

الآية

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

قال تعالى:

وَإِنْ تَعُدُّوا نِعْمَةَ اللَّهِ لَا تُحْصُوهَا إِنَّ اللَّهَ لَعَدُورٌ رَحِيمٌ (18).

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DEDICATION

To

My father and my mother

My sister Sara and my brother Mohammed alsadig

My wife Nuha and my sister samia

My daughters, Tayba, Zainab, and Lamar

My brothers Siddig Kardaman and Ali D. A. Alsiddig

The Contents

الآية.....	I
Acknowledgement.....	II
Dedication....	III
The contents	IV
List of Tables	VIII
List of Figures	IX

List of Abbreviations.....	XIII
Abstract.....	XV
المستخلص.....	XVII
Chapter One: Introduction and Basic Concepts	
1.1 Introduction	1
The study objectives	2
Thesis structure... ..	2
Laser industrial applications	2
1.4.1 Laser cutting	3
1.4.1.1 A comparison of CO ₂ and Nd:YAG laser cutting	5
1.4.2 Laser drilling	6
1.4.3 Laser welding	9
Laser cladding	10
1.4.5 Laser scabbling	11
1.4.6 Laser bending	12
1.4.7 Laser cleaning	13
1.4.8 Laser shot peening	14
1.4.9 Laser heat treatment	15
1.4.10 Laser Hardening	16
1.4.11 Velocity Measurement	17
1.4.11.1 Lasers in Information Storage	18
1.4.11.2 Bar Code Scanner	22
1.4.12 Precision Length Measurement	23
1.4.13 Laser Alloying	24
1.4.14. Laser glazing.....	25
CHAPTER TWO: Laser Micromachining and Annealing	
2.1 Introduction	27
2.2 Fabrication of PN-Junction Diode by IC Fabrication process	27
2.2.1 Fabrication Facilities	27
2.2.2 Fabrication Process	28

2.2.2.1 Silicon wafer cleaning (RCA process)	28
2.2.2.2 Oxidation	29
2.2.2.3 Photolithography	29
2.2.2.4 Oxide etching	30
2.2.2.5 Diffusion	30
2.2.2.6 Metallization	31
2.2.2.7 Photolithography	31
2.2.2.8 Metal Etching	31
2.2.2.9 Annealing	31
2.2.3 Processing Effects	32
2.2.4 Advantage	32
2.3 Diode Resistance	33
2.3.1 Static Resistance	33
2.3.2 Dynamic Resistance	33
2.3.2.1 Graphical analysis	34
2.3.2.2 Mathematical analysis	34
2.4. Laser micromachining	35
2.4.1. Resistor trimming	36
2.4.2 Laser direct –write	39
2.4.3 Laser marking	40
2.4.3.1 Laser marking mechanism	41
2.4.4 Hole drilling	42
2.5 Laser Annealing	44
2.5.1. Annealing - CW Lasers	46
2.5.2. Recrystallization.	49
2.5.3. Laser induced formation of silicide.	50
2.6 Literature review	53
CHAPTER THREE: Materials and Methods	
3.1 Introduction	60
3.2 Materials	60

3.3 Scanning electron microscope (SEM).....	62
3.3.1 Principles and capacities	63
3.3.2 Sample preparation	64
3.3.3 SEM Materials	65
3.3.4 Magnification	66
3.3.5 Beam-injection analysis of semiconductors	66
3.3.6 Cathodoluminescence	67
3.4 Sputter coating	67
3.5 Samples investigation methods	68
CHATER FOUR: Results and Discussion	
4.1 Introduction	69
4.2 Solid phase epitaxial regrowth (SPER)	69
4.3-The results of Laser annealing	71
4.3.1 Annealing by Nd:YAG laser ($\lambda = 1064$ nm), group I	71
4.3.2 Annealing by Nd:YAG laser ($\lambda = 532$ nm), group II	74
4.3.3 Annealing by CW CO ₂ laser, group III	78
4.3.4 Annealing by pulsed CO ₂ laser, group IV.....	80
4.4 The discussions	82
4.4.1 Annealing by Nd:YAG laser ($\lambda = 1064$ nm), group I.....	82
4.4.2 Annealing by Nd:YAG laser ($\lambda = 532$ nm), group II	84
4.4.3 Annealing by CW CO ₂ laser ($\lambda = 10.6$ μ m), group III.....	84
4.4.3 Annealing by pulsed CO ₂ laser ($\lambda = 10.6$ μ m), group IV	85
4.5 Conclusions	87
4.6 Future work	88
References	89

