CHAPTER I
INTRODUCTION

1.1 Background and motivation

When people first learned to manufacture fire, they also developed a desire for light. Because lighting currently plays a crucial role in people's daily lives and consumes 20% of the world's electricity (Schubert, E. F. et al., 2005), (Cho, J. et al., 2017). Numerous researchers, like Joseph Swan and Heinrich Goebel, have examined the development of light bulbs before the invention. However, light bulbs remained a scientific concept at that time. It was only feasible for commercial usage once Thomas Alva Edison received a patent for a carbon incandescent lamp in 1879. Another significant milestone in the development of lighting is the creation of light bulbs for commercial usage. An electric current was run through the filament until it heated up and released light by the incandescent principle. However, Edison's carbon-based filament lasts only about 13 hours and has a very short lifespan. Scientists then worked to create a filament to improve performance and service life until William Davis made a tungsten filament in 1910. Because of the filament’s ability to withstand temperatures up to 3,000 degrees Celsius, tungsten filament lamps now last between 1,000 and 3,000 hours instead of just using 13 hours. A fluorescent light, commonly referred to as a gas lamp, was created in 1934. A gas lamp's basic operating concept is to drive the movement of the mercury gas, which emits heat and light, using electricity that flows through the starter and ballast. There is a wavelength of light that is harmful and has a spectrum that humans cannot see. Scientists developed a phosphorous coating to cover the surface of inner tubes. Create a fluorescent bulb, a type of phosphorescent phenomenon, to provide light next (Fluorescent).

This lamp uses less energy since it loses power as heat significantly less than incandescent lamps. A type of lamp with high potential and small size, lifespan, safety, and environmental protection entered the vision of scientists before the advent of

The inchoate semiconductor LED in the 1960s (Round, H. J., 1907; Holonyak, N., 1962; Craford, M. G., 1977).

In 1962, Nick Holonyak Jr. continued to advance this technology while employed by General Electric. Red LEDs were the first type of light-emitting diode. The first yellow LED and the red LED were created by M. George Craford, a graduate student at Holonyak. To exploit fiber optics in telecommunications, Thomas P. Pearsall created high brightness light-emitting diodes in 1976 (Holonyak, N., 1962; Craford, M. G., 1977). The first blue LED was created in 1979 by Shuji Nakamura of Nichia Corporation, but it took until 1994 to become economically viable for commercial use. Today, light-emitting diodes can be made in one or many colors. Since light-emitting diodes cost $200 each initially, they were exclusively utilized as indicators in specialist laboratory equipment (Nakamura, S. et al., 1994). Through the use of a semiconductor chip for light emitting diodes, Fairchild Semiconductor lowered the price of individual LEDs to just 5 cents in the 1970s. LEDs for commercial devices have been successfully created by Fairchild, employing cutting-edge packaging techniques and chip fabrication procedures. Instead of incandescent bulbs, illuminated LEDs are utilized, and fluorescent lights provide brightness and energy efficiency benefits. Infrared LEDs are used in TV remotes, DVD players, other gadgets and calculators, clocks, lanterns, and other applications. We need wireless control, but its drawback is that it is costly and produces much heat.

Glass material has been used in various structural applications for centuries (Luewarasirikul, N. et al., 2018; Pawar, P. P. et al., 2016; Pawar, P. P. et al., 2017). Only the Dy^{3+} ions in the lanthanide group were of interest to the researcher because they have features that can be used in white light emission applications. Yellow light emission from the electric dipole (ED) corresponds to the intense radiation spectrum for Dy^{3+} ions at the 4F9/2⟶6H13/2 transition (Ullah, I. et al., 2020; Wantana. N. et al., 2020). The other emission spectra signify a magnetic dipole's (MD) blue light emission at the 4F9/2⟶6H15/2 transition. For choosing to employ unique borate-glass in this sculpture. The attractive optical and structural features (Kaur, S. et al., 2018; Ichoja, A. et al., 2018) and ease of fabrication in the literature analysis result in a relatively cheap manufacturing cost. Borate glass is a promising and excellent material for applications such as nonlinear optics, detectors, and ionizing radiation transformers for the detection of electroluminescence. (Wantana. N. et al., 2020; Ichoja, A. et al., 2018). In addition, the compound gadolinium oxide, also known as Gd_2O_3, is an interesting component of the glass's overall make-up. In addition to having a linear solid glow with energy transfer behavior, it also has a high light yield due to its high atomic number (Wantana, N. et al., 2020; Shoaib, M. et al. 2020). Last, Gd/Dy co-doping in glass has been reported for photonic and scintillation applications (Wantana, N. et al., 2020). Developed lithium-aluminium-borate glasses doped Dy^{3+} for W-LED applications by (Rittisut, W. et al., 2021). For scintillation, materials can convert ionized radiation into visible photons. Furthermore, it has a variety of applications such as space exploration, industrial inspection security and medical radiography that obtain images with high resolution and efficiency from X-rays (A. Owens., 2008; D. Rinaldi. et al., 2020; Q. Chen. et al, 2018; X. Ou. et al., 2021)

The idea of the researcher is to create glass encapsulation in the form of a bell. Phosphors and epoxy resin are employed to encapsulate the LED, reducing the WLED structure to two layers as opposed to three. The structure's X-ray images still need to be reported in the Dy^{3+}doped Gd_2O_3-B_2O_3 X-ray imaging design. So, we'll develop the system and research the fundamentals of photography.

