الآيـة

قال تعالى:

(وما تكـون في شأن وما تتلو منه من قرءان ولا تعملون من عمل إلا كنا عليكم شهودا إذ تفيضون فيه وما يعزب عن ربك من مثقال ذرة في الأرض ولا في السماء ولا اصغر من ذلك ولا أكبر إلا في كتاب مبين)

صدق الله العظيم

سورة يونس (اية 61)

Dedication

First persons whom I dedicate this work are My family members, especially my work is dedicated to the Souls of My ***Mother*** *"Aisha" and* ***Sister*** *"Nibras" whom I missed them and I will remember them every second in my life. To my* ***Father****, who always support and encourage me to go forward. Also my work is dedicated to my lovely sisters "***Nibras***" and "Fatima" and her daughter and son. To my Brothers: Mohaid, Ahmed, Abd Alraheim, and Fadi.*

My work is dedicated also to my small family,, my lovely wife ***Eman*** *she was patient with me, she was helped me and organize my life. She was keeping my note sheets that I was wrote during the course of this study... To the beautifully thing that I have in 2016 my Son "***Mohammed***" and to the One's whom comes after insha Allah.*

I also dedicate my work to the Souls of the following Professor's whom dead during the course of my study I will never forget them, they give me the power, the dream and they taught me several courses in my undergraduate study.. To the late Professor: ***Ahmed Khogali M. Khair*** *and the Associate Professor:* ***Badawi Mohamed Alamin*** *...*

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I would like to extend deep gratitude to my current Supervisor **Dr. Khalid Mohamed Haroun,** who helped me in organizing this Thesis and discussing with me the title, the content and the whole thesis up to a point of discussion. And also he discussed with me and organized the article: Pulse Energy Effect on the Optical Properties of Pulse Laser deposited SiO_2 Thin Films.

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Abstract

The field of this research is thin films fabrication using pulse laser deposition technique. The main objectives of this work were to fabricate some oxide (such as SiO_2) thin films using pulsed laser deposition technique (PLD) and to study the optical properties of the fabricated thin films. Also this research aimed to study the effect of laser parameters (properties) mainly the laser pulse energy and pulse repetition rate on the optical properties at certain wavelengths (transmission spectra, refractive indices and absorption coefficients) of the fabricated thin films. In this research silicon dioxide (SiO_2) thin films were deposited on glass substrate from SiO_2 solid disk using pulsed laser deposition technique. In this technique a Q-Switch Nd: YAG laser emitting the fundamental wavelength 1064 nm with pulse duration of 10 nanosecond was used to produce nine samples of SiO_2 thin films, five of them were fabricated by changing the pulse energy and the four samples were deposited by varying the pulse repetition rate.

The fabricated SiO_2 thin films were inspected and each film thickness was measured using scanning electron microscope MIRA3 type. Then the transmission spectrum at certain wavelengths from different monochromatic light sources for each film was recorded. SiO_2 thin films transmission data and the measured films thicknesses were used to deduce their optical properties. The results showed that increasing the laser pulse energy results in an increase of the film thickness from 0.39 µm when the laser pulse energy was 100 mj to 0.71 µm when the laser pulse energy was 250 mj, and the morphology of the films becomes more dense and non-smooth at higher pulse energy, also the optical properties showed to be affected by the thickness variation and hence by the laser pulse energy. The results also showed that increasing the pulse repetition rate results in an increase of the film thickness from 0.39 μm at 2 Hz repetition rate to 1.04 μm when the pulse repetition rate was 5 Hz and it was noticed that increasing the pulse repetition rate results in more dense and non-smooth film morphology. Also the optical properties of the produced films were found to be highly dependent on the film thickness and hence on the pulse repetition rate used in fabrication of films.

The results showed that the transmission spectra of the samples were in the range from (0.85 to 0.97) %. And The optical absorption coefficients of the samples were varied from $38.461*10^3$ cm^{-1} and $12.250*10^3$ cm^{-1} depending on the thickness of the thin film, and the refractive indices were found to be varied from 1.43 to 1.67 with the wavelengths from 532 nm to 915 nm, and the optical properties (transmission spectra, refractive indices, and the absorption coefficients) of the SiO_2 thin films were in good agreement with literature.

المستخلص

يعد هذا البحث ضمن مجال تصنيع الاغشية الرقيقة المصنعة بتقانة الترسيب بالليزر النبضي. تتمثل الاهداف الرئيسة لهذا البحث في تصنيع اغشية بعض الاكاسيد (كثاني اكسيد السيليكون) الرقيقة بإستخدام تقانة الترسيب بالليزر النبضي ودراسة الخصائص البصرية للأغشية الرقيقة المصنعة. أيضا يهدف هذا البحث لدراسة اثر معاملات (خصائص) الليزر تحديدا طاقة نبضة الليزر ومعدل تكرار النبضات علي الخصائص البصرية (أطياف النفاذ، معاملات الانكسار ومعاملات الإمتصاص) للاغشية الرقيقة المصنعة عند أطوال موجية محددة. في هذا البحث تم ترسيب اغشية ثاني اكسيد السيليكون علي ركائزالزجاج من اقراص ثاني اكسيد السيليكون الصلبة باستخدام تقانة الترسيب بالليزر النبضي. في هذه التقانة ليزر نيوديوم- ياك ذو التشغيل المفتاحي ذو الطول الموجي الاساسي (1064) نانومتر بزمن نبضة 10 نانوثانية استخدم لانتاج تسعة عينات من اغشية ثاني اكسيد السيليكون، خمسة منها صنعت بتغيير طاقة النبضة واربعة منها رسبت بتغيير معدل تكرار النبضات.

