CHAPTER 1

INTRODUCTION

Hydrogenated amorphous silicon (a-Si:H) has been a subject of extensive studies because of its important device applications. Films prepared by plasma decomposition of silane have wide applications especially as solar photovoltaic energy converters[1,2] and xerographic photoreceptors[3,4]. Empirical optimization of deposition parameters had indicated that from electronic point of view, 'optimal' material could be prepared from plasmas of pure silane at low discharge power densities. These conditions unfortunately are associated with very low deposition rates that make some applications impractical. Higher deposition rates can be achieved by increasing the power density but in the specific instance of pure silane , depending on pressure and flow rates, lead to a rapid gas phase reactions[5] resulting in powder formation and deterioration of film properties. In order to avoid such reactions, dilution of the silane with argon, an inert gas commonly used in sputtering and plasma deposition systems are currently widely investigated[6,7] to overcome these problems. Argon diluted silane has become a major interest in a-Si:H film produced by glow discharge technique since late 1970's. In spite of its chemical non-reactivity, argon is believed to affect the deposition process of a-Si:H films in the sputtering systems as well as the plasma deposition systems.

In this work, a-Si:H films are prepared from the discharge of argon mixed with silane using a horizontal DC plasma glow discharge system. Silane and argon gases at different flow rate ratios are mixed and discharged in the deposition chamber in order to produce the a-Si:H films studied in this work. The films are deposited at room temperature on soda glass substrates for optical transmission spectroscopy work and on crystal silicon substrates for infrared spectroscopy work.

The main objective of this work is to investigate the effects of argon dilution on the a-Si:H films produced using the horizontal DC plasma glow discharge system. Through the optical transmission spectra, some of the optical properties of a-Si:H films are analyzed. From the FTIR spectra, the total hydrogen content, microstructure parameter and bonding configurations of the a-Si:H films are investigated.

A detailed literature review on a-Si:H are presented in Chapter 2. In this chapter, some of the findings related to argon effects in the deposition of a-Si:H films are also reported. Works in this area of research by researchers who have done intensive research on argon diluted silane like J. C. Knights, R. A. Street, K. Tanaka, P. Chandhuri and their co-workers are quoted.

The experimental and calculation techniques are presented in chapter 3. The home built DC plasma glow discharge system used to prepare the a-Si:H films is discussed in detail in this chapter. The optical and infrared spectroscopy techniques used in this work to study the film properties are described in this chapter. Calculation techniques to determine the various parameters studied are also detailed here.

The deposition parameters for sample preparation and results obtained from the optical spectroscopy studies are presented in chapter 4. In this chapter, the optical transmission spectra of the a-Si:H films prepared are presented and discussed. The effects of different argon to silane flow rate ratios and deposition rate on the refractive index, optical energy gap and the Urbach tail bandwidth are discussed and analyzed in this chapter.

The FTIR spectroscopy results and parameters extracted are presented, discussed and analyzed in chapter 5. The effects of argon dilution on the parameters derived from the FTIR spectra are scrutinized and analyzed. The deposition rates of the films prepared using different argon to silane flow-rate ratios are analyzed and the effects on the microstructure and H content are discussed.

Chapter 6 concludes the results obtained from this work and suggested some possibility of further works in this area of research.

References:

1. H.Onikawa and K.Nakatani, JARECT vol.6, Amorphous Semiconductor Technologies and devices (1983).
2. H.Haruki and Y.Uchida, JARECT vol.6, Amorphous Semiconductor Technologies and devices (1983).
3. I.Shimizu, T.Komato, K.Saito and E.Inone, J. Non-Cryst. Solids, 507(35), (1980), p.773.
4. J.Mort, S.Grammatica, J.C.Knights and R.Lujan, Solar Cell Materials (in press).
5. J.C.Knights, R.A.Lujan, M.P.Rosenblum, R.A.Street, D.K.Bieglesen and J.A.Reimer, Appl. Phys. Lett. 38(5), (March 1981), p.331-3.

6. R.A.Street, J.C.Knights and D.K.Biegelsen, Phys. Rev. B, 18, (1978), p.1880.
7. J.C.Knights and R.A.Lujan, Appl. Phys. Lett., 35, (1979), p.244.