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材料合成及性能

Ho^{3+}：$LiYF_4$晶体的中红外发光特性

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摘要： 用坩埚下降法制备了Ho^{3+}离子掺杂的$LiYF_4$单晶。测定了Ho^{3+}:$LiYF_4$晶体的偏振吸收光谱。应用Judd-Ofelt理论分别计算了Ho^{3+}:$LiYF_4$晶体中Ho^{3+}离子的有效强度参数$\Omega_{2,4,6}$、能级跃迁振子强度f_{exp}和f_{cal}、自发辐射跃迁几率A、荧光分支比β、辐射寿命τ_{rad}等光谱参数。测定了样品在640 nm光激发下的红外发射光谱,观测到由Ho^{3+}离子的$^5I_6\rightarrow{}^5I_7$跃迁所致的2.8~3 μm中红外发光,以及在1.2 μm ($^5I_6\rightarrow{}^5I_8$)和2.0 μm($^5I_7\rightarrow{}^5I_8$)处较强的荧光。Ho^{3+}:$LiYF_4$单晶样品的吸收峰线宽较宽,计算得到1.2 μm和2.0 μm的峰值发射截面分别达到0.20×10^{-20} cm^{2}和0.51×10^{-20} cm^2,同时测定了1 191 nm($^5I_6\rightarrow{}^5I_8$)和2 059 nm($^5I_7\rightarrow{}^5I_8$)发射的荧光寿命。研究结果表明:Ho^{3+}:$LiYF_4$晶体在2.0~3 μm波段的中红外激光器中有较大的应用前景。

关键词： 偏振吸收光谱 $LiYF_4$：Ho^{3+}晶体 中红外荧光 Jodd-Ofelt理论

Mid-infrared Emission Properties of Ho^{3+} Doped $LiYF_4$ Single Crystals

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Abstract: The Ho^{3+}-doped $LiYF_4$ single crystals were grown by Bridgman method. The axial and transverse absorption spectra of Ho^{3+} ions in $LiYF_4$ crystals were measured. The Judd-Ofelt theory was applied to calculate the J-O effective intensity parameters $\Omega_{2,4,6}$, spontaneous radiative transition rate, branching ratio, radiative lifetime of σ transition and π transition. IR emission spectra of Ho^{3+}:$LiYF_4$ single crystals were measured under 640 nm wavelength excitation, and the emission band around 2.9, 1.2 and 2.0 μm due to $^5I_6\rightarrow{}^5I_7$, $^5I_6\rightarrow{}^5I_8$, $^5I_7\rightarrow{}^5I_8$ transition were observed. Based on the absorption spectra, the maximum calculated emission cross section emission at 1.2 and 2.05 μm in $LiYF_4$:Ho^{3+} crystal are 0.20×10^{-20} and 0.51×10^{-20} cm^2, respectively. In the meantime, the emission lifetimes at 1 191 nm ($^5I_6\rightarrow{}^5I_8$) and 2 059 nm ($^5I_7\rightarrow{}^5I_8$) were determined to be 2.13 and 17.23 ms. The research results indicate that Ho^{3+}:$LiYF_4$ crystal is a good candidate for mid-infrared laser media.

Keywords: polarized absorption spectra Ho^{3+}：$LiYF_4$ single crystal mid-infrared luminescence Jodd-Ofelt theory

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