Radiation Effects & Defects in Solids
Vol. 167, No. 12, December 2012, 921–928

Taylor & Francis
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The effect of Pb^{2+} dopant in the crystal of CsI and its application as scintillation detector: a study of alpha particles

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(*Received 30 March 2012; final version received 14 August 2012*)

Scintillation crystals have been used in various fields, such as high energy physics, nuclear instrumentation, radiation measurements, medical imaging, nuclear tomography, astrophysics and other fields of science and engineering. For these applications, the development of scintillation crystals with good performance is required. Scintillation crystals based on cesium iodide (CsI) matrix are matters with relatively low hygroscopicity, easy to handle and of low cost, characteristics that favor their use as radiation detectors. In this study, pure CsI crystal and lead doped CsI crystals were grown using the Bridgman vertical technique. The concentration of the lead doping element (Pb) was studied in the range of 10^{-2} to 5×10^{-4} M. The distribution of the doping element in the crystalline volume was determined by atomic absorption technique. The CsI:Pb crystal with nominal concentration of 10^{-3} M was cut into 14 slices of 6 mm. The results show a higher concentration at the top of the crystal with a decrease in the initial phase of growth. The dopant concentration of Pb showed good uniformity from the slice 2 to the slice 12: the region is, therefore, suitable for use as a radiation detector. The luminescence emission of these crystals was measured. A predominant luminescence band near 450 nm and a single broad band around 320 nm were found with the addition of the Pb^{2+} ions in the CsI matrix. Alpha particles spectrometry measurements were carried out to evaluate the developed scintillators. The resolution of 5.6% was obtained for the CsI:Pb 5×10^{-4} M crystal, when excited with alpha particles from a ^{241}Am source, with energy of 5.54 MeV.

Keywords: radiation detectors; alpha particles; crystals growth; Bridgman technique; CsI:Pb

1. Introduction

Scintillators based on cesium iodide (CsI) are the leading ones now, among the materials available for solid-state detectors. The progress in high energy physics and nuclear physics has stimulated the science of scintillation materials in two directions: (1) the search and development of new materials for scintillators and (2) improvement in scintillators based on alkali halides already existing. The scintillators grown on the basis of alkali iodides, such as CsI, find wide applications in the areas of high energy physics, nuclear physics, medicine, industry, security, environmental control devices, geology, astrophysics and other fields of science and engineering. The crystals

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ISSN 1042-0150 print/ISSN 1029-4953 online

http://dx.doi.org/10.1080/10420150.2012.723002
http://www.tandfonline.com