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Research Article

Sample Preparation, Characterization, & Thermoluminescence Analysis of Plotted Glow Curves of Europium Activated Synthesized Phosphor Via Conventional Solid-State Reaction Technique

Shashank Sharma[1*], Sanjay Kumar Dubey[2]

[1]Dept. of Physics, Govt. Gramya Bharti Mahavidyalaya, Hardibazar, Korba (C.G.), India
[2]Dept. of Physics, Dr. Radha Bai, Govt. Navin Girls College, Mathpara, Raipur (C.G.), India

**Corresponding Author: shashanksharma1729@gmail.com*

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Abstract— In this section, we have examined the thermal characteristics of Eu^{2+}-activated $Ba_2MgSi_2O_7$ phosphor sample at 5 mol% concentrations employing a traditional solid-state reaction approach with highly elevated temperature under a weak degrading environment. Entire chemical reaction process was conducted for three hours at a constant furnace temperature of 1100^0C. To ensure that confirm the distinctive features of the presented thermoluminescence (TL) glow curve, it was further examined using a Nucleonix (Hyderabad, India) Pc based TLD Reader (TL 1009I). The synthesized phosphor sample's TL glow curve revealed an appearance of a single, broad peak at 102.21°C. We are able to investigate from the plotted TL glow curve that the TL intensity has become optimal at15 minutes of ultraviolet (UV) light radiation time. Trapping/kinetic parameters of trap centers with the objective to figuring out the following order of kinetics [b], activation energy [E], & frequency factor [s] have been calculated by applying Chen's empirical formula. The activation energy [E] of trap depths have been determined to be 0.55 to 0.68 eV. In accordance with this, the frequency factor (s) was estimated within the following range to be 6.2×10^7 to $9.8 \times 10^7 s^{-1}$. In conclusion, the present research investigation has described into detail about the thermal characteristics of the synthesized $Ba_2MgSi_2O_7$: Eu^{2+} phosphor. The synthesized phosphor shows the potential application for long-term persistence as a good TL phosphor.

Keywords— $Ba_2MgSi_2O_7$: Eu^{2+}, Phosphor, Solid-state Reaction, Thermoluminescence (TL), Trap Centers, Trapping/Kinetic Parameters, Chen's Empirical Formula, Long-term Persistence etc.

1. Introduction

Material science is a multidisciplinary field that explores the properties, characterization, and processing of materials. It involves understanding the relationship between the structure, properties, and performance of materials and how they can be enhanced for various applications. Material scientists study the composition, micro and nanostructure, and behaviour of materials, from metals and alloys to ceramics, polymers, and composites. They apply basic principles from physics, chemistry, and engineering to develop new materials with improved properties, such as strength, long-term stability, conductivity, and responsiveness. Material science plays a very crucial role in advancing technology, manufacturing, energy, healthcare, bioimaging, and many other essential fields. In the field of material science, thermoluminescence is utilized as a unique technique to study the properties and behaviour of material. Additionally, thermoluminescence (TL) can provide valuable insights into the defects and impurities exist in materials. By studying the characteristics of the emitted light, researchers can gain information about the crystal structure, impurity concentration, and energy levels within the materials. This knowledge aids in understanding the key properties, stability, enhanced efficiency, color tunability, and performance of various materials widely utilized in fields such as electronics, optoelectronics, materials science & engineering, as well as radiation dosimetry. Overall, the relationship between the interdisciplinary nature of thermoluminescence and material science allows researchers to explore and innovate in the development of advanced materials for diverse applications of this phenomenon as a tool for dating, characterizing, and better understanding the behaviour of materials, ultimately leading to technological advancements and improved functionalities. A natural phenomenon referred to as thermoluminescence (TL) takes place when heated materials or chemical substances that have been bombarded with ionizing radiation begin releasing visible light. The capability of thermoluminescence materials to accurately measure the

entire amount of ionizing radiation they have been exposed to makes them advantageous for radiation dosimetry applications. Alkali halides that consist of potassium bromide (KBr) and sodium iodide (NaI), as well as feldspars like potassium feldspar ($KAlSi_3O_8$) and plagioclase feldspar ($NaAlSi_3O_8$-$CaAl_2Si_2O_8$), quartz (SiO_2), and aluminium oxide (Al_2O_3), lithium fluoride (LiF), and calcium fluoride (CaF_2) are frequently used instances of highly efficient TL materials, which have also been widely used as thermoluminescent (TL) applications. The survey of recent literature also reveals that the different silicate materials have been widely investigated for their thermoluminescent properties for long persistent behaviour in the last few years.

