

$\text{Li}_6\text{Gd}(\text{BO}_3)_3:\text{Ce}$ 晶体的提拉法生长和闪烁性能

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摘要

采用提拉法和铂坩埚感应加热技术生长出最大尺寸为直径25mm, 长40mm的 $\text{Li}_6\text{Gd}(\text{BO}_3)_3:\text{Ce}$ 晶体. XRD分析表明, 生长出的晶体为单一的 $\text{Li}_6\text{Gd}(\text{BO}_3)_3:\text{Ce}$ 相, 结构属 $\text{P}2_1/c$ 空间群. 对晶体生长中存在的解理开裂、应力开裂及多晶问题进行了讨论, 并从晶体结构的角度解释了(020)完全解理面出现的原因. 晶体在380~800nm之间的透过率接近90%, 200~380nm之间的吸收是由 Ce^{3+} 离子的4f-5d跃迁和 Gd^{3+} 离子的4f-4f跃迁引起的. 不同激发源激发下的发射均显示 Ce^{3+} 离子的双谱峰特征; 相比于紫外激发下的发射而言, X射线激发下的发射光谱略有红移. 该晶体发光符合单指数衰减模型, 衰减时间为30.74ns在 ^{241}Am 源的 α 射线激发下晶体的能量分辨率为28.84%.

关键词 [硼酸钪锂](#) [晶体生长](#) [光学透过](#) [闪烁性能](#)

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Czochralski Growth and Scintillation Properties of Cerium-doped $\text{Li}_6\text{Gd}(\text{BO}_3)_3$ Crystals

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Abstract

Cerium-doped lithium gadolinium borate ($\text{Li}_6\text{Gd}(\text{BO}_3)_3:\text{Ce}$) single crystals up to 25mm in diameter and 40mm in length were grown by the Czochralski method using inductively heated platinum crucibles. The as-grown $\text{Li}_6\text{Gd}(\text{BO}_3)_3:\text{Ce}$ crystals are of single-phase and they belong to the monoclinic system with space group of $\text{P}2_1/c$. Problems existing in crystal growth such as cleavage crack, stress crack and polycrystalline were discussed. The appearance of the perfect cleavage plane (020) was explained by considering the structure of $\text{Li}_6\text{Gd}(\text{BO}_3)_3$. The results show that optical transmittance in the range of 380~800nm is near 90%. The absorption from 200nm to 380nm can be related to 4f-5d transitions of Ce^{3+} ions and 4f-4f transitions of Gd^{3+} ions. Both the mission under the optical excitation and the emission under X-ray excitation display the typical double-peaks characteristic of Ce^{3+} ions. Compared with the emission under the optical excitation, the emission under X-ray excitation shows a slight 'red shift'. Decay time spectrum from $\text{Li}_6\text{Gd}(\text{BO}_3)_3:\text{Ce}$ can be well fitted with a decay time of 30.74ns. The energy resolution under the excitation of α -ray from ^{241}Am measured is 28.84%.

Key words [lithium gadolinium borate](#) [crystal growth](#) [optical transmittance](#) [scintillation properties](#)

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