Chapter I

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A relatively small group of elements and compounds has the important electrical property of semiconduction. They are neither good electrical conductors nor good electrical insulators. Instead , their ability to conduct electricity is intermediate. These materials are called semiconductors. Generally, semiconductors are classified into two major groups: namely, elemental semiconductors found in group IV of the periodic table and the compound semiconductors which are formed by the combination of groups III & V and groups II & VI elements. Silicon(Si) is the widely used elemental semiconductor known today and is mostly used in the fabrication of rectifiers, transistors, MOS devices and integrated Circuits. In 1950's, Germanium was the major semiconductor material used for technological applications but due to the high leakage current in Ge diodes at moderately higher temperatures, it proved unsuitable for device applications.

Now the development of tetrahedrally bonded amorphous silicon has led to a wide variety in its applications. These exciting developments have led to intense experimental and theoretical studies in hydrogenated amorphous silicon. Both chalcogenide and tetrahedrally bonded amorphous semiconductors are usually fabricated in the form of thin films by evaporation, sputtering and chemical vapour depositions. Without the constraint of atomic periodicity, amorphous materials can be deposited onto any foreign substrates. Their relatively low cost of fabrication over larger areas as thin film elements, which is necessary for electronic and optoelectronic device applications, has made them a sought-after material. Another technological advantage of amorphous material is the variability of their physical constants due to the imperfections in their close-packed random atomic networks. Owing to the lone pair bonding in the flexible twofold co-ordination of the host element in the network, chalcogenide glass has a good structural flexibility. A number of interesting phenomena, such as reversible phase transitions, photo-darkening, photonucleation, photo-structural changes and photo-dopings have been observed in chalcogenide glasses. In 1976, valence control with subsitutional impurity doping has been realised in hydrogenated amorphous silicon produced by the glow discharge technique. The discovery of this structural sensitivity has opened up a wide variety in their potential applications in both electronics and optoelectronics. The incorporation of hydrogen atoms in the a-Si network has reduced the number of dangling bonds in the material significantly and has modified its electronic and optical properties. This material is widely used in making devices like photoreceptors, solar cells, transistors, imaging sensors, printer heads, document scanners and lot more devices. In a defect free crystalline semiconductor, the optical absorption spectrum terminates abruptly at the energy gap. In contrast, in an amorphous material, a tail in the absorption spectrum extends even into gap regions. In this work, first the single crystal Silicon and Germanium are studied for a better understanding of the amorphous structure. The process of annealing the amorphous material has been used as a tool to understand the role of hydrogen atoms incorporated in the amorphous silicon network and thereby to determine the optimum hydrogen concentration in it.

Chapter II, gives a theoretical background of crystalline and amorphous semiconductors. In this chapter a brief introduction of the physics of crystalline, amorphous and polycrystalline material has been presented.

Chapter III, presents the experimental techniques and formulas employed in the characterisation of crystalline Silicon, Germanium and hydrogenated amorphous silicon (a-Si:H). The x-ray diffraction and the conductivity measurements for crystalline material, preparation of hydrogenated amorphous silicon, electrical and structural characterisation of a-Si:H have also been discussed in this chapter. The experimental details of infra-red spectroscopic technique for a-Si:H and optical characterisations for both crystal Si and a-Si:H have also been discussed in detail in this chapter.

In chapter IV, the experimental results on structural characterisation, optical characterisation and electrical characterisation of the crystalline Si, crystalline Ge and a-Si:H have been discussed. In chapter V, analyses the various experimental results mentioned earlier. Chapter VI, concludes this work and suggests proposal for further studies.