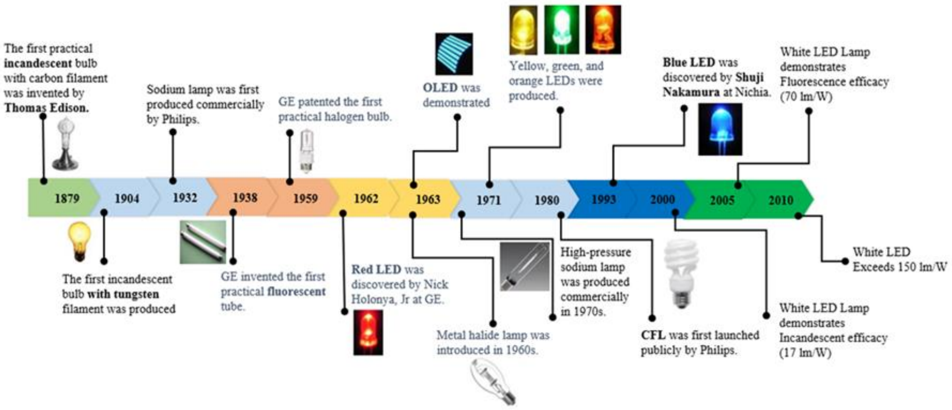

Figure 1.1 The timeline of major discoveries in modern lighting technologies. (Adaptform: GE History, the history of the LED, OSRAM, and Lengthening the day)

This work will divide the study into two parts: 1. Design a new LED encapsulation 2. Design a luminescence system for X-ray imaging. We synthesize binary gadolinium borate glass doped with dysprosium ion from both of these. Therefore, we will use synthetic glass to determine its optical behavior, whether it is designing a blue LED to monitor light emissions before and after encapsulation. Including the creation of X-ray imaging systems for use in radiology or medical imaging areas.

1.2 Objectives of the thesis

The primary goal of this research was to explore the physical properties of the glass we synthesized and bring it to the composition $27.5Gd_2O_3$-$(72.5-x)B_2O_3$-xDy_2O_3 for applications in LED encapsulation and x-ray imaging. X-ray excitation luminescence (XEL), optical photoluminescence (PL), and electroluminescence (EL). The main aim of this thesis can be summarized as follows:

1.2.1 To synthesize $27.5Gd_2O_3$- $(72.5-x)B_2O_3$-xDy_2O_3 utilize Encapsulation in the Blue LED.

1.2.2 To compare the physical, optical, and emitting properties of Dy^{3+} ion-doped gadolinium borate glass by rapid melting and cooling technique.

1.2.3 To study the physical structure, including images obtained by X-ray stimulation.

1.2.4 To analyze the mechanical properties and structure characteristics of $27.5Gd_2O_3$-$(72.5-x)B_2O_3$-xDy_2O_3 glasses series by using XRD, FTIR, Photoluminescence X-ray luminescence, Decay time and UV-Vis.

1.3 Outline of the thesis

In this study, a variety of gadolinium borate glass samples were made by mixing and melting the appropriate amounts of $27.5Gd_2O_3$- $(72.5-x)B_2O_3$-xDy_2O_3 glasses, where x is between 0.05 and 1.50 mol%, and the host matrix was prepared using the traditional melt quenching method. Doping was performed on the samples using both a single and a double dose of Dy^{3+} and trivalent rare-earth ions.

Using Gd_2O_3, trivalent rare earth oxide was incorporated into the borate to improve the host organization. Additionally, borate was used as a modifier to reduce the hygroscopic qualities. To investigate the effect of the dopant on the structural, physical, chemical group, optical, photoluminescence, and radioluminescence properties of the material, the rare earth oxide from the Dy^{3+} series was chosen to serve as the dopant rare earth oxide. The estimations that were used came from a variety of sources. Initially, the Archimedes method was utilized to calculate the densities of the samples. The X-ray diffraction (XRD) measurement was carried out to validate the treated materials' original structure. To explore the optical features of the glass series, a UV-visible-NIR spectrometer was utilized, and the band gap was subsequently calculated using the data obtained from the UV-Visible-NIR spectra. Fourier-transform infrared (FTIR) spectroscopy was used in doped and undoped studies to regulate the primary highlights. The luminescence properties were under the supervision of X-ray luminescence spectrometers and photoluminescence. The oxidation status of borate glass treated with rare earth oxide was evaluated with the help of X-ray Absorption Near Edge Structure (XANES) spectroscopy.