CHAPTER 1

INTRODUCTION

1.1 Introduction

Hydrogenated amorphous silicon (a-Si:H) thin films have been the subject of extensive research in the past thirty years, boosted by applications and the challenging fundamental issues related to this disordered semiconductor (structure, doping, stability etc.) [1]. This films are useful since it can be use in many semiconductor devices such as solar cell [2], photoreceptors [3], flat panel display [4], page wide document scanners [5] and printer heads [6].

Most interest is focused on a-Si:H and its alloys because the hydrogen reduces the defect density, thereby allowing n-type and p-type doping and providing good electronic and optical properties. The presence of hydrogen in amorphous silicon efficiently passivates the dangling bonds and modifies the structure to make the over-constrained tetrahedral network of Si more flexible to satisfy most of the bonding requirements resulting in a more relaxed random network [7]. The hydrogen content in a-Si:H can be determined using various techniques such as Nuclear Magnetic Resonance (NMR) and Secondary Ion Mass Spectroscopy (SIMS). In this work, the integration of absorption areas under the Si–H peaks obtained from the FTIR transmission spectrum is used to determine the H content of the samples.

In this thesis, the effect of helium dilution at different helium to silane flow-rate ratios on optical, structural and electrical properties is investigated. Many reports are presented on the development of helium diluted a-Si:H solar cells compared with devices made with hydrogen dilution. H- and He-dilution are equivalent in developing device quality materials in d.c. PECVD, but He dilution has the advantage of allowing higher deposition rate [8]. Roca I Cabarrocas et. al. has reported that the deposition rate of He-diluted a-Si:H can be increased up to 15Å/s without sacrificing its initial opto-electronic properties and the defect densities [9].

A review on a-Si:H material will be presented in chapter 2. The search for a-Si:H with improved properties (low defect density, higher carrier mobility, enhanced stability, etc.) has led researchers to explore a large number of deposition methods. The various fabrication process of making this a-Si:H film are presented in section 2.3. The d.c. plasma glow discharge technique will be highlighted in this section since the technique will be used in this work. The growth mechanisms will be presented in section 2.4. The formation of powder which mainly associates with the films produced at high deposition rates will be explained in section 2.5. The role of hydrogen in a-Si:H film is reviewed in section 2.6. The vibrational properties, the optical properties, the morphological properties and the electronic properties of a-Si:H film will be highlighted in the next sections.

The preparation, characterization and analytical techniques will be explained in chapter 3. The horizontal d.c. plasma glow discharge system will be detailed in section 3.2. The deposition procedure is presented thoroughly in section 3.3. The details of the material characterization are also explained in this chapter.

In chapter 4 and 5, the results and analysis of all samples are presented. The structural properties as well as the preparation conditions of the samples are discussed in chapter 4. The infrared spectroscopy, XRD and AFM results are analyzed in this chapter. The optical and electrical properties of the samples containing the optical spectroscopy results and the electrical measurement results are discussed in chapter 5.

Finally all the important results acquired in this work are combined and concluded in the last chapter. Suggestions for further work using this material are also provided in this chapter.

1.2 References

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