Silicate materials possess significance for the reason that they are capable of being employed as TL materials, consisting of some glasses or ceramics. Considering the alkaline earth silicates that might be employed for the production of luminescent materials, they have attracted plenty of research attention [1,2]. Comparing the most recent silicate-based phosphors to earlier invented aluminate and sulfide materials, an enormous amount of interest has been drawn towards them owing to their numerous benefits, which include extremely high temperatures, chemical stability, heat stability, being less expensive, outstanding water resistance, a variety of colors [3,24], outstanding brightness, prolonged lifespan, excellent photo resistance, and preservation of the environment [4]. The host ($Ba_2MgSi_2O_7$) crystal structure is a monoclinic formation in a single phase with a space group of C2/c [5]. Additionally, the layered structure of the host ($Ba_2MgSi_2O_7$) appears to be one dimensional, or 1D. Eight oxide ions of SiO_4 and MgO_4 units are therefore coupled with the Ba^{2+} site [6]. Materials falling under the extensive group of silicate materials are primarily composed of silicon and oxygen atoms. In addition to their extended phosphorescence persistence, radiation resistance, and exceptionally high quantum yield in the range of visible light, the lanthanide-doped alkaline earth silicates (i.e., Eu, Dy, Ce, Tb, Er, Nd, and Mn) constitute a significant family of phosphorescence materials [7]. It is generally agreed that lots of phosphors have been studied regarding their optical transitions of dopant europium ions. The electric dipole transitions with parity allowed [$4f^6 5d^1 \rightarrow 4f^7$], which produce the spectra of Eu^{2+}-activated compounds, take place at an extremely high probability of transition [8] in an array of color emission bands coming from the ultraviolet region, based on the host crystalline structure in pursuit of coordination number, lattice site size, as well as its lattice site symmetry [9]. Eu^{2+} ions acted as traps for electrons ($Eu^{2+} + e^- \rightarrow Eu^+$), corresponding to a "hole transfer model" proposed by Matsuzawa et al. [10]. Eu^{2+} frequently serves as a luminescent centre. The $Ba_2MgSi_2O_7$ phosphor may serve as an outstanding host material because there is less chance for the energy that stimulates to be captured via the killer centre [11].

During the past five years, several reports have been presented regarding the thermoluminescent characteristics of different rare earth-doped $Ba_2MgSi_2O_7$ phosphor obtained through a highly elevated temperature traditional solid-state reaction approach. The present investigation focuses on the preparation of Eu^{2+}-activated $Ba_2MgSi_2O_7$ phosphor employing a highly elevated temperature traditional solid-state reaction approach at weak reducing environment using burning charcoal with a dopant concentration ratio of 5 mole% of europium ions. The persistency of the developed phosphor has been estimated through measurement of the thermoluminescence (TL) light curve with trapping requirements. The TL glow curve of synthesized phosphor revealed the appearance of a single, broad peak at 102.21°C temperature. Applying Chen's empirical formula, the trapping or kinetic parameters of the trap centers have been well determined.

2. Experiment Section

2.1 Solid-State Reaction Method

The development of silicate bio-ceramics, particularly akermanite [$M_2MgSi_2O_7$ (i.e., M= Ba, Ca, Sr)] structures, requires the vital implementation of a variety of traditional approaches in the advancement of material science and technology. These procedures consist of the combustion synthesis approach, the sol–gel procedure, the coprecipitation technique, and the spray pyrolysis technique. Each of these techniques, nevertheless, are appropriate for producing bioceramic structures. In general, traditional solid-state chemical reaction procedures, which necessitate extremely high temperature heat treatment, are the most suitable synthesis methods for the development of luminescent materials [specifically silicates] to more effectively employ. Although chemical compositions are built layer by layer in nanomaterials and their high temperature treatment performs a critical role in their production [12]. This process involves heating the reactants in order to begin nature of the chemical reaction shortly after they have been homogenized or crushed together solidly. The heat provides the required energy for the process of reaction that takes place, which leads to the production of the desired products. As a result, this procedure is frequently utilized in order to synthesize phosphor of numerous types, including ceramics, minerals, intermetallic compounds, and other solid-state materials. Numerous benefits are available with it, including ease of use, non-toxicity, environmental friendliness, a superior rate of response, excellent particle size and shape morphology, cost-effectiveness, and the possibility of manufacturing in large quantities.

