PHYSICAL PROPERTIES OF THE $\text{As}_2(\text{Se,Te})_3$ GLASSES
(Review Article)

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Abstract

Recent interest in the properties of amorphous chalcogenides has resulted in a great expansion in the literature on this subject. The present work reviews the physical properties of one of the most carefully studied alloy systems: the $\text{As}_2\text{Se}_3 - \text{As}_2\text{Te}_3$ glasses. The review emphasises experimental results and suggests areas of research which need to be more closely examined.
I. Introduction

Scientific research into the properties of amorphous chalcogenides has been progressing at an impressive rate for more than a decade. Much of this work has been stimulated by the fact that these materials are easy to prepare in non-crystalline form and, unlike silicate glasses for example, electrical conduction in these materials is primarily electronic rather than ionic in nature. It is frequently observed that the electrical properties of amorphous chalcogenides are insensitive to doping, which suggests that the bulk resistivity of such materials will not depend sensitively on purity, in contrast to that of the more commonly studied crystalline semiconductors, Si and Ge.

Numerous applications for these materials have been suggested. These range from the well established field of xerography to the very exciting field of threshold and memory switching. For any application, an understanding of the fundamental properties of these materials is essential. Since glasses are not bound by stochiometry for their existence, the number of possible chalcogenide glass compositions is limited only by the ability to quench the melt rapidly enough to avoid crystallization. Much work has been done on the As-Se-Te system, and it is the properties of this system which are covered in this paper.

The alloys chosen for this review consist of the members of the pseudobinary system $\text{As}_2\text{Se}_3 - \text{As}_2\text{Te}_3$. Extensive work has been performed on the electronic, optical and thermodynamic properties of these alloys, and they thus constitute one of the better understood systems of chalcogenide glasses. Of particular interest is the observation that most physical properties vary smoothly with glass composition, thus allowing an alloy to be tailored to a specific band gap, for example, by adjusting the Se/Te ratio. The smooth variation in the properties of the non-crystalline alloys in this composition range is made more interesting by the fact that the crystal structures of the end members differ significantly, even with respect to the local atomic coordination.

The scope of this review is limited to experimental results. A brief discussion of the theory of amorphous chalcogenides is also presented; however, the reader is encouraged to consult more detailed works such as the recently published book by Mott and Davis (1) for a better understanding of amorphous semiconductor theory. Other recent reviews which include extensive references on chalcogenide glasses have been written by Adler (2) and by Grigorovici (3).

II. Theory

The theory of amorphous semiconductors has been complicated by the fact that while short range order (nearest neighbor arrangement) exists, long-range order is non-existent in non-crystalline solids. This means that the electron momentum is not a good quantum number, and consequently many of the theorems used in the physics of the crystalline