

**SUDAN UNIVERSITY OF SCIENCES AND TECHNOLOGY**

**COLLEGE OF GRADUATE STUDIES**

**Fabrication of CaO & Fe<sub>2</sub>O<sub>3</sub> Disks to Attenuate  
and Filtrate Some Visible and Infrared  
Wavelengths**

تصنيع أقراص من أكسيد الكالسيوم و أكسيد الحديد  
لتوهين وترشيح بعض الأطوال الموجية المرئية وتحت  
الحمراء

A Thesis Submitted for Partial Fulfillment of the Requirements for  
the Degree of M.Sc. in Laser Application in Physics

**BY:**

Sara Abu-Obieda Yousif Basheir

**SUPERVISED BY:**

Prof.Dr.Nafie Abd Al-Latief Al-Muslet

May 2009

بِسْمِ اللّٰهِ الرَّحْمٰنِ الرَّحِیْمِ

ا قرأ باسم ربك الذي خلق (١) \* خلق ”  
الإنسان من علق (٢) \* ا قرأ وربك الأكرم (٣)  
\* الذي علم بالقلم (٤) \* علم الانسان ما لم  
” (يعلم) ٥

سورة العلق

صدق الله العظيم

# **Dedication**

**To my family .....,  
Who gave me self  
confident, knowledge,  
education, happiness and  
future.**

**To my staff in work.....  
Who supported,  
encouraged and taught me,  
to achieve this goal,  
To my friends**

**Who are my side, helped  
and guided to be loyal,  
respectful and thankful to  
all of those.**

## **Acknowledgment**

I can truthfully say this work would not have been completed without **GOD** then their assistance.

With deep appreciation to my supervised **Prof.Dr.Nafie Abd Al-Latief Al-Muslet** for every thing to finished this work.

I would like to thank Khartoum university and all the staffs of chemistry department in that university specially **Technician Johnson Isaac Madol Pam** who helped me to find my materials. I will be failing if I not mention **Mr. Mohamed Kuku Mohamed** in stack laboratory" store department", who found the last material that I was search for it. Their cooperation is really appreciated.

I would thank my **family** inside and outside the Sudan country for their enduring, support and indispensable assistance with this project. Finally, I would not forget all the staff in **Institute of laser** who gave me encouragement to undertake this effort.

## Abstract

In this work some optical attenuators and filters for some wavelengths in the visible and infrared regions of the electromagnetic spectrum were designed and fabricated.

The selected materials in this work were Calcium Oxide and Iron (III) Oxide.

By pressing each of those materials with Potassium Bromide using a classic pressing machine, different disks were produced.

Two groups of disks were produced: group with different thickness of the CaO. And group two with different thickness of  $\text{Fe}_2\text{O}_3$ . The produced disks were rigid enough to be dealt with.

Using a photodetector accompanied with digital multimeter, the incident and transmitted laser intensity for each disk were recorded and plotted.

The absorption coefficient and the transmission spectrum were determined for the wavelengths: [(532), (632.8), (675), (810), (820), (940) and (1064)] nm.

The results showed that the CaO disks can be used as a filter for the wavelength 810 nm.

Also the  $\text{Fe}_2\text{O}_3$  disks can be used as good monochromatic filters for the wavelength 1064 nm and as attenuators for the wavelengths 532nm and 632.8 nm.

## المستخلص

في هذا العمل تم تصميم وتصنيع موهنات ومرشحات بصرية لبعض الأطوال الموجية في المنطقتين المرئية وتحت الحمراء من الطيف الكهرومغناطيسي.

والمواد المختارة في هذه الدراسة هي أكسيد الكالسيوم و أكسيد الحديد التي تم تصنيع الموهنات والمرشحات في شكل أقراص حيث تم ضغط كل من أكسيد الكالسيوم و أكسيد الحديد على حدة مع مسحوق بروميد البوتاسيوم بواسطة ماكينة ضغط تقليدية والتي هي طريقة التشكل بالقولبة.

وتم إنتاج مجموعتين من الأقرص : المجموعة الأولى هي مجموعة مادة أكسيد الكالسيوم حيث كانت الأقرص ذات سماكات مختلفة ومتناسكة بدرجة جيدة يمكن التعامل معها بسهولة.

والمجموعة الثانية هي مجموعة مادة أكسيد الحديد وأيضا بسماكات مختلفة.

و قد تم قياس شدات الليزر الساقطة والنافذة من هذه الأقرص وذلك باستخدام كاشف ضوئي وفولتميتر رقمي حساس ومن ثم دونت النتائج ومثلت بيانياً. و قد تم تحديد معامل الامتصاص وطيف النفاذية لليزر المستخدمة ذات الأطوال الموجية التالية : [ (٥٣٢) , ( ٦٣٢,8 ) , (٦٧٥) , (٨١٠) , (٨٢٠) , (٩٤٠) , (١٠٦٤) ] نانومتر.