2.2 Powder Sample Synthesis Process

The powder sample of Eu^{2+}-activated $Ba_2MgSi_2O_7$ was well fascinated with the help of the solid-state reaction approach, which is shown in Figure 1. The initiating raw reagents with analytical reagent (AR) grade with (99.99%) purity, such as: $BaCO_3$, MgO, SiO_2, and rare-earth oxide Eu_2O_3, and exceptionally minimal amount of H_3BO_3 (AR) like flux, were also utilized in this present research investigation. Eu_2O_3 can be used as a doping agent in several situations. The raw ingredients were combined in an agate mortar for about two hours, weighted stoichiometrically, and then sintered for three hours at 1100^0C within a weak degrading environment. This was generated through burning charcoal. In a weak reducing environment, entire Eu^{3+} ions had been transformed to Eu^{2+} ions in matrix.

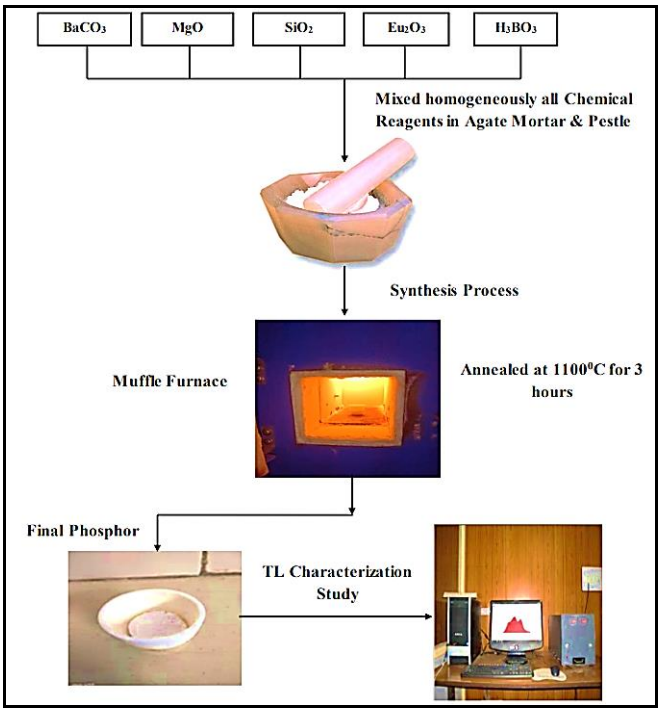

Figure 1. Sample Synthesis Process Via Solid-state Reaction Approach

The raw reagents chemical reaction process as follows:

$$2BaCO_3 + MgO + 2SiO_2 \rightarrow Ba_2MgSi_2O_7 + 2CO_2 (\uparrow) + O_2 (\uparrow) \quad (1)$$

$$2BaCO_3 + MgO + 2SiO_2 + Eu_2O_3 + H_3BO_3 \rightarrow Ba_2MgSi_2O_7: Eu + 2CO_2 (\uparrow) + O_2 (\uparrow) \quad (2)$$

2.3 Powder Sample Characterization Study

To ensure that confirm the distinctive features of the presented thermoluminescence (TL) glow curve of the resultant powder sample, which was irradiated with ultraviolet (UV) light source. It was explained further employing the Nucleonix (Hyderabad, India) Pc based TLD Reader (TL 1009I). All experiments, measurements, and plotting of TL glow peak curves were carried out at room temperature in identical conditions.

2.4 Significant Role of the Flux's

Any type of nano-and microphosphor's crystalline structure formation is significantly influenced by fluxes. Such fluxes accelerate the mechanism that occurs when a product's crystalline structure forms. As a result, the initial chemicals and fluxes have a complete influence on the shape and dimensions of the particles. Phosphors with actual chemical compositions are consequently synthesized. In order to improve the formation of crystal structures, certain particular fluxes, which mean boric acid (H_3BO_3), lithium fluoride (LiF), calcium chloride ($CaCl_2$), and potassium chloride (KCl) are mixed together [13].

