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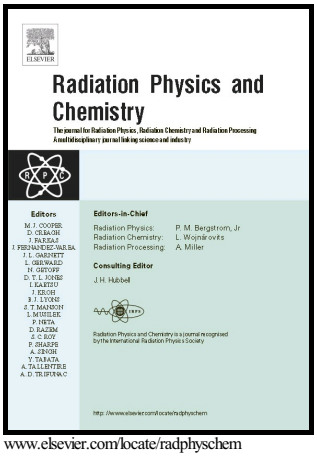

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# Heating Rate Properties and Kinetic Parameters of Thermoluminescence Glow Curves of La-doped Zinc Borate

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**Abstract**

The aim of this study is to evaluate the effect of different heating rates (HRs) on low and high temperature thermoluminescence (TL) glow-peaks, reusability properties, and the kinetic parameters (activation energy (*E*), frequency factor (*s*) and order of kinetics (*b*)) of 1, 4 and 10% La-doped $ZnB_2O_4$ phosphors. All La-doped $ZnB_2O_4$ phosphors have two characteristic TL peaks at around 80–85°C and 150–160°C. The experimental results show that the TL glow-peak temperatures ($T_M$) shift to higher temperatures for all doped materials as the HRs increase because of the temperature lag effect. The maximum peak intensity ($I_M$) decreases for the first peak of 1% doped, remains roughly constant for second peak of 1% and both peaks of 4% doped, and increases for both peaks of 10% La-doped $ZnB_2O_4$ samples as the HRs increases. Differences between the intensities of various amounts of La-doped phosphors were explained with anomalous HR phenomenon except the first peak of 1% La-doped $ZnB_2O_4$ which was clarified by thermal quenching effect. In this study, the temperature dependence of the recombination rate of released carriers during the heating process by increasing the doping concentration of La might explain the peaks of the glow curves, which shows an unexpected behavior with the increasing HR values. In addition, the calculated *E* values of all doped phosphors were found similar in the range of 0.62 – 1.03 eV for 1%, 0.65 – 1.15 eV for 4%, and 0.69 – 1.01 eV for 10% La-doped phosphors. However, *s* values were found slightly different related to the dopant amount. Furthermore, different dopant amounts indicate the similar and reasonable properties for the repeated cycles of 5 Gy with the same readout conditions.

*Keywords:* Thermoluminescence, anomalous heating rate, $ZnB_2O_4$:La, reusability, activation energy



## 1. Introduction

Thermoluminescence (TL) is a method used for dosimetry of ionizing radiations as the energy absorbed by the crystalline materials on being exposed to ionizing radiation can be easily detected as light on stimulating it with heat. TL provides convenient information about the charges trapped and energy transfer processes in a crystalline lattice resulting in light emission (Chen and McKeever, 1997; Daniel et al., 2014).