List of Tables

Table 1.1 The calculated time for a 2 kW beam focused to 0.2 mm spot diameter	8
Table 1.2 Comparison of various parameters of CD, DVD, and Blue Ray DVD	20
Table 2.1 Laser marking technologies	42
Table 2.2. Laser Applications in. Semiconductor Processing and Device Manufacture	45

Table 2.3. Electrical Properties and Structure Comparison of Different Laser Anneal Condition on $5 \times 10^{14} \text{ B}^+ \text{ cm}^{-2}$ Implanted Polysilicon.....	49
Table (3.1). Silicon diode parameters	60
Table (3.2) samples grouping.....	61
Table (3.3). Nd:YAG and CO2 laser types and specifications.....	62
Table (4.1) Dynamic resistance obtained at room temperature for diodes irradiated by Nd:YAG laser ($\lambda=1064 \text{ nm}$).....	72
Table (4.2). Data obtained at room temperature for the diodes irradiated by Nd:YAG laser ($\lambda=1064 \text{ nm}$).....	74
Table (4.3). Data obtained at room temperature for diodes irradiated by Nd: YAG laser ($\lambda=532 \text{ nm}$).....	76
Table 4.4. Data obtained at room temperature diodes irradiated by CW CO2 laser ($10.6 \mu\text{m}$).....	79
Table 4.5 Current- voltage for diodes irradiated at room temperature by single pulse from pulsed CO2 laser by different energies and pulse duration of 0.02 sec.....	81

List of Figures

Figure 1.1 A schematic of laser cutting. The lens mount or the nozzle (or both) can be adjusted from left to right or into and out of the plane of the sketch. This allows for centralisation of the focused beam with the nozzle. The vertical distance between the nozzle and the lens can also be adjusted.....	4
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Figure 1.2. An arrangement for measuring the back reflection signal from the process. This signal can be used to detect the moment of full penetration during laser drilling and, if measurements are made of the red and blue frequencies from the laser generated plasma, it can be used as a signal on the focal position.....	8
Figure 1.3 An example of laser bending being used to narrow a pipe while at the same time thickening the walls in the narrow section.....	13
Figure 1.4 Schematic of an arrangement for measuring the velocity of a moving object using Doppler shift.....	18
Fig. 1.5 In a compact disc (CD), information is stored in the form of pits along a spiral track.....	19
Fig. 1.6 In a CD, transition from land to pit or pit to land is read as “1s,” while the duration within the pit or the land is read as “0s”.....	20
Fig. 1.7 Comparison between the pit sizes in a CD and a DVD.....	21
Fig. 1.8 A laser beam is focused on the CD and the reflected intensity is read and converted into the signal.....	21
Fig. 1.9 Reading of a CD at a wavelength of 780 nm and a DVD at a wavelength of 650 nm.....	21
Fig. 1.10 A bar code consisting of series of strips of dark and white bands.....	22
Fig. 1.11 A laser beam is scanned across the bar code and the scattered light is focused on a detector which converts the code into	

