LaAlO$_3$·Pr$^{3+}$ powder TL response for electron beam

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Abstract

Review of the thermoluminescent (TL) characteristics of praseodymium doped lanthanum aluminate exited by high-energy electron beams are reported. LaAlO$_3$·Pr$^{3+}$ powders samples were prepared using modified Pechini’s method. The formations of the obtained samples were confirmed by x-ray diffraction patterns. TL glow curve and dosimetric characteristics of LaAlO$_3$·Pr$^{3+}$ powder samples were investigated under electron beam irradiation effects. All TL measurements were made using a Harshaw TL reader 3500. TL glow curves were obtained using a constant heating rate 10 °C/s from 100°C temperature up to 400°C in a nitrogen atmosphere. Powders were irradiated using a linear accelerator, model Clinac IX. Dosimetry characteristics of the samples were found to be weakly dependent on the electron beam energy. The effect of electron beam dose rate was reported. Experimental results of TL dosimetric characteristics of the powder samples appear to have potential application for electron dose measurements. The technique is low cost, faster and produces well very homogeneous particles TL materials that can be used for electron checking.

Introduction

Phosphors materials have been the object of study for their synthesis, due to the thermoluminescent properties that they present, working groups analyze the possible applications that these may have in the field of radiation measurement [3]. LaAlO$_3$ is a class of materials whose cubic crystalline structure follows the general formula ABO$_3$. The main applications of LaAlO$_3$ are mainly related to their mechanical and electrical properties [4, 5]. TL properties of LaAlO$_3$ applied to radiation dosimetry have been recently studied [1, 8]. Meanwhile, other studies focused on thermoluminescent characteristics of RE doped LaAlO$_3$ powders under ultraviolet radiation effect have been reported [2, 6, 7]. But in the literature LaAlO$_3$·Pr$^{3+}$ has not been observed as ionizing radiation dosimetry. Therefore, it is anticipated that synthesized LaAlO$_3$·Pr$^{3+}$ can be used for ionizing radiation dosimetry purposes by means of thermoluminescence method. In the present work, lanthanum aluminate powders doped with trivalent praseodymium ion were prepared by modified Pechini’s method and the samples were irradiated by high energy electron beams and subsequently subjected to the TL measurement for its application as electron radiation dosimeter.

Results

Thermoluminescent properties of LaAlO$_3$ powder doped with Pr$^{3+}$ ions have been investigated for high energy electron beams dosimetry. Samples of LaAlO$_3$·Pr$^{3+}$ phosphor shows good TL properties. TL signal of LaAlO$_3$·Pr as a function of high energy electron dose show a TL glow curve with two peaks centered at 205±5 °C and 315±7 °C respectively. The nature of the glow curve form in samples is attributed to at least two types of traps. Then, after experimental results LaAlO$_3$·Pr$^{3+}$ can be used as thermoluminescent material for high energy electron beam measurements. Considering, the purpose of developing materials that is TL dosimetry of ionizing radiation, the LaAlO$_3$·Pr$^{3+}$ is useful in determining this type of radiation in the range studied (4MeV – 18MeV) that have a lineal response for 200 Gy. Finally, we conclude LaAlO$_3$·Pr$^{3+}$ powders with prominent TL characteristics can be used as good candidate as high energy electron beams measurements applications and it is also good candidate to be used as QC meter in 4 MeV to 18 MeV LINACs.

Conclusion

Thermoluminescent properties of LaAlO$_3$ powder doped with Pr$^{3+}$ ions have been investigated for high energy electron beams dosimetry. Samples of LaAlO$_3$·Pr$^{3+}$ phosphor shows good TL properties. TL signal of LaAlO$_3$·Pr as a function of high energy electron dose show a TL glow curve with two peaks centered at 205±5 °C and 315±7 °C respectively. The nature of the glow curve form in samples is attributed to at least two types of traps. Then, after experimental results LaAlO$_3$·Pr$^{3+}$ can be used as thermoluminescent material for high energy electron beam measurements. Considering, the purpose of developing materials that is TL dosimetry of ionizing radiation, the LaAlO$_3$·Pr$^{3+}$ is useful in determining this type of radiation in the range studied (4MeV – 18MeV) that have a lineal response for 200 Gy. Finally, we conclude LaAlO$_3$·Pr$^{3+}$ powders with prominent TL characteristics can be used as good candidate as high energy electron beams measurements applications and it is also good candidate to be used as QC meter in 4 MeV to 18 MeV LINACs.

References