Journal of Luminescence 271 (2024) 120587

Contents lists available at ScienceDirect

Journal of Luminescence

journal homepage: www.elsevier.com/locate/jlumin

Full Length Article

Effect of helium ion and gamma irradiation on the TL and OSL properties of Tb-doped LiF nanophosphors

Debashish Sen [a,b,**], Shaila Bahl [a], Pooja Seth [c], Birendra Singh [a], A. Pandey [d], Mohammad Zulfequar [b,***], Asokan Kandasami [a,e,*]

[a] Inter University Accelerator Centre, Aruna Asaf Ali Marg, New Delhi, 110067, India
[b] Department of Physics, Jamia Millia Islamia, Jamia Nagar, New Delhi, 110025, India
[c] University School of Basic and Applied Sciences, Guru Gobind Singh Indraprastha University, New Delhi, India
[d] Department of Physics, Sri Venkateswara College, University of Delhi, Benito Juarez Road, Dhaula Kuan, New Delhi, 110021, India
[e] Department of Physics & Centre for Interdisciplinary Research, University of Petroleum and Energy Studies (UPES) Dehradun, Uttarakhand, 248007 India

ARTICLE INFO

Keywords:
Dosimetry
Gamma radiation
Ion irradiation
Nanophosphors
Thermoluminescence
Optically stimulated luminescence

ABSTRACT

Lithium Fluoride (LiF) stands out as a extensively researched material in Thermally Stimulated Luminescence Dosimetry (TLD). This study specifically delves into nanocrystalline Tb-doped LiF TL dosimeters, synthesized through the co-precipitation method, and evaluates their efficacy under He ion and gamma rays radiation. Morphological examination via transmission electron microscopy has revealed cubic-shaped particles. These particles were subjected to irradiation by 120 keV He ion beams ranging from 10^{14} to 10^{16} ions/cm^2 and gamma rays ranging from 10 to 1000 Gy, facilitating a comprehensive comparative analysis. Deconvolution of the glow curves enabled the extraction of trapping parameters. Under gamma irradiation, the nanophosphor exhibited a distinctive, intense single TL glow peak centered at 400 K with a minor hump at 512 K, diminishing with increasing doses. Conversely, under He ion irradiation, the nanophosphor displayed a peak at 492 K, accompanied by a slight shoulder around 600 K. Additionally, gamma doses displayed a highly promising response to Optically Stimulated Luminescence (OSL). Fading studies further underscore its suitability for radiation dosimetry applications. The unique characteristics of the TL glow curve, dose-response behaviours, and OSL responses highlight the versatility and effectiveness of these nanophosphors in radiation dosimetry, making significant contributions to advancements in this field.

1. Introduction

Accurate measurement and monitoring of radiation exposure are critical for ensuring individual safety, precise medical treatments, and quality control in industrial processes. Achieving this goal requires the development and application of sophisticated dosimetry techniques, with Thermoluminescent Dosimetry (TLD) standing out as a pivotal method. TLD serves as a powerful and versatile tool in the field of radiation research and dosimetry, operating on the principle that certain materials, when exposed to ionizing radiation, temporarily store energy. Upon controlled heating, these materials release the stored energy as visible light, a phenomenon known as Thermoluminescence (TL). The intensity of this emitted light is directly proportional to the amount of radiation absorbed by the material, making TLD an invaluable means to accurately quantify radiation doses.

The historical application of TLD spans several decades, particularly in measuring doses from conventional radiation beams [1–5]. However, recent times have witnessed a steadily increasing demand for dosimetry of charged particle beams [6–10]. This surge in interest is primarily motivated by the crucial role TLD plays in cancer diagnosis and therapy [11,12]. Despite the availability of various commercial TLDs to users and researchers, the scientific community remains actively involved in refining their properties and enhancing the characteristics of TL. These dedicated efforts focus on tailoring TLDs to meet the precise demands of

* Corresponding author. Inter University Accelerator Centre, Aruna Asaf Ali Marg, New Delhi, 110067, India.
** Corresponding author. Department of Physics, Jamia Millia Islamia, Jamia Nagar, New Delhi, 110025, India.
*** Corresponding author. Department of Physics & Centre for Interdisciplinary Research, University of Petroleum and Energy Studies (UPES) Dehradun, Uttarakhand, 248007 India.
E-mail addresses: deb.june8@gmail.com (D. Sen), mzulfequar@jmi.ac.in (M. Zulfequar), asokaniuac@gmail.com (A. Kandasami).

https://doi.org/10.1016/j.jlumin.2024.120587
Received 30 December 2023; Received in revised form 19 March 2024; Accepted 23 March 2024
Available online 2 April 2024