information.....	22
Figure 1.12 Laser interferometer arrangement for precision length measurements.....	24
Figure 2.1. Current – Volt characteristic of silicon diode	34
Figure 2.2. Resistor trimming by (a) removal of discrete areas and (b) by cutting lines.....	36
Figure 2.3 Various resistor trimming patterns.....	37
Figure 2.4. Possible problems in laser trimming of resistors. Detritus in the kerf, microcracks in the region surrounding the kerf, current crowding in the shocked zone (due to poor geometrical design), and Q-switched trail are the major potential sources of trouble in a laser trimming operation.....	39
Figure 2.5. Schematic of laser direct-write addition process showing deposition within the substrate.....	40
Fig. (2.6) 355 nm-laser drilled hole in SiC after etching and metallization.....	43
Figure 2.7. System for CW annealing with Ar ⁺ laser.....	46
Figure 2.8. As concentration profile in As-implanted Si after laser anneal and thermal anneal.....	47
Figure 2.9. Transmission electron micrograph of B-implanted laser annealed sample at laser scan boundary	49
Figure 2.10. Optical transmission micrograph of a laser crystallized Ge	

film showing periodic structural features. Inset: expanded view illustrating four different microstructure regions.....	50
Figure 3.1 Scanning electron microscope.....	62
Figure(4.1) Scanning Electron Microscope (SEM) image for the surface of silicon diode after conventional annealing.....	70
Figure(4.2) Scanning Electron Microscope (SEM) images (a) 1000 mJ, 3Hz (b) 1000mJ, 4Hz (c) 1000mJ, 5Hz.....	72
Figure (4.3), the change of dynamic resistance of the diodes with pulse repetition rate.....	73
Figure (4.4), I-V characteristics of samples irradiated with pulse energy of 1000 mJ and variable repetition rate by Nd:YAG laser ($\lambda=1064$ nm).....	73
Figure(4.5) Scanning Electron Microscope (SEM) of silicon diodes irradiated by Q-switched Nd:YAG ($\lambda = 532$ nm (a) 350 mJ, 3Hz (b) 300 mJ, 4Hz (c) 400 mJ, 3Hz (d) 450 mJ, 4Hz.....	75
Figure (4.6) I-V characteristics for the diodes irradiated with Nd:YAG/second harmonic generation ($\lambda= 532$ nm).....	77
Figure (4.7) the dynamic resistance for the diodes irradiated with Nd:YAG/second harmonic generation ($\lambda= 532$ nm).....	77
Figure (4.8) the dynamic resistance for the samples irradiated with CW CO ₂ laser with different powers.....	78
Figure (4.9). Current-voltage characteristics of the diodes treated by	

different laser powers of CW CO ₂ laser.....	79
Figure 4.10, I-V characteristics for diodes irradiated by single pulse from CO ₂ laser with different energies with pulse duration of 0.02 sec..	80
Figure (4.11), the dynamic resistance of the diodes irradiated with single pulse by CO ₂ laser with different energies and pulse duration of 0.02 sec.....	81
(4.12) Illustration of the structural changes induced by laser irradiation of an a-Si overlayer on c-Si.....	82

List of abbreviations

a/c	amorphous/crystalline
a-Si	amorphous- Silicon
AFM	Atomic Force Microscopy
BSE	Back-Scattered Electrons
BST	Barium Strontium Titanate
DC	Direct Current
CRT	Cathode Ray Tube

CL	Cathodoluminescence
CNC	Computer Numerical Control
CD	Compact discs
CL	Cathodoluminescence)
c-Si	crystalline Silicon
CVD	Chemical Vapor Deposition
CW	Continuous Wave
DC	Direct Current
DEP	Di Electro Phoresis
DPSS	Diode Pumped Solid State
DVD	Digital Video Disc
ELA	Excimer Laser Annealing
ESEM	Environmental SEM
FA	Furnace Annealing
FEG	field emission guns
FG	fine-grained
FM	Ferromagnetic
FWHM	full-width-at-half-maximum
GIXRD	Grazing Incidence X-ray Diffraction
IC	Integrated Circuit
IGBT	Insulated Gate Bipolar Transistor
IR	Infrared
IZO	indium–zinc oxide
LA	Laser Annealing
LDW	Laser direct-write
LG	Large Grain
LPE	liquid phase epitaxy
LOCOS	Local-Oxidation-Of-Silicon
LO	Longitudinal Optical
MLG	Multi-Layer Graphene
MSM	Metal -Semiconductor–Metal
MWCNTs	Multi-Wall Carbon Nanotubes
Nd:YAG	Neodymium-doped yttrium aluminium garnet
Nd:YVO ₄ ,	Neodymium-doped yttrium orthovanadate
PAI	Pre Amorphised Silicon

