



بسم الله الرحمن الرحيم

Sudan University of Science and Technology



College of Graduate Studies

Synthesis and Characterization of Nano Copper Oxide

تخليق وتشخيص اوكسيد النحاس النانوي

A Thesis Submitted for the Partial Fulfillments of the Requirement of the
Degree Master of Science in Chemistry

By:

Randa Awad Harown Ahmed

B.Sc. (Honors) in Chemistry

Supervisor:

Dr. Elfatih Ahmed Hassan

June 2016

الآية

بسم الله الرحمن الرحيم

قال تعالى:

لَهُ إِلَّا هُوَ الْحَيُّ الْقَيُّومُ لَا تَأْخُذُهُ سِنَّةٌ وَلَا نَوْمٌ لَهُ مَا فِي السَّمَاوَاتِ وَالْأَرْضِ مَنْ ذَا
إِلَّا بِرَأْسِ يَدَيْهِ يُعَلِّمُ نِعْمَتَهُ أَعْيُنَهُ أَيْدِيهِمْ وَمَا خَلَقَهُمْ وَلَا يُحِيطُونَ بِشَيْءٍ مِنْ أَعْمَالِهِ إِلَّا مَا شَاءَ
السَّمَاوَاتِ وَالْأَرْضِ وَالْأَرْضِ وَلَا يُتَوَدُّ حِفْظُهُمَا وَهُوَ الْعَلِيُّ الْعَظِيمُ)

سورة البقرة (255)

صدق الله العظيم

dedication

-To my Parents, brother, sister and my friends.

Acknowledgement

First of all, thanks are due to Almighty Allah

I would like to express my heartiest gratitude to my supervisor **Dr. .Elfatih Ahmed Hassan** for his keen interest, invaluable help, expert guidance and continuous encouragement during the period of this research work.

My thanks are also extended to my family and my relative **Munzir Hamedeneil** and to those who have contributed to this work

Abstract

In this work copper oxide nanoparticles were synthesized using hydrothermal method adopting simple procedure.

The synthesized particles were characterized using X-ray diffraction spectroscopy, surface adsorption analysis via , BET isotherm, and pore size distribution for the nanomaterial, which revealed that the pore size was of the order of 47.2×10^{-9} m, while the specific surface area is $24.672 \text{ m}^2/\text{g}$. A computational procedure was used to determine the nanoparticles crystal structure parameter .

مستخلص البحث

في هذا البحث تم استخدام الطريقة الهيدروثيرمية وعبر خطوات بسيطة لتخليق أكسيد النحاس النانوي . تم التحضير من أكسيد النحاس النانوي الذي تم توصيفه عن طريق تقنية فلورة الأشعة السينية ومطيافيه الأشعة فوق البنفسجية-المرئية وايزوثيرم الامتصاص متعدد الطبقات والذي استخدم في حساب توزيع المسافات الناتوي على سطوح جسيمات أكسيد النحاس النانوي . وكان توزيع المسافات النانويه على سطح جسيمات أكسيد النحاس النانوي في حدود 47.2×10^{-9} وكانت المسافه السطحيه $24.672 \text{m}^2/\text{g}$ تم استخدام طريقة الحوسبه لتقدير معاملات البنيه البلوريه للجسيمات النانويه التي تم تخليقها.

List of Contents

| No. | Content | Page |
|----------------------------------|--|------|
| 1 | الايه الكريمه | II |
| 2 | Dedication | III |
| 3 | Acknowledgment | IV |
| 4 | Abstract | V |
| 5 | مستخلص البحث | VI |
| 6 | List of contents | VII |
| 7 | List of Table | XI |
| 8 | List of figures | XII |
| Chapter one: Introduction | | |
| 1-0 | Introduction | 1 |
| 1-1 | Nanoparticles | 1 |
| 1-2 | Nanostructure | 1 |
| 1-3 | What is nanotechnology | 1 |
| 1-4 | Why metal oxide nanoparticles | 3 |
| 1-5 | Techniques of preparation of nanostructure | 3 |
| 1-5-1 | a-Top-down technique | 3 |
| 1-5-2 | b-Bottom-up technique | 4 |
| 1-6 | Effect of size | 5 |
| 1-7 | Effect of temperature | 6 |
| 1-8 | Size Control of Nanoparticles | 8 |