و قد أثبتت النتائج إمكانية استخدام مادة أكسيد الكالسيوم كمرشح للطول الموجي ٨١٠ نانومتر وأيضا لبعض الأطوال الموجية لكن بنسب مختلف.

أما بالنسبة لمادة أكسيد الحديد فهي مرشح أحادي للطول الموجي ١٠٦٤ نانومتر وموهن للطول الموجي ٥٣٢ نانومتر وأيضا للطول الموجي ٦٣٢,8 نانومتر.

# Contents

	II
	الآية
<b>Dedication</b>	<b>III</b>
<b>Acknowledgment</b>	<b>IV</b>
	<b>V Abstract</b>
المستخلص	<b>VI</b>
<b>Chapter one</b>	<b>1</b>
1-1 <b>Introduction</b>	1
1-2 <b>Light-Matter Interaction.</b>	1
1-2-1 Reflection.	1
1-2-2 Refraction.	2
1-2-3 Absorption.	3
1-2-4 Scattering.	5
1-2-5 Microwave Interaction	6
1-2-6 Infrared Interaction	6
1-2-7 Visible Light Interaction	7

1-2-8 Ultraviolet Interaction	7
1-2-9 X-ray Interaction	7
<b>1-3 Laser Fundamentals</b>	<b>7</b>
1-3-1 Absorption and Stimulated Emission.	8
Laser Elements	9 1-3-2
Active Medium	9 1-3-2-1
Excitation Mechanism	10 1-3-2-2
Feedback Mechanism	11 1-3-2-3
Output Coupler	11 1-3-2-4
1-3-3 Laser Properties.	
1-3-3-1 Coherence.	11
1-3-3-2 High Brightness and Intensity.	12
1-3-3-3 Directionality.	14
1-3-3-4 Monochromaticity.	14
1-3-3-5 Focusability.	14
1-3-4 Modes of Operation.	15
1-3-5 Laser Types.	15
1-3-6 Laser Applications.	17
<b>1-4 Detection of Light.</b>	<b>18</b>
1-4-1 Thermal Detectors.	19
1-4-2 Quantum Detectors.	19
<b>1-5 Optical materials and components.</b>	<b>19</b>
1-5-1 Optical Attenuator.	20
1-5-2 Optical Filter.	20



<b>1-6 Aim of the Work</b>	<b>22</b>
<b>Chapter two</b>	<b>23</b>
<b>2-1 Introduction</b>	<b>23</b>
<b>2-2 The Materials</b>	<b>23</b>
2-2-1 CaO (Calcium Oxide)	23
2-2-2 Fe <sub>2</sub> O <sub>3</sub> (Iron (III) Oxide)	24
2-2-3 KBr (Potassium Bromide)	25
<b>2-3 The Used Equipments</b>	<b>26</b>
2-3-1 Fourier Transform Infrared Spectrophotometer	26
2-3-2 UV- VIS Spectrophotometer	27
2-3-3 The Pressing Machine and its Parts	28
2-3-4 The Lasers Sources.	28
2-3-4-1 Diode Laser 532 nm	29
2-3-4-2 HeNe Laser 632.8 nm	29
2-3-4-3 Diode Laser 675 nm and 820 nm	29
2-3-4-4 Diode Laser 810 nm	30
2-3-4-5 Diode Laser 940 nm	31
2-3-4-6 Nd-YAG Laser 1064nm	32
2-3-5 The Digital Multimeter.	32
2-3-6 Photodetector.	32
<b>2-4 Methodology and Setup</b>	<b>33</b>
2-4-1 Fabrication of Disks	33
2-4-2 Experimental Procedure.	34
2-4-3 Calculation of the Absorption Coefficients.	35

2-4-4 Determination of the Absorption Spectrum for each Disk.	36
<b>Chapter Three</b>	<b>37</b>
<b>3-1 Introduction</b>	<b>37</b>
<b>3-2 Results of CaO Disks</b>	<b>37</b>
3-2-1 Determination of the Absorption Coefficient for each Wavelength.	37
3-2-2 Determination of the Transmission Spectrum for CaO Disks.	43
<b>3-3 Results of Fe<sub>2</sub>O<sub>3</sub> Disks</b>	<b>47</b>
3-3-1 Determination of the Absorption Coefficient for each Wavelength .	47
3-3-2 Determination of the Transmission Spectrum for Fe <sub>2</sub> O <sub>3</sub> Disk.	52
<b>3-4 Discussion</b>	<b>56</b>
<b>3-5 Conclusions</b>	<b>58</b>
<b>3-6 Future Work</b>	<b>58</b>
<b>References</b>	<b>59</b>