QWI	Quantum Well Intermixed
QW	Quantum Well
RTA	Rapid Thermal Annealing
SEM	Scanning Electron Microscopy
SEI	Secondary Electron Imaging
SE	secondary electrons
SPER	Solid Phase Epitaxial Regrowth
SLD	Superluminescent Diodes
SoP	System-On-Package
TCE	trichloroethylene
TGM	Thermal Gradient Method'
TRR	Time resolved reflectivity
TEM-SAED	Transmission Electron Microscope -Selected Area Electron Diffraction
VCE	Collector-Emitter Voltage
VLSI	Very Large Scale Integration
VUV	Vacuum Ultra-Violet
XRD	X-ray diffraction measurements

Abstract

In this work, enhancement of defects arising from conventional thermal annealing, electrical characteristics and dynamic resistance of silicon diode has been carried out by using two types of lasers in order to improve the electrical characteristics of these silicon diodes

First: Q-switched Nd:YAG laser (1064 nm) was applied with pulse energy of 1000 mj with repetition rate of 3,4 and 5 Hz, respectively. The Results

obtained from the I-V characteristics of silicon diode showed an improvement in the curve behavior, and the dynamic resistance. Calculations based on diode I-V characteristic, showed a decrease in dynamic resistance value from 3.56 to 2.64 Ω , and the forward voltage from 0.7 to 0.64 V with increasing pulse repetition rate to 5 Hz. The Scanning Electron Microscope (SEM) images showed also a reduction of defects in silicon diode surface after laser annealing. In the case of the silicon diodes which were irradiated by Q-switched Nd:YAG laser (532 nm) with energy dose ranged between 1×10^{-9} and 1.8×10^{-9} J, a slight improvement in the surface defects, I-V characteristics, and dynamic resistance were noticed where the dynamic resistance decreased from 3.56 to 3.16 Ω .

Second: By using two kinds of CO₂ lasers, CW CO₂ ($\lambda= 10.6 \mu\text{m}$) with power ranged from 5 to 30 W and pulsed CO₂ laser with pulse energy ranged between 500 to 600 mJ. In the case of CW laser with irradiation time of 5 seconds for each diode, an improvement in the I-V characteristic curve behavior and decreasing in dynamic resistance was resulted when the laser power reach 15 W, where the dynamic resistance was decreased from 3.16 to 2.6 Ω , and the forward voltage also decreased from 0.7 to 0.597 V. At laser power of 20, 25, and 30 W. The behavior of the I-V characteristics curve was changed, where the forward voltage increased from 0.7 to 0.72 V, and the dynamic resistance also increased from 3.16 to 3.48 Ω when the laser power reached 30 W. The silicon diodes irradiated 5 times for each diode by pulsed CO₂ laser with pulse energy ranged from 500 to 600 mJ, the results showed an improvement in the behavior of I-V characteristics curve, where the dynamic resistance and the forward voltage were decreased from 3.16 to 2.56 Ω and from 0.7 to 0.588 V at pulse energy of 600 mJ, respectively.

As conclusions, laser irradiation of silicon diodes improves the electrical characteristics of these diodes. The power of the CW lasers and pulse energy beside the frequency are the major parameters affect the diode characteristic.

Irradiation by excimer laser for silicon or germanium films, fabrication of gap capacitor and formation of silicide have been suggested as future work.

