Contents

Chinese Abstract **I**

English Abstract **III**

Acknowledgment (Chinese) **V**

Content **VI**

Table Captions **VIII**

Figure Captions **IX**

Chapter.1 Introduction

1.1 Background 1

1.2 Overview of grain control technologies 2

1.3 Introduction of diamond like carbon (DLC) 3

1.4 Laser crystallization mechanisms 3

1.5 Grain barrier carrier transport mechanism under high lateral field In poly-Si TFTs 4

1.5.1 Seto' s model 4

1.5.2 Possible grain boundary carrier transport mechanism in poly-Si TFTs 6

1.6 Motivation 9

1.7 Thesis outline 10

Chapter.2 Experimental and Material Analysis

2.1 Instrument 12

2.1.1 Introduction of laser crystallization instrument 12

2.1.2 Introduction of Raman 13

2.2 Diamond like carbon characteristics 13

2.2.1 Diamond like carbon deposition 13

2.2.2 Material analysis 13

2.3 Amorphous silicon thin film with and without capped DLC crystallized by ELA 15

2.3.1 Sample fabrication and Laser irradiation 15

2.3.2 Material analysis 16

2.4 Crystallization mechanism for 1000A a-Si with heat retaining Layer of DLC 18

Chapter.3 Analysis of Kink Effect in Poly-Si TFTs

3.1 Possible kink effect related mechanisms 20

3.2 Device Fabrication 20

3.3 Parameter extracted method 21

3.4 Electrical characteristics 22

3.4.1 Different laser crystallized quality 22

3.4.2 Different bias voltage 24

3.4.3 Different laser crystallization 24

3.4.4 Kink current 25

Chapter.4 Conclusion 27

Reference 30

Tables

Figures

Table Captions

Table I. The average grain size of different laser energy (scan pitch fixed to 2um)

Table II The trap density of ELA (380mJ/cm^2) and SSL with laser energy density of 415mJ/cm^2 to 507mJ/cm^2.

Figure Caption

Chapter 1

Fig.1-4-1 The simple schematic diagram of melted silicon (a) flow from the edge to the middle (b) flow from the middle to the edge during crystallization

Fig.1-5-1 The distribution of the charges in poly-Si

Fig.1-5-2 The relationship between energy barrier height and gate voltage

Fig.1-5-3 The output characteristic of device before and after passivation

Fig.1-5-4 The “activation energy” is from this charged trap energy level to the conduction band edge

Chapter 2

Fig.2-2-1 The reflectivity of DLC film. The thickness of DLC is 100*nm*

Fig.2-2-2 The transmittance of DLC film. The thickness of DLC is 100*nm*

Fig.2-2-3 The Raman spectrum of DLC before and after laser irradiated by 300 to 500mJ/cm^2

Fig.2-2-4 The calculated absorptivity of DLC films before and after laser irradiation with laser energy density of 300 and 500mJ/cm^2

Fig.2-3-1 The cross-section of sample A. The space between DLC pattern are 3,6,10,20,30,50*um* and the length of DLC are 4,6,8,12,16,20,30,60*um*

Fig.2-3-2 (a) The cross-section of sample B. (b) The cross-section of reference of sample B

Fig.2-3-3 The optical picture, of sample A with the laser energy of (a) 400mJ/cm^2 (b) 500mJ/cm^2 (c) 600mJ/cm^2

Fig.2-3-4 The AFM result of the region near the middle of the DLC patterns

Fig.2-3-5 SEM image of sample A with laser energy density of (a) 400mJ/cm^2 (b) 500mJ/cm^2 (c) 600mJ/cm^2

Fig.2-3-6 (a) The position of Raman irradiated (b) The Raman spectra of different position which is shown as (a)

Fig.2-3-7 The Raman result of sample A with the laser energy of (a) 400mJ/cm^2 (b) 500mJ/cm^2 (c) 600mJ/cm^2

Fig.2-3-8 The Raman spectra for sample B at the position of poly-silicon near DLC patterns with the laser energy of (a) 500mJ/cm^2 (b) 600 mJ/cm^2 (c) The Raman spectra for the reference sample of sample B without DLC patterns

Fig.2-4-1 The schematic diagram of the proposed crystallization process

Chapter 3

Fig.3-2-1 The cross-section of view of poly-Si TFT with self-align source/drain

Fig.3-3-1 The saturation voltage at various gate voltages can be defined from the "first" minimum points of the conductance

Fig.3-3-2 The kink current I_{KINK} can be evaluated by using the drain current at high drain voltage to minus the rectified saturation current, such that $I_{KINK}=I_D-I_{D,SAT}$

Fig.3-3-3 Arrhenius plot of the drain current of TFT with different gate voltages and $V_{DS}=0.1V$. The slope of each line defines the activation energy at the grain boundary

Fig 3-3-4 The average trap density was extracted from slope of this plot

Fig.3-4-1 The model of grain boundary accelerated electron. The grain boundary barrier height is fixed. (a) carriers are accelerated by the grain boundary energy trop (b) larger grain size shows a gentler energy drop

Fig.3-4-2 (a) The grain boundary barrier height with the laser energy density of 415mJ/cm^2 (b) The multiplication factor with the laser energy density of 415mJ/cm^2

Fig.3-4-3 (a) The grain boundary barrier height with the laser energy density of 438mJ/cm^2 (b) The multiplication factor with the laser energy density of 438mJ/cm^2

Fig.3-4-4 (a) The grain boundary barrier height with the laser energy density of 507mJ/cm^2 (b) The multiplication factor with the laser energy density of 507mJ/cm^2

Fig.3-4-5 The average trap density of SSL with different grain sizes (from 0.1um-1um)

Fig.3-4-6 The multiplication factor of laser energy density form 415~507mJ/cm^2. Multiplication factor decreases with the laser energy density increases

Fig.3-4-7 The band diagram of the grain boundary accelerated electron affect by the drain voltage

Fig 3-4-8 The multiplication factor increases with the drain voltage. And the larger laser energy density shows less serious kink effect.

Fig.3-4-9 The multiplication factor is decreases with the gate voltage increases. Because of the effective lateral electric field lowering and the effective grain barrier height reduction

Fig.3-4-10 The multiplication factor of different laser energy density for a fixed V_D-$V_{D,SAT}$ value. The multiplication factor of a larger laser energy poly-Si film achieve a negligible small value faster

Fig.3-4-11 The grain barrier height of ELA and SSL 415mJ/cm^2 silicon films. The grain barrier height of ELA is larger than the SSL 415mJ/cm^2one

Fig.3-4-12 Under the same lateral electric field, the multiplication factor of ELA is larger than the one of SSL 415mJ/cm^2.

Fig.3-4-13 The grain barrier height of ELA and SSL 415~507mJ/cm^2. The grain barrier height of SSL is smaller than ELA. And also the grain sizes with laser energy density of 438mJ/cm^2 and 507mJ/cm^2 are much larger than ELA.

Fig.3-4-14 The grain size of SSL 438mJ/cm^2 and 507mJ/cm^2 is larger than ELA and the grain barrier height is also small than ELA. So the multiplication factor of SSL 438mJ/cm^2 and 507mJ/cm^2 is much smaller than ELA's.

Fig.3-4-15 The kink current of SSL with laser energy density from 415mJ/cm^2 to 507mJ/cm^2