3. Results and Discussion

In addition to the two ions' varying electro-negativity, which leads to the $Ba_2MgSi_2O_7$ host crystal lattice deformation, dopant [Eu^{2+}] ions exit the lattice and substitute Ba^{2+} ions, occupying Ba^{2+} lattice positions and creating traps in the corresponding host lattice phosphor. Given the fact that Ba^{2+} ions have eight coordination numbers, Mg^{2+} ions have four, and Si^{4+} ions have four, it appears evident that the dopant [Eu^{2+}] ions are expected to take the place of Ba^{2+} locations [14]. Dopant [Eu^{2+}] ions acquired the position of Ba^{2+} ions in their original location, and with Ba^{2+} ion is now situated somewhere else. Dopant [Eu^{2+}] ions are anticipated to acquire Ba^{2+} ions within the $Ba_2MgSi_2O_7$ host crystal lattice site for the reason of their nearly identical ionic radii of 1.25 Å and 1.12 Å, accordingly. Since the ionic radius of Si^{4+} ions (0.40 Å) and Mg^{2+} ions (0.72 Å) is considerably shorter compared to the radius of Dopant [Eu^{2+}] ions. It is very clear that dopant [Eu^{2+}] ions cannot substitute for Mg^{2+} & Si^{4+} ions [15]. In accordance with this, we may conclude that the octahedral [BaO_8] lattice readily provides dopant [Eu^{2+}] ions, but the tetrahedral [MgO_4] or [SiO_4] lattice makes it hard to get them all to incorporate together.

The transition that occurs between the $4f^7$ (ground state) to $4f^65d^1$ (excited state) of dopant [Eu^{2+}] ions is highly responsible for the spectrum of excitation in the region of ultraviolet radiation. The distinctive characteristics of the $4f^65d^1$ (excited state) → $4f^7$ (ground state) transition of Dopant [Eu^{2+}] ions, an authorized electric dipole transition, may be attributed to the spectrum of emission [8,15]. Figure 2. depicts the schematic representation of the energy levels dopant [Eu^{2+}] ions.

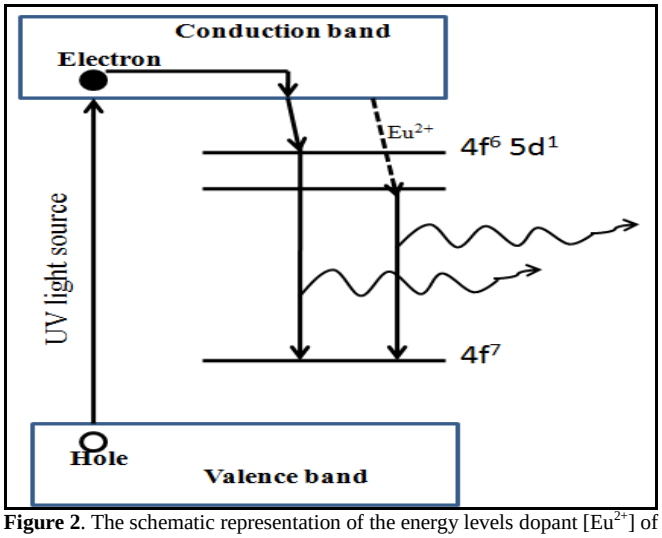

Figure 2. The schematic representation of the energy levels dopant [Eu^{2+}] of ions

3.1 Analysis of Thermoluminescence (TL) Spectra

Long afterglow characteristics, also referred to as persistence luminescence, can be observed by TL-based phosphors. They may be used for emergency advertisements, biological imaging, and illumination on dark roadways, among several other applications. Innovative novel TL materials are in tremendous demand in the current era, which is why their advantages are being continually explored by a variety of research areas, including radiation dosimetry measurements, physical science, and cancer therapy, chemotherapy, extraction of minerals, as well as archaeological dating [16].

When a solid substance becomes heated while being exposed to radiation, thermal luminescence (TL) discharges through the material, which can be an inorganic, semiconductor, or insulator [17].

The TL spectra of the Eu^{2+}-activated $Ba_2MgSi_2O_7$ phosphor are displayed in Figure 3., within a range of ultraviolet (UV) exposure times, including five, ten, fifteen, twenty, twenty-five, and thirty minutes, respectively. It seems evident that the amount of thermoluminescence signals expands as the time spent under ultraviolet light increases. Considering the current conditions, TL intensity may rise by as much as fifteen minutes, depending upon the amount of ultraviolet (UV) radiation. With the passage of time, it progressively declines as a result of the population's trapped charge carrier, the amount attaining its optimum level in a metastable condition during a particular time. There may have been a decline in thermoluminescence signals owing to trap level depletion. The TL glow curve has revealed that it possesses a single, prominent peak at 102.21°C in temperature.

