PREFACE

This thesis presents the preparation of multicomponent phospho-silicate, silicate, and phosphate glasses doped with transition metal ions (Cu^{+}, Cu^{2+}, Fe^{3+}), heavy metal ions (Pb^{2+}), and rare earth ions (Sm^{3+}, Pr^{3+}). These glasses were characterized through various physical, optical, mechanical, and fluorescence analyses. The preparation process involved melting precise amounts of analytical reagent (AR) grade chemicals, casting, air quenching, and annealing. The annealing process was employed to relieve thermal stresses and strains, with the glasses being gradually cooled to ambient temperature within the furnace. After **the furnace cooled**, the glass samples **underwent** mechanical cutting, etching, and polishing for detailed optical, fluorescence, and mechanical characterizations. The structural and functional properties of the glasses were investigated using a combination of X-ray diffraction (XRD), Fourier-transform infrared (FTIR) spectroscopy, and Raman spectroscopy. To assess the optical characteristics of the synthesized, optically polished glass samples, a Jasco V-770 twin-beam UV-VIS spectrophotometer (Japan) was employed, and interfaced with a PC running UV-Win Lab software. Additionally, fluorescence measurements of rare earth ion-doped phosphate glasses were performed using a WITec α-300 spectrophotometer (Germany), which is equipped with a 75W xenon lamp and covers the visible frequency range. The mechanical properties of phospho-silicate glasses doped with transition metal ions (Cu^{+}, Cu^{2+}, Fe^{3+}) were evaluated through universal testing machine (UTM) measurements, focusing on compression strength and Young's modulus. For silicate glasses doped with heavy metal ions (Pb^{2+}), the mechanical properties were derived from ultrasonic measurements. Specifically, longitudinal ultrasonic velocity (V_L) and shear ultrasonic velocity (V_S) were measured using an ultrasonic flaw detector, from which relevant mechanical properties were calculated. The physical properties of the prepared glass samples, including density, molar volume, and oxygen packing density, were also assessed. The density of these glasses was determined using Archimedes' principle. However, this thesis is organized into seven chapters, as outlined below:

Chapter 1 provides an overview of the literature and introduces the core concepts of the study. It includes a timeline review of glass synthesis, general uses of glasses, and glass preparation modification techniques, with a focus on the amorphous structure of silicate glasses. The chapter also emphasizes the importance of doping metallic ions such as transition metals, heavy metals, and rare earth elements into phosphate and silicate glass matrices. These modifications enhance the glasses' suitability for applications in building envelopes, optoelectronics, and laser technologies. Additionally, the chapter briefly discusses the tetrahedral network structure of silicate glasses and the essential criteria for oxides that form a stable glass network. This **chapter 1** also outlines the objectives of the investigation, focusing on the significance of doping transition metal oxides (e.g., CuO, Cu_2O), heavy metal oxides (e.g., PbO), and rare earth oxides (e.g., Sm_2O_3, Pr_2O_3) into phosphate and silicate glass matrices. The chapter highlights the potential applications of these doped glasses in building envelopes, optoelectronics, and laser technologies.

Chapter 2 provides a detailed description of the materials and methods used in this research, including the reagents and the conventional melt-annealing technique employed for glass preparation. It also offers an overview of the instruments and characterization techniques used to analyze the samples.

Chapter 3 examines the optical, mechanical, and chemical properties of Na_2O-P_2O_5-SiO_2-based tinted glasses, specifically for building construction applications. The analysis suggests that these glasses could be promising candidates for use in commercial building envelope materials, especially in areas with abundant daylight exposure.

Chapter 4 investigates the doping effects of pigment oxides on the optical and mechanical properties of PbO-based glasses. The results from the characterizations provide insights into the potential of these doped glasses for use in commercial construction, particularly for exterior applications in high-light environments, as well as in optoelectronic devices.

Chapter 5 reports on the optical, structural, physical, and radiative properties of samarium (Sm_2O_3) and praseodymium (Pr_2O_3)-doped phosphate glasses. The UV-visible and fluorescence spectra observed in these samples show promising results for their use in optoelectronic devices and laser technologies, especially as heat-absorbing window glasses for building envelopes.

Chapter 6 presents a summary of the research findings from Chapters 4 to 6 and discusses the potential for further work and future developments related to the synthesized glass samples.