المستخلص

جرى في هذا البحث محاولة لتقليل العيوب الناشئة في الثنائي السيليكوني من جراء عملية التلدين الحراري التقليدي وكذلك تحسين الخصائص الكهربائية والمقاومة الديناميكية باستخدام نوعين من انواع الليزرات:

أولاً: ليزر النيوديميوم- ياق النبضي بطول موجي 1064 نانومتر و بطاقة نبضة مقدارها 1000 مل جول بمعدل تكرارية 3, 4 و 5 هيرتز على التوالي. النتائج المتحصل عليها من منحنى

خصائص التيار والجهد للتنائي السيليكوني في هذه الحالة اوضحت تحسن في سلوك وشكل المنحني وكذلك بينت النتائج انخفاض المقاومة الديناميكية من 3.56 أوم قبل التشعيع بالليزر الي 2.64 أوم بعد التشعيع بالليزر بطاقة نبضة قدرها 1000 ملي جول ومعدل تكرار نبضة 5 هيرتز, كما انخفض جهد الإنحياز الامامي من 0.7 فولت الي 0.64 فولت عند نفس قيمة الطاقة ومعدل تكرار النبضة. اوضحت الصور الماخوذة بواسطة الميكروسكوب الالكتروني تحسن واضح في تقليل العيوب الناتجة عن التلدين التقليدي. اما عند استخدام الطول الموجي 532 نانوميتر من نفس الليزر وبجرعة طاقة تتراوح بين 10^{-9} الي 1.8×10^{-9} جول. فقد اظهرت النتائج المتحصل عليها تحسنا طفيفا في المقاومة الديناميكية حيث انخفضت قيمتها من 3.56 أوم قبل التشعيع بالليزر الي 3.16 أوم بعد التشعيع.

ثانيا: ليزر ثاني اكسيد الكربون ($\lambda = 10.6$ مايكروميتر) ذو الموجة المستمرة بقدرة تتراوح بين 5 الي 30 واط وزمن تشعيع 5 ثواني لكل ثنائي وليزر ثاني اكسيد الكربون النبضي بطاقة نبضة تتراوح بين 500 الي 600 ملي جول . اوضحت النتائج لليزر المستمر تحسن كبير في خائص التيار والجهد عند المعالجة الحرارية بقدرة تتراوح من 5 الي 15 واط. حيث انخفضت المقاومة الديناميكية من 3.16 أوم الي 2.6 أوم, وكذلك انخفض جهد الانحياز الامامي من 0.7 فولت الي 0.597 فولت. وعند زيادة القدرة اعلى من 15 واط كان تأثير الليزر سلبي على خواص الثنائي من حيث المقاومة الديناميكية وخصائص الجهد و التيار حيث زادت قيمة المقاومة الديناميكية من 3.16 أوم حتى وصلت الي 3.48 , و زاد ايضا جهد الانحياز الأمامي من 0.7 فولت الي 0.72 عند زيادة قدرة الليزر الي 30 واط .اما عند المعالجة الحرارية للتنائي السيليكوني بليزر ثاني اكسيد الكربون النبضي بطاقة نبضة تتراوح بين 500 الي 600 ملي جول وتكرار التشعيع 5 مرات لكل ثنائي سيليكوني.فقد اظهرت النتائج حدوث انخفاض في المقاومة الديناميكية وجهد الانحياز الامامي حيث انخفضت المقاومة الديناميكية من 3.16 أوم الي 2.56 أوم و جهد الأنحياز الأمامي من 0.7 فولت الي 0.588 فولت عند طاقة نبضة تساوي 600 ملي جول.

في خلاصة هذا البحث, نجد ان تشعيع الثنائيات المصنوعة من السليكون باستخدام الليزر أدى الي تحسين الخواص الكهربائية لهذه الثنائيات. وكذلك نجد ان قدرة الليز في حالة الليزر المستمر وطاقة النبضة في حالة الليزر النبضي بجانب معدل تكرار النبضة كانت عوامل مؤثرة حيث أثرت على خواص الثنائي.

تشعيع رقائق السيليكون والجرمانيوم باستخدام ليزر الإكسايمر, تكوين الفجوة الهوائية في المكثفات, و تكوين مركب السيليسيد (وهو عبارة عن مركب يحتوي على السيليكون مع عنصر نشط كهربائيا مثل البورون) اقترحت كعمل مستقبلي.