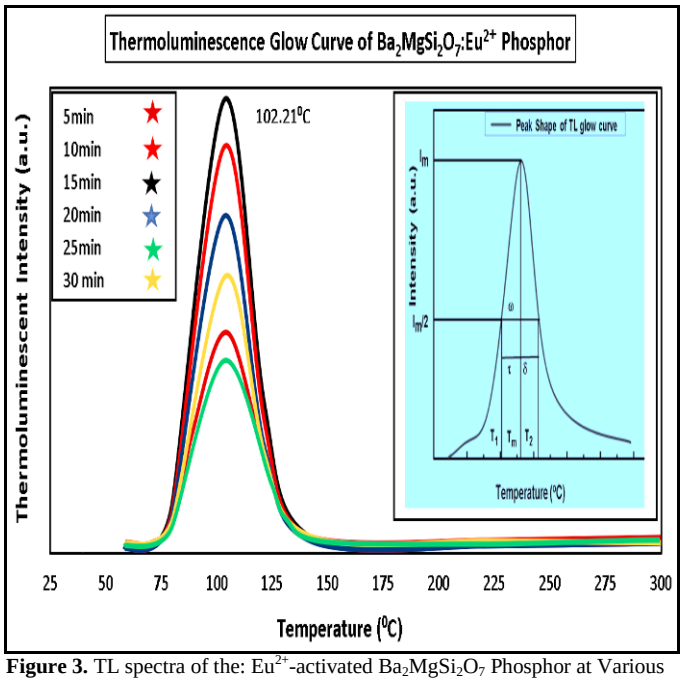

Figure 3. TL spectra of the: Eu^{2+}-activated $Ba_2MgSi_2O_7$ Phosphor at Various UV Exposure Time

At room temperature, the different trapping or kinetic parameters derived from Chen's empirical formula or peak shape method regarding the TL glow curve of synthesized Eu^{2+}-activated $Ba_2MgSi_2O_7$ phosphor have depicted in Table 2. The radiative recombination caused by dopant [Eu^{2+}] ions enhances the thermoluminescence intensity as well as releases trapped electrons after the phosphor becomes heated [17]. Consequently, TL measurements indicate that the Eu^{2+}-activated $Ba_2MgSi_2O_7$ phosphor has a single trapping level. There have been reports previously in certain published literatures of long-lasting alkaline earth silicate phosphors prepared using the conventional high temperature solid-state reaction and combustion synthesis approaches. The activation energy of recently synthesized efficient thermoluminescent silicate phosphors that appear in Table 1.

Table 1. Efficient Thermoluminescent Silicate Phosphors

Phosphor	Activation Energy	Reference
$Ba_2MgSi_2O_7$: Eu^{2+}, Dy^{3+}	0.62-0.76 eV	[3]
$Ca_2MgSi_2O_7$: Ce^{3+}	0.66 eV	[4]
$Ca_2MgSi_2O_7$: Dy^{3+}	0.62 to 0.70 eV	[17]
$Ba_2MgSi_2O_7$: Eu^{2+}	0.57 to 0.69 eV	[18]

3.2 Determination of Trapping/Kinetic Parameters

For estimating trapping/kinetic parameters of trap centers of the plotted TL glow peak curves with the objective to figuring out the following order of kinetics [b], activation energy [E], & frequency factor [s] was implemented by applying Chen's empirical formula [19]. Theoretically, the following equation may be used to get the geometric shape factor or symmetry factor ($\mu_g = \delta/\omega$).

$$\mu_g = \frac{T_2 - T_m}{T_2 - T_1} \quad (3)$$

The temperature measured at half-intensity on the upward and downward portions of the TL illumination peak curves is symbolized by the values T_1 & T_2, correspondingly. The optimum temperature is denoted by T_m, and the optimum-temperature half width is denoted via [$\delta = T_2 - T_m$] maxima (FWHM). While somewhat interesting, the shape factor (μ_g), which varies between 0.45 to 0.48, seems to be very near about to the estimated numerical value of the IInd order kinetics [i.e. μ_g = 0.49-0.52]. The possibility of recapturing liberated carriers of charge prior to the recombination mechanism is supported by IInd order kinetics, as explicitly stated [17,18,20,21]. The deeper trap depth can be attributed to IInd order kinetics, evidenced through the plotted TL glow curve.

