2003 Vol.39 No.3 pp.349-358 DOI:

Pressure Effects on Spectra of Tunable Laser Crystal GSGG:Cr^{3+} II: Energy Spectra at Normal Pressure, Low and Room Temperatures

ZHANG Ji-Ping[1] and MA Dong-Ping[1,2]

[1] Department of Applied Physics, Sichuan University, Chengdu 610065, China
[2] International Centre for Materials Physics, the Chinese Academy of Sciences, Shenyang 110015, China
(Received: 2002-8-20; Revised:)

Abstract: With the strong-field scheme and trigonal bases, the complete d^3 energy matrix in a trigonally distorted cubic-field has been constructed. By diagonalizing this matrix, the normal-pressure energy spectra and wavefunctions of GSGG:Cr^{3+} at 70 K and 300 K have been calculated without the electron-phonon interaction (EPI), respectively. Further, the contributions to energy spectra from EPI at two temperatures have also been calculated, where temperature-independent terms of EPI are found to be dominant. The sum of aforementioned two parts gives rise to the total energy spectrum. The calculated results are in good agreement with all the optical-spectral experimental data and the experimental results of $g_{//}(R_1)$ and $g_{\perp}(R_1)$. It is found that the contribution from EPI to R_1 line of GSGG:Cr^{3+} with taking into account spin-orbit interaction (H_{so}) and trigonal field (V_{trig}) is much larger than the one with neglecting H_{so} and V_{trig}, and accordingly it is essential for the calculation of the EPI effect to take first into account H_{so} and V_{trig}. The admixture of base-wavefunctions, $|t_2^3\ ^2E\rangle$ and $|t_2^2(^3T_1)e\ ^4T_2\rangle$, the average energy separation $\Delta=\bar{E}[t_2^2(^3T_1)e^4T_2]-\bar{E}[t_2^3\ ^2E]$ and their variations with temperature have been calculated and discussed.

PACS: 71.70.Ch, 71.70.Ej, 63.20.Mt
Key words: crystal fields, optical properties, spin-orbital interaction, electron-phonon interaction, tunable laser crystal