SUDAN UNIVERSITY OF SCIENCE AND TECHNOLOGY
COLLEGE OF GRADUATE STUDIES

FABRICATION OF CuO DISKS TO ATTENUATE AND FILTER SOME VISIBLE AND I.R. WAVELENGTHS

A THESIS SUBMITTED FOR PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF M.Sc. IN PHYSICS

By:
MOHAMMED SULEIMAN HUSSEIN SULEIMAN

Supervised by:
Prof. Dr. NAFIE ABD AL-LATIEF AL-MUSLET
Institute of Laser

DECEMBER 2006

Dedication`

This work is dedicated to the marvelous success of my sister, Um-Alharith, at her B.Sc. final exams.

ACKNOWLEDGEMENTS

"Who does not thank people will never thank Allah"

First of all, I thank my god for the uncountable granted blessings and for the help in completion of this work.

I am indeed indebted to the expert guidance I received from my supervisor, Prof. Nafie, who very patiently gave me all the stimuli required to complete this work, and whose constant encouragement have made me go a head with this work, in spite of many set backs.

I am at loss when I think of expressing my sincere gratitude to those, who helped me in this work, with their assistance in various forms at various times. While the list is very large, to accommodate in this limited space, I will be failing if I do not mention the members of the department of chemistry (at Sudan University of Science and Technology), my colleagues at the Institute of Laser, specially my classmate Suleiman Al-Tyib and Mr. Abbass, my classmates at the M.Sc. programme, specially Mr. Mustafa Ahmed, the staff of the Institute of Environment Researches, and Mr. Asaad (at the department of chemistry, University of Khartoum).

It would never have been possible for me to complete this work without the support of my mother (to whom I owe everything), my two sisters, my wife and my brother, whom without their prayers, constant encouragement, continuous services and patience; this work would never have seen the light . .

Finally, I would like to express my sincere appreciation to my two little daughters, whom their lovely smiles left a lasting fervent impressions on me.

□□□□□□□□

الهدف من هذه الدراسة هو تصميم و تصنيع مُوهِّنات و مُرشِّحات بصرية لبعض الأطوال الموجية في المنط قتين المرئيّة و تحت الحمراء من الطيف الكهرومغناطيسي.

تمّ اختيار المواد الداخلة في تصنيع هذه المكونات بالم قام الأول اعتماداً على الفحوصات الطيفية الأوّلِيّة و التي تمّ إجراؤها بواسطة الم قاييس الطيفية التالية : (UV-VIS. NIR spectrophotometer) ، (spectrophotometer) و (FT-IR spectrometer).

تمّ ضغط خليط من مسحوق أكسيد النحاس و مسحوق بروميد البوتاسيوم بواسطة ماكينة ضغط و ذلك بإتباع طري قة التشكيل بال قولبة. تمّ إنتاج ط قمين من الأ قراص : ط قم به أ قراص ذات سماكات متساوية لكنها تختلف في تراكيز أكسيد النحاس فيها، و ط قم به تركيز ثابت من أكسيد النحاس إلاّ أنّ الأ قراص فيه لها سماكات مختلفة. الأ قراص المُنتَجة كانت متماسكة بدرجة جيدة و يمكن التعامل معها بسهولة.

تمّ اختبار خصائص توهين لهذه الأقراص لليزرات ذات الأطوال الموجية : (675، 820، و 1064 نانوميتر) و ذلك باستخدام كاشف ضوئي و فولتميتر ر قمي حسّاس، حيث تمّ قياس شدّات الأشعة السا قطة و النافذة، و من ثمّ دونت النتائج و مثّلت بيانياً، و تمّ منها

حساب امتصاصيات هذه الأ قراص كدوالّ في الأطوال الموجية المستهدفة. أثبتت النتائجُ درجةً عاليةً من الاعتمادية على هذه الأ قراص بغرض استخدامها كموهِّناتلاّ يـزرات ذات الأطوال الموجية المذكورة. كما أُثبِت أنّ أ قراص الط قم الثاني – ذات التركيز الثابت – لها خصائص و كفاءة توهين أفضل، و ذلك لثبات انعكاسيتها. جميع هذه الـ قياسات تمّت عند السـ قوط العمودي للأشعة.

عن طريق الفحوصات الطيفية (التي أجريت في المدى 200-25000 نانوميتر) أمكن الحصول، من هذه الأ قراص، على مرشِّح تمرير نطا قي في المنط قة تحت الحمراء المتوسِّطة (2.5 – 25 ميكروميتر) عند طول موجيٍّ أعظميٍّ ($\lambda_m \sim 15.2\ \mu m$) و بعرض نطا قي ($\Delta\lambda_{0.5} \sim 1.9\ \mu m$). كما أُثبِت أنّه يمكن استخدام هذه الأ قراص كمرشحات ذات كثافة ضوئية متعادلة ND في المدى (2.5 – 10.0 ميكروميتر).

بناءاً على النتائج المتحصّلة، تمّ ا قتراح بعض الأعمال المستـ قبليّة.

ABSTRACT

The main objective of this work is to design and fabricate suitable optical attenuators and filters for some wavelengths in the visible and the infrared regions of the electromagnetic spectrum.

Selection of the attenuators materials was based mainly on the pre-spectroscopic investigations of these materials. These had been carried out using: UV-VIS. spectrophotometer, NIR spectrophotometer, and FT-IR spectrometer.

Using a classical pressing machine, copper oxide disks had been synthesized after mixing with potassium bromide. Two sets of disks were produced : a set with different concentrations of the CuO and constant physical thickness, and a set with different physical thicknesses and fixed concentration of CuO. The produced disks were rigid enough to be dealt with.

Using a photodetector, accompanied with digital multimeter, intensity attenuation measurements of these two sets for the wavelengths : 675, 820, and 1064 nm, were carried out. Graphs were plotted from the results and the absorptivities were calculated in each case showing a good liability of using these disks as good optical attenuators for the three tested laser beams at normal angle of incidence. It was noticed that the performance of the second set, with constant concentration of CuO, was better than the performance of the first set. This is because of the constant reflectance of the second set.

The spectral performance, extending from 200 to 25000 nm, of these disks were investigated. An optical pass-band filter in the middle IR region (2.5 – 25 μm) at wavelength (λ_m ~ 15.2 μm) with bandwidth of ($\Delta\lambda_{0.5}$ ~ 1.9 μm), and an absorption neutral density filter in the range: (2.5 ~ 10.0 μm) was obtained from the same materials and the same fabricated disks.

Based on the obtained results, some future works were suggested.

CONTENTS

Chapter One: Basic Concepts