Activation energy or trap depth [E] plays a crucial role in the persistentivity of thermoluminescent materials. Persistentivity refers to the ability of a material to retain luminescent properties over an extended period. In thermoluminescence, the persistentivity is related to the trap states within the material's lattice structure. When a thermoluminescent material is exposed to radiation, energy from the radiation is absorbed by the material, causing electrons to become trapped in localized energy states known as trap sites. The trapped electrons can remain in these states for extended periods, contributing to the persistent luminescence. The activation energy is the energy barrier that needs to be overcome for the trapped electrons to be released from the trap states and return to their ground state [3]. This activation energy determines the temperature at which the trapped electrons are thermally released and recombine with positively charged holes, resulting in luminescence. By controlling the activation energy, one can manipulate the persistentivity of thermoluminescent materials. Higher activation energy values can lead to longer persistent luminescence, as it requires higher temperatures to release the trapped charge carriers and produce luminescence. On the other hand, lower activation energy values result in shorter

persistentivity. Understanding and optimizing the activation energy in thermoluminescent materials is essential for tailoring their luminescent properties and enhancing their performance in various applications such as radiation dosimetry and material characterization.

To determine the trap depth or activation energy [E] is very essential for liberating the charge carriers, such as electrons that have been trapped [18,19].

$$E_\alpha = C_\alpha\left(\frac{kT_m^2}{\alpha}\right) - b_\alpha(2kT_m) \quad (4)$$

The estimated numerical values of C_α & b_α (where $\alpha = \tau, \delta, \omega$) are indicated for kinetics of general order (b) following mathematical relation [3,4,17].

$$c_\tau = [1.51 + 3(\mu_g - 4.2)] \quad (5)$$

$$b_\tau = [1.58 + 0.42(\mu_g - 0.42)] \quad (6)$$

$$c_\delta = [0.976 + 7.3(\mu_g - 0.42)] \quad (7)$$

$$c_\omega = [2.52 + 10.2(\mu_g - 0.42)] \quad (8)$$

$$b_\delta = 0 \;\&\; b_\omega = 1.0 \quad (9)$$

In the procedure of characterizing samples, the frequency factor (s) can be considered one of the most significant parameters to be implemented [3,17,18]. With modifying the earlier estimated values for activation energy [E] and order of kinetics [b] in the calculation (as specified), one may determine this trapping parameter as follows:

$$\frac{\beta E}{kT_m^2} = s\left[1 + (b-1)\frac{2kT_m}{E}\right]exp\left(-\frac{E}{kT_m}\right) \quad (10)$$

Where k symbolizes the Boltzmann constant, b symbolizes the order of the kinetics, that is the value is equal to two in the present analysis, and β symbolizes the linear heating rate, that is, the value is equal to 5°Cs^{-1}.

Table 2. Kinetic/Trapping Parameters of Eu^{2+}-activated $Ba_2MgSi_2O_7$ Phosphor at Various UV Exposure Times

UV Exposure Time	β	μ_g	E (eV)	Frequency Factor (s^{-1})
5 min	5	0.46	0.55	7.9×10^7
10 min	5	0.48	0.61	9.8×10^7
15 min	5	0.48	0.68	6.2×10^7
20 min	5	0.46	0.57	8.5×10^7
25 min	5	0.46	0.57	8.5×10^7
30 min	5	0.45	0.56	6.4×10^7

Accordingly, the frequency factor (s^{-1}) was determined between (6.2×10^7 and 9.8×10^7 s^{-1}), correspondingly. Trap depth or activation energy were both found to range between 0.55 to 0.68 eV, suggesting that the sample has enhanced persistency in terms of its thermoluminescence features. According to investigations, the materials must exhibit persistent behaviour over time at depths of trap/activation energy [E] values that vary between 0.65 to 0.75 eV [4,18,22,23].

Practical Applications of Thermoluminescent Materials & Future Scope

The thermoluminescence (TL) features are very essential in an extensive variety of applications, like as monitoring of the environment, bioimaging in healthcare facilities, scintillation detectors, radiation detection, defense & measurement, dating archaeological evidence artifacts, geological sciences, and exposing food to radiation as security precautions. When the silicate material undergoes heating, its stored charges can be liberated in the form of energy, revealing important details regarding chronological age or exposure to radiation [16].

