Chapter 1

Introduction

1.1 General Background and Motivation

In post ten years, the world was into new generation. The people can get information more easily by network. The wireless technique was been development the people could get any information anywhere by personal digital assistants (PDA) and notebook. The flat panel display (FPD) was being an important role for acts as a critical interface to connect with people is assembled into those tools. The FDP can replace the cathode ray tube (CRT) due to the volume and weight for FDP is smaller than CRT. The amorphous silicon thin film transistor based active matrix liquid crystal display (AMLCD) is a main stream for FPD [1.1]. However, the thin film transistors were acts an important pixel switch element for AMLCD [1.2]. The TFTs characteristic is direct determinate the display performance. But α-Si:H TFTs have low electrical mobility and so the channel width is difficult to scale down and limited the signal response time. In order to overcome those disadvantage, Many research for low temperature polycrystalline silicon were been proposed.

Poly-Si TFTs are fabricated on large area glass substrate. The electrical characteristic are poor than that of single-crystal silicon MOSFETs. Due to there are many trap states existing inside the channel. These defects at the grain boundaries as well as inside the grains are well known to degrade the device performance [1.3]-[1.4]. Although the primary use of TFT's presently is as pixel drivers, additional use for on- board peripheral circuitry is gaining interest as the TFT technology matures [1.5]. However, before TFT's are used for both of these applications, they must satisfy a few basic requirements. First, they need to be fabricated on the same glass substrate, at the same process [1.6]. Second, the electrical characteristics of the TFT's must satisfy both the pixel driver's requirement for

low off leakage current, and the peripheral circuitry's need for high mobilities [1.7]-[1.8].

The poor thermal tolerance of low cost glass substrate, many techniques about crystallization of amorphous silicon (α-Si) have been proposed. First is solid phase crystallization (SPC) [1.9]-[1.12]. SPC is an effective method for forming poly-Si films with uniform and large grain size, but many crystalline defects at grain boundaries as well as inter-grain defect and intra-grain defect. Additionally, SPC needs for long time to crystallization of amorphous silicon (>20 hrs) [1.11] by low temperature furnace (600℃), So the throughput was difficult to improve. Second is metal induce lateral crystallization (MILC) [1.13]-[1.16], this method can reduce the crystallization time and process temperature (below 550℃). There are two kinds of crystallization mechanisms related with silicide formation. Stress-induced crystallization which stress is due to the difference in Si mass density between α-Si and silicide, and SMC (silicide-mediated crystallization) requires a formation of silicide with the same lattice structure and a similar lattice constant with Si. For instance at Ni-MILC, Ni and Si form octahedral precipitates $NiSi_2$. The $NiSi_2$ precipitates acts as nucleation site for crystallization. Needlelike crystallites are formed as a result of migration of the migration of the $NiSi_2$ precipitates through the a-Si network [1.17]. However, poly-Si includes many metal impurities, which may lead to the degradation of device performance. Third is excimer-laser annealing (ELA) [1.18]-[1.19]. Amorphous silicon film was heat to melting point by excimer laser irradiation, and re-crystallization to poly-Si without thermal damage of glass substrate. The device characteristic of ELA method is better than other methods, such as high field effect mobility, low subthreshold swing (S) value and low threshold voltage [1.20].

Many reports have shown that hydrogen and ammonia plasma passivation not only compensated defects at the grain boundaries as well as inside the grains, but also reduced trap densities at the gate dielectric and channel interface [1-21]-[1-22]. The hydrogen

atoms can passivated dangling bonds in the poly-Si channel, remarkably improving device characteristics. However, NH_3 plasma treatment can further improve TFTs property as compared with H2 plasma treatment [1-23]. In addition, pure oxygen and nitrogen plasma passivation are other effective techniques to improve the characteristic of the poly-Si TFTs. In this study, we will discuss effects of NH3 plasma passivation time on TFTs performance, including the new structure and conventional TFTs electrical property. And also compare the device characteristic of Top-gate and Bottom-gate structure.

The several reports are reduction the lateral electric field by change the device structure to decrease the off-state leakage current. The Offset-structure has been used to reduce the drain electric field, thereby reducing the leakage current. However, this structure also significantly reduces the ON current due to extra series resistance introduced [1-24]. Then the GOLDD structure has been introduced, it can effective reduce the leakage current and ON current degraded slightly [1-25], and it will additional the extra mask. In this paper, we design a new structure to reduce the leakage current by decrease the lateral electric field and without addition mask.

1.2 Organization of This Thesis:

In this thesis, we concentrate our efforts on influences of NH_3 plasma passivation on electrical characteristics of p-type poly-Si thin film transistors. Chapter 1 describes the background and motivation. In chapter 2, the leakage current models are introduced and compare the bottom-gate and top-gate characteristic after and before NH_3 plasma treatment. We also verified physical properties from SIMS analysis. In chapter 3, T-shape gate structure was introduced to reduce the off-state leakage by decrease the lateral electric field. We study the NH3 plasma treatment and hot carrier endurance of T-gate poly-Si TFT. At last, in chapter 4, a conclusion is given for this thesis, and some future works extended from our investigation are proposed.