Sudan University of Science and Technology

College of graduate Studies

A Study of the Effects of Radiation on Barium Carbonate ($Baco_3$) Treated with Gum Arabic in Different Time Periods

دراسة تاثيرات الأشعاع على كربونات الباريوم المعالجة بالصمغ العربي في فترات زمنية مختلفة

A Thesis submitted in partial for requirement of the Degree of Master in physics

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الايـــــة

قَالَ الله تَعَالَى:

(إِنَّ هَذَا الْقُرْآنَ يَهْدِي لِلَّتِي هِيَ أَقْوَمُ وَيُبَشِّرُ الْمُؤْمِنِينَ الَّذِينَ يَعْمَلُونَ الصَّالِحَاتِ أَنَّ لَهُمْ أَجْرًا كَبِيرًا (9) وَأَنَّ الَّذِينَ لَا يُؤْمِنُونَ بِالْآخِرَةِ أَعْتَدْنَا لَهُمْ عَذَابًا أَلِيمًا (10))

سورة الاسراء

صدق الله العظيم

Dedication

The search locomotive passed through many obstacles, yet I tried to surmount them steadily, with the grace and grace of God.

To the one who placed heaven at its feet, and revered it in his dear book, to whom do I prefer it over myself, and why not; you sacrificed for me, She did not always spare any effort to make me happy(My dear *mother*).

We walk the paths of life, and it remains the one who controls our minds in every way we take it. The owner of a kind face, and good deeds.

He did not spare me all his life(My dear father).

To my friends, and everyone who stood next to me and helped me with everything they owned, in many ways, My friends, to whom I testify that they are yes, comrades in all matters, I dedicate to you my humble research on. To the symbols of devotