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Optimized crystal growth and luminescence properties of Ce^{3+} ions doped $Li_6Gd(BO_3)_3$, $Li_6Y(BO_3)_3$ and their mixed crystals

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Abstract:

Ce^{3+} ions doped $Li_6Gd(BO_3)_3$ crystal is a promising low density scintillators for thermal neutron detection. The Czochralski growth of LGBO crystal have been optimized and single crystals with larger sizes have been grown with different techniques. LGBO crystal bowl with diameter larger than 43 mm were grown with Iridium ring increasing the radial temperature gradient and after-heater decreasing the upside axial temperature gradient. Meanwhile LGBO crystal disk with diameter larger than 50 mm were also grown with very low pulling rate and radial temperature gradient. To investigate the overall performance of LGBO series of crystal, $Li_6Y(BO_3)_3$ crystal and its mixed crystals with $Li_6Gd(BO_3)_3$ have also been grown using Czochralski method. The thermal expansion coefficients of LGBO and LYBO crystals were investigated using the high temperature XRD patterns, respectively. The big difference between melting and freezing point meant that the metastable phases have formed during cooling cycle for the Ostwald's rule. The optical transmission spectra, x-ray stimulated, photoluminescence and thermal stimulated luminescence spectra were also investigated, respectively. And $Li_6Gd_{0.1}Y_{0.9}(BO_3)_3$:Ce crystal may be the most promising crystals for thermal neutron detection for the best light output by α particles and the highest light output ratio α/ γ of 0.16.

Keywords: crystal growth; thermal properties; scintillator; neutron detection

1. Introduction

Inorganic scintillation crystals have been widely used in the detection of X- and γ- ray radiation in the field of high energy physics, medical imaging and homeland security [1]. For neutrons detection, it is more complex because the neutron is a kind of particle carrying no charge and can't generate scintillation light directly. So to detect neutrons, the scintillation crystals should