| | | |
|----------------------------------|---|----|
| 1-9 | Shape Control of Nanoparticles | 9 |
| 1-10 | Structure Control of Nanoparticles | 11 |
| 1-11 | Copper oxide | 13 |
| 1-11-1 | Preparation of CuO Nanoparticles | 14 |
| 1-11-1-1 | Sol- gel method of synthesis | 14 |
| 1-11-1-1-1 | Structure and microstructure of CuO nanoparticles | 15 |
| 1-11-1-1-2 | Structure analysis CuO of Nanoparticles | 15 |
| 1-11-1-1-3 | Scanning Electron Microscopy (SEM) Examination | 16 |
| 1-11-1-1-4 | Nano fluid preparation (CuO) | 18 |
| 1-11-1-2 | Another Method | 19 |
| 1-11-1-2-1 | Synthesis | 19 |
| 1-11-1-2-2 | Characterization | 19 |
| 1-11-1-2-3 | XRD study | 19 |
| 1-11-1-2-4 | SEM and TEM study | 20 |
| 1-11-1-2-5 | PL study | 21 |
| 1-11-1-3 | Synthesis of Copper Oxide Nanoparticles by a Novel Method | 22 |
| 1-11-1-3-1 | Preparations | 22 |
| 1-12 | Opjective | 22 |
| Chapter Two: Experimental | | |
| 2-1 | Chemicals | 23 |
| 2-2 | Instrumentations and equipment's | 23 |
| 2-2-1 | Instrumentations | 23 |

| | | |
|--|--|----|
| 2-2-2 | Equipment's | 23 |
| 2-3 | Preparation procedure | 23 |
| 2-3-1 | Seed solution for CuO nanostructure growth | 23 |
| 2-3-2 | The aqueous chemical growth solution for the CuO nanowire | 24 |
| 2-3-3 | Standard cleaning procedure | 24 |
| 2-4 | Characterization methods | 24 |
| 2-4-2 | XRD instrument | 24 |
| 2-4-3 | BET test | 25 |
| Chapter Three: Results and Discussion | | |
| 3.1 | Characterization Of CuO nanoparticles | 26 |
| 3.1.1 | BET Isotherm | 27 |
| 3.1.2 | XRD characterization | 28 |
| 3.1.3 | Computation procedure for characterization of CuO nanoparticle | 28 |
| 3.1.4 | Conclusions | 30 |
| | References | 31 |

List of Table

| Table | Page |
|--|------|
| Table 1: Angles values of XRD for the Copper Oxide | 31 |

List of Figures

| Figure` | Page |
|---|------|
| Figure 1.1: Schematic images of bimetal nanoparticles: alloy structure (a), core–shell structure (b), and heterojunction structure (c) of complex metal nanoparticles | 12 |
| Figure1.2: SEM image of gold nanotubes that had been broken through sonication to show their cross-sections. | 13 |
| Figure1 3: XRD pattern of CuO nanoparticle | 17 |
| Figure1 4: SEM images of CuO nanoparticles | 18 |
| Figure1. 5: TEM image of CuO Nanoparticles | 18 |
| Figure1.6: Select-area electron diffraction Nanoparticles (SAED) of as prepared CuO | 19 |
| Figure 1.7: XRD of CuO nanoparticles | 21 |
| Figure1. 8: SEM image of as prepared CuO nanoparticles | 22 |
| Figure1.9: (a) TEM image, (b) SAED pattern of as prepared CuO Nanoparticles. | 22 |
| Figure3.1: BET of CuO nanoparticles | 28 |
| Figure3.2: BET Isotherm | 29 |
| Figure 3.3: XRD of CuO nanoparticles | 30 |
| Figure 3.4: projection of the single crystal of Copper oxide | 31 |