Glasses with Chalcogenides: An Overview

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Abstract

Chalcogenide glasses are a significant class of advanced materials composed primarily of chalcogen elements, such as sulfur, selenium, and tellurium, combined with other elements, including arsenic, germanium, and antimony. These glasses have attracted considerable scientific and technological interest because of their distinctive optical, electrical, thermal, and structural properties. This research paper presents an overview of the composition, preparation methods, fundamental properties, and emerging applications of chalcogenide glasses. Unlike conventional oxide glasses, chalcogenide glasses generally exhibit high infrared transparency, low phonon energy, and high refractive indices, making them suitable for a wide range of photonic and optoelectronic applications. Their ability to transmit infrared radiation enables their use in thermal imaging, infrared optical lenses, optical fibers, and chemical sensing systems. Furthermore, their photosensitivity and reversible phase-change behavior have made them valuable materials for optical data storage, photonic devices, and non-volatile memory technologies. The structural characteristics of these glasses depend on their chemical composition, bonding configurations, and glass-forming conditions, which significantly influence their physical and optical performance. Various preparation techniques, including melt-quenching and thin-film deposition, are employed to develop chalcogenide materials with desired characteristics. Despite their advantages, challenges such as thermal stability, crystallization, material toxicity in certain compositions, and long-term durability require further investigation. Advances in material engineering and characterization techniques continue to expand the potential applications of chalcogenide glasses in modern technology. This overview highlights the importance of understanding their composition–structure–property relationships and emphasizes their growing role in infrared photonics, sensing, data storage, and next-generation optical devices.