CHAPTER 1. INTRODUCTION

Silicon nitride is a dense, hard, chemically inert and a dielectric material. Silicon nitride thin films are widely used in various microelectronic-related applications, for example as gate dielectrics, masks for many processing steps, passivation and encapsulation of LSI-ICs, and as interlayer insulation due to its excellent barrier effect for alkali-ions and its good electrical insulation [1,2]. An important recent application is as a gate insulator in amorphous silicon thin film transistors [3]. Silicon nitride Si_3N_4 thin films have been deposited using various techniques, which includes RF or DC sputtering, glow discharge decomposition, chemical vapour deposition and direct nitridation [4]. Among these techniques, much interest is focused on glow discharge or also called as Plasma Enhanced Chemical Vapour Deposition (PECVD). The major attraction of glow discharge method is its significantly lower processing temperature and with deposition rates which are compatible with one or more of the steps in semiconductor processing, enables this technique to be used on metalized wafers without adverse effects [5]. However, due to the low deposition temperature in glow discharge method, the decomposition of the hydrogen-containing molecule is not complete and large concentrations of hydrogen are incorporated [6]. Glow discharge method also has the disadvantage of the incorporation of pinholes due to plasma bombardment [7].

The properties of silicon nitride thin films are known to depend strongly upon the method and conditions for film deposition. In the present work, hydrogenated silicon nitride SiN_x:H thin films have been prepared utilizing a home-built DC plasma glow discharge system from the silane SiH_4 and ammonia NH_3 gas mixtures. The compositional, bonding and optical properties of the films have been studied as a function of deposition parameters, namely the ammonia to silane gas flowrate ratio $R=[NH_3]/[SiH_4]$ and the substrate temperature.

The literature reviews on silicon nitride thin films shall be highlighted in Chapter 2. The various existing methods of preparation of silicon nitride thin films are reported. Emphasis is given on the glow discharge technique, its reaction mechanism and system design. Finally the reported properties of the deposited glow discharge silicon nitride thin films are discussed.

Features of the home-made DC plasma glow discharge system and its operational procedures are provided in Chapter 3, together with the details of preparation conditions of the present study. The particulars of the material characterization are also specified in this chapter.

Measured properties of the SiN_x:H thin films are presented in Chapter 4 as a function of deposition parameters, i.e. NH_3 to SiH_4 flowrate ratio and substrate temperature. The analytical methods utilized are also explained.

In Chapter 5 the dependence of the properties of the deposited SiN_x:H thin films, in particular the compositional, local bonding network and optical properties, on the NH_3 to SiH_4 flowrate ratio at a given substrate temperature, and the effect of substrate temperature at a fixed NH_3 to SiH_4 flowrate ratio, are discussed in length.

Finally the results obtained in the present study on the fabrication of silicon nitride thin films utilizing a home- built system, and the dependence of the properties of the deposited films on the NH_3 to SiH_4 flowrate ratio and the growth temperature are concluded in Chapter 6.

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