1. Dosimetry Radiation: In order to assess the overall radiation dosage in substances and environments, thermoluminescence materials are frequently utilized in radiation dosimetry. This is vital in energy production at nuclear plants, commercial radiography, and radiation for medical treatment, among other areas of study [3].

2. Archaeology: The age of ancient artifacts and archaeological sites can possibly be ascertained through applying the technique of thermoluminescence dating. Researchers can determine exactly how long it has been since the last occasion when they were exposed to heat or sunshine by calculating the cumulative radiation dosage, which gives them essential details about the development of humanity [17].

3. Geology: Thermoluminescence has been utilized in geochronology to establish the time period of sediments, rocks, and other types of geological materials. Geologists may use this understanding to research the processes of geology, recreate Earth's past, and better understand how deposits of mineral substances arise.

4. Food Irradiation: The high purity and healthiness of food products that have been irradiated can be verified by thermoluminescence evaluation. The authorities may determine if appropriate irradiation techniques have been implemented and that the product is suitable for ingestion through surveillance of the amount of radiation absorbed by food products.

5. Environmental Monitoring: By identifying and quantifying the amount of radiation in soil, air, and water, thermoluminescence materials help in environmental radiation monitoring. This information is useful in tracking nuclear plants, evaluating possible radiation risks, and guaranteeing environmental safety [17,18].

6. Radiation Protection: Personnel in radiation-prone situations might use thermoluminescent dosimeters (TLDs) made of these materials as personal or area monitoring devices. They monitor both individual and group exposure, encouraging safety and adherence to recommended radiation protective protocols [17].

Limitations & Challenges

There are several limitations and challenges associated with thermoluminescence dosimetry and dating that researchers

and practitioners need to consider. Despite these limitations and challenges, thermoluminescence dosimetry and dating remain valuable techniques in various fields. Researchers and practitioners need to be aware of these limitations and apply appropriate methods and precautions to ensure accurate and reliable results.

1. Material Selection: The selection of suitable thermoluminescent materials is crucial. Not all materials exhibit desirable thermoluminescent properties, and some may have limitations in terms of sensitivity, stability, or reproducibility.

2. Calibration: Accurate calibration using known radiation doses is essential to establish a reliable relationship between the measured thermoluminescence signal and the actual radiation dose received. Calibration curves need to be regularly updated to maintain accuracy.

3. Fading: Some thermoluminescent materials exhibit fading, which is the loss of stored energy over time. This can distort the measured thermoluminescence signal and affect the accuracy of dose or age estimations. Fading correction methods are employed to mitigate its impact.

4. Environmental Interference: Environmental factors such as heat, light, and moisture can affect thermoluminescent materials and introduce uncertainties in the measured signal. Proper handling and storage conditions are necessary to minimize these interferences.

5. Sample Heterogeneity: In dating applications, the composition and characteristics of the sample can influence the thermoluminescence properties and dating accuracy. Sample selection and preparation should consider the potential heterogeneity within the material.

6. Thermal History: The thermal history of the sample can affect the thermoluminescence properties, making it necessary to understand and control the heating process during analysis. Incorrect heating profiles can lead to inaccurate results.

7. Limited Dating Range: Thermoluminescence dating has a limited dating range. The technique is most effective for materials with ages ranging from hundreds to hundreds of thousands of years. Beyond that range, other dating methods are generally more suitable.

8. Cost and Infrastructure: Establishing and maintaining a thermoluminescence laboratory with the necessary equipment and expertise can be costly. The availability of suitable facilities and trained personnel may be a limitation in some regions.

5. Conclusion

In summary, Eu^{2+}-activated $Ba_2MgSi_2O_7$ phosphor was well synthesized in a good way by employing a traditional solid-state reaction approach with highly elevated temperature under a weak degrading environment (which was generated by burning charcoal). Employing a TLD reader, the thermal (TL) characteristics was examined. The precise position of a single intense and broad TL glow curve was situated at 102.21°C. The optimal concentration was determined to be 5mol%, according to the TL investigation of dopant [Eu^{2+}] ions. TL spectra of the $Ba_2MgSi_2O_7$ based phosphor that is activated by dopant [Eu^{2+}] ions at varying ultraviolet (UV) exposure durations, likewise 5, 10, 15, 20, 25, & 30 minutes. Under the present conditions, TL intensity may increase by up to 15 minutes, depending on the amount of ultraviolet (UV) radiation. The thermal stimulation spectra exhibit a broad band within the ultraviolet (UV) range, because of this transition from ground state to excited state ($(4f^7 \rightarrow 4f^6 5d^1)$ of Eu^{2+} ions. The ground state is a lower energy state, and the excited state is a higher energy state. Dopant [Eu^{2+}] ions have the potential to serve as both luminescence centres and traps. With the passages of time, after that it progressively declines as a result of the population's trapped charge carrier the amount attaining its optimum level in a metastable condition during a particular time. The trap depth measurements varied between 0.55 to 0.68 eV. Accordingly, the frequency factor (s^{-1}) was determined to vary around 6.2×10^7 to 9.8×10^7 s^{-1}. The prepared phosphor sample exhibits long-term persistence behaviour at 10min & 15min UV exposure. Based on this, we may recommend that the synthesized Eu^{2+}-activated $Ba_2MgSi_2O_7$ phosphor is a good thermoluminescent (TL) material.

