permeability
n	refractive index of light
$n_\alpha, n_\beta, n_\gamma$	refractive indices for biaxial indicatrix, $n_\alpha < n_\beta < n_\gamma$
n_o	ordinary refractive index
n_e	extraordinary refractive index
Ψ_i	wavefunction of state i
P_i	i th component of electric polarization
p_{ijkl}	$ijkl$ th component of elasto-optic (strain-optic) tensor
\hat{p}	electric dipole operator

ρ	optical rotatory power
$\pi_{ijk\ell}$	$ijk\ell$ th component of linear piezo-optic tensor
r_{ijk}	ijk th component of linear electro-optic tensor
\hat{s}	unit vector in the direction of s , the wave normal
S_{ij}	ij th component of strain tensor
T_{ij}	ij th component of stress tensor
v	velocity of sound
V	half the angle between optic axes
ω	cyclic frequency
x_i	direction of i th Cartesian axis, $i = 1, 2, 3$

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