تم فحص أغشية ثاني اكسيد السيليكون المحضرة وتم قياس سماكة كل غشاء باستخدام المجهر الالكتروني الماسح نوع MIRA3. ومن ثم تم تسجيل طيف النفاذ عند اطوال موجية محددة من مصادر ضوئية أحادية الطول الموجي لكل غشاء. بيانات النفاذ المسجلة لاغشية ثاني اكسيد السيليكون مع سماكات الاغشية المقاسة تم استخدامهم لاستنتاج خصائصهاالبصرية. قد أوضحت النتائج ان زيادة طاقة نبضة الليزر تؤدي الي زيادة سمك الغشاء من 0.39 ميكرون عندما كانت طاقة نبضة الليزر 100 ملي جول الي 0.71 ميكرون عندما كانت طاقة نبضة الليزر 250 ملي جول،وان تكوين الغشاء يصبح اكثركثافة وغير مستوي عند طاقة النبضة العالية، ايضا أن الخصائص البصرية للأغشية المصنعة تتأثر بتغيير سمك الغشاء وبالتالي بطاقة نبضة الليزر. وكذلك أوضحت الدراسة ان زيادة معدل تكرار النبضات يؤدي الي زيادة سمك الغشاء من 0.39 ميكرون عند 2 هيرتز الي 1.04 ميكرون عندما كان معدل تكرار النبضة 5 هيرتزولوحظ أن زيادة معدل تكرار النبضة يؤدي الي تكوين غشاء اكثر كثافة و سطح غير مستوي . ايضا وجد ان الخصائص البصرية للأغشية المنتجة تعتمد اعتمادا كبيرا علي سماكة الغشاء وبالتالي علي معدل تكرار النبضات المستخدم.

وكذلك أوضحت الدراسة ان اطياف النفاذ للعينات تكون في المدى من (0.85 الي 0.97)%. وأن معاملات الإمتصاص البصري للعينات تتغير من $38.461*10^{3}$ سم$^{-1}$ و $12.250*10^{3}$ سم$^{-1}$ وذلك إعتمادا علي سمك الغشاء الرقيق، ووجد أن معاملات الإنكسار تتغير من 1.43 الي 1.67 مع الاطوال الموجية في المدى 532 نانومتر الي 915 نانومتر، وقد اتفقت الخصائص البصرية لاغشية ثاني اكسيد السيليكون (اطياف النفاذ، معاملات الانكسار ومعاملات الامتصاص) مع الدراسات السابقة.

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List of Abbreviations

Abbreviation	Stands for
AES	**Auger Electron Spectroscopy**
AFM	**Atomic Force Microscopy**
APCVD	**Atmospheric-Pressure Chemical Vapor Deposition**
A. R .	**Anti-reflection**
ARE	**Activated Reactive Evaporation**
BDT	**Beam Deceleration Technology**
CBD	**Cluster beam deposition**
CAAC	**C-Axis-Aligned Crystalline**
CDW	**Charge Density Wave**
CVD	**Chemical Vapor Deposition**
CW	**Continuous Wave**
EDX	**Energy Dispersive X-Ray**
EBSD	**Electron back scatter diffraction**
GLAD	**Glancing Angle Deposition**
GMR	**Giant Magneto-Resistance**
FESEM	**Field Emission Scanning Electron Microscope**
Fig.	**Figure**
Fs	**Femtosecond**
HTS	**High-Temperature Superconducting**
IB	**Inverse Bremsstrahlung**
IGZO	**Indium Gallium Zinc Oxide**
IML	**Intermediate Lens**
LA-ICP-MS	**Laser-Ablation Inductively Coupled Plasma Mass Spectrometry**
LCDs	**Liquid Crystal Displays**
LEDs	**Light Emitting Diodes**
LIBS	**Laser-Induced Breakdown Spectroscopy**
LPCVD	**Low Pressure Chemical Vapor Deposition**
MBE	**Molecular-Beam Epitaxy**
MIT	**Metal-Insulator Transition**
MOCVD	**Metal Organic Chemical vapor deposition**
MOSFET	**Metal-Oxide Semiconductor Field Effect Transistor**
OLEDs	**Organic light-emitting diodes**
PEPLD	**Plasma-Enhanced Pulsed Laser Deposition**

PHCVD	**Photo –Enhanced Chemical Vapor Deposition**
PI	**Photoionization**
PLA	**Pulse Laser Ablation**
PLD	**Pulse Laser Deposition**
PVD	**Physical Vapor Deposition**
RBS	**Rutherford Backscattering Spectroscopy**
RGO	**Reduced Graphene Oxide**
RHEED	**Reflection High Energy Electron Diffraction**
SEM	**Scanning Electron Microscopy**
SIMS	**Secondary Ion Mass Spectroscopy**
TCOs	**Transparent Conducting Oxides**
TEM	**Transmission Electron Microscopy**
TFT	**Thin-Film Transistor**
WDS	**Wavelength Dispersive Spectroscopy**
XAS	**X-ray Absorption Spectroscopy**
XRD	**X-Ray Diffraction**
XPS	**X-ray Photoemission Spectroscopy**