Instituto Politécnico Nacional

Centro de Investigación en Ciencia Aplicada y Tecnología Avanzada

$LaAlO_3:Pr^{3+}$ powder TL response for electron beam

A A Barrera-Angeles [1*], D Barrera-Hernández[1], M A Ugalde-Valdés[1], D Nolasco-Altamirano[1], J G Gutiérrez-Márquez[2], A Morales-Hernández[3] and T Rivera-Montalvo[1]

1 CICATA-Legaria del IPN, 694 Av. Legaria, 11500, Ciudad de México, México
2 CMN-Siglo XXI, 330 Av. Cuauhtémoc, 06720, Ciudad de México, México
3 Tecnológico Nacional de México/ITM/DEPI, 1500 Av. Tecnológico, 58120, Michoacán, México

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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 Pechinis´s method. The formations of the obtained samples were confirmed by an 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

Phosphorous materials have been the object of study for their synthesis, due to the thermolumniscent properties that they present, working groups analyze the possible applications that these may have in the field of radiation measurement [3]. $LaAlO_3$ crystalline is a class of materials whose cubic crystalline structure follows the general formula ABO_3. The main applications of $LaAlO_3$ crystalline are mostly 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 aluminates 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

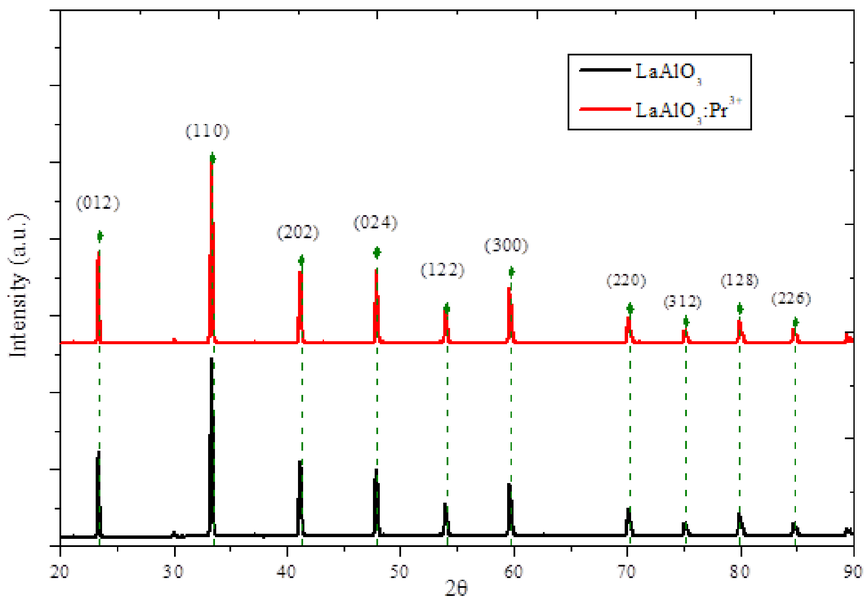

Figure 1. Sow the X-ray diffraction patterns of LaAlO3:RE calcined at 1600 °C.

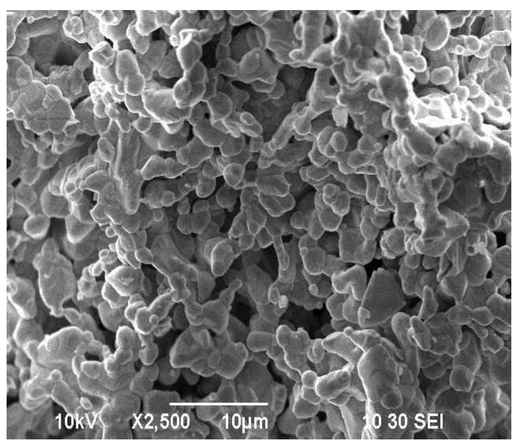

Figure 2. Micrographs of powders obtained by modified pechini´s method at 1600 °C, La0.98Pr0.02AlO3

TL response

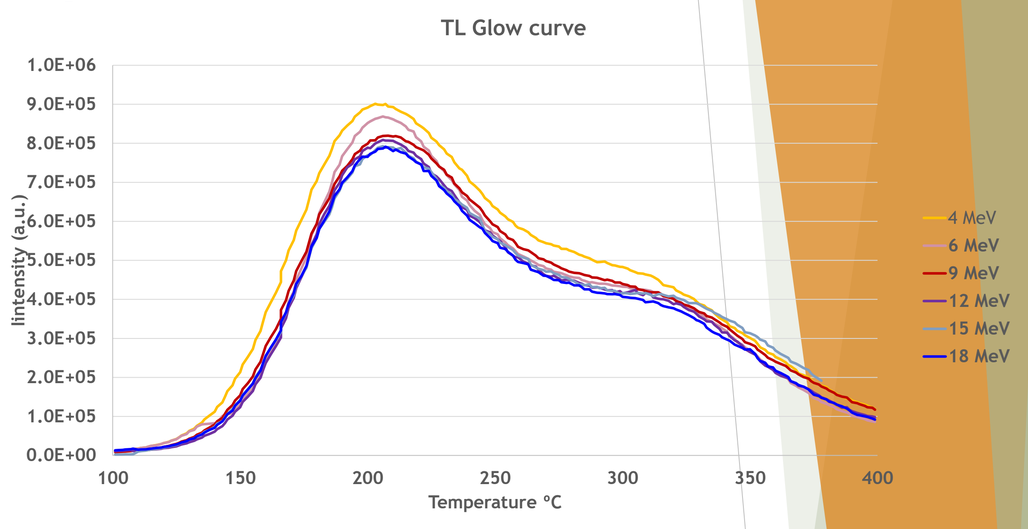

Figure 3. Tl glow curve 200cgy for high electron beam in the range of 4 MeV to 18 MeV.

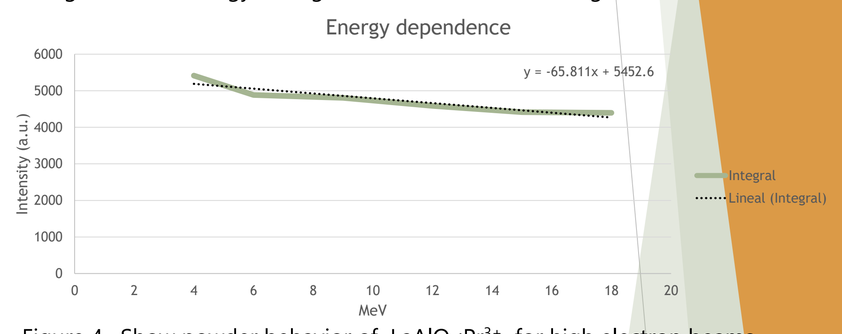

Figure 4. Show powder behavior of $LaAlO_3:Pr^{3+}$ for high electron beams.

Conclusion

Thermoluminescent properties of LaAlO3 powders doped with Pr3+ 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 cGy. 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.

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