Data Availability
None.

Conflict of Interest
Both authors certify that have no competing interests of any kind and they are completely independent.

Funding Source
None.

Authors' Contributions
The final edited version of the research manuscript have been authorized, revised, and reviewed by both authors.

Dr. Shashank Sharma: Conceptualization, Research Methodology, Data analysis, Results-Discussion, Writing & Drafting of Original Manuscript.

Dr. Sanjay Kumar Dubey: Synthesis of Material Sample, Research Article Design, Writing, Properly Checked the Spelling and Grammatical Error.

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AUTHORS PROFILE

Dr. Shashank Sharma have successfully completed his Ph.D. degree in material science at private state university of chhattisgarh [Kalinga University, Atal Nagar Nava Raipur (C.G.), India], and earned his undergraduate degree and postgraduate degree at Govt. E. R. Rao Postgraduate Science College Bilaspur, which is affiliated with Bilaspur University (Govt. state university of chhattisgarh), Bilaspur (C.G.). He is currently employed at the Govt. Gramya Bharti College in Hardibazar, Korba (C.G.) as a Guest Lecturer (Assistant Professor) in the Department of Physics. During 2013-2018, the Department of Science & Technology (DST), Inspire Division, New Delhi (India), awarded him the Inspire Scholarship for further educational studies. He has also completed a summer vacation research project on "Sol-Gel Processed Barium Stannate Thin Films Using Spin Coating Technique" during 2016. He has been appointed as a reviewer in the American Journal of Nano Research & Applications (International Research Journal), Science Publishing Group, United States of America. He has published more than 40 research papers, 10 book chapters, 1 book as an editor, 2 books as a co-editor, 4 patents (Policy documents) in reputed International and National research journals, including SCI, Springer, ESCI, Peer Reviewed, Thomson Reuters, & Web of Science, as well as conference, seminar proceedings. It's also available online. He has participated in many National, and International conferences, seminars and the Faculty Development Programme (FDP). He has 2 years of teaching experience. He has reviewed more than 50 research journals as a reviewer for reputed national, and International journals. His main research work focuses on nano technology, luminescence & its applications, nanomaterials, photo, thermo & mechano luminescent materials, material science, and white light emitting diodes, solid-state physics, thin films, dielectric properties of materials as well as long persistent materials.

Dr. Sanjay Kumar Dubey have completed his Ph.D. degree in Materials Science at private state university of chhattisgarh [Kalinga University, Atal Nagar Nava Raipur (C.G.), India], and earned his undergraduate degree and postgraduate degree at Pt. Ravishankar Shukla University Raipur (C.G.) [Govt. state university of chhattisgarh]. He is currently employed at Dr. Radha Bai, Govt. Navin Girls College Raipur, (C.G.) as an Assistant Professor in the Department of Physics. He has 32 years of teaching experience. He has currently been appointed as a research guide at Pt. Ravishanker Shukla University, Raipur (C.G.). He has published 40 research papers, 10 book chapters in reputed International and National research journals like SCI, Springer, ESCI, Peer Reviewed, Thomson Reuters, & Web of Science, as well as conference, seminar proceedings. It's also available online. He has participated many National, International conferences, seminars and the Faculty Development Programme (FDP). His main research work focuses on nano technology, luminescence & its applications, solid-state physics, nanomaterials, photo, thermo & mechano luminescent materials, and material science, white light emitting diodes as well as long persistent materials. he has reviewed more than 35 research journals as a reviewer in reputed national and international journals. More than 60 postgraduate students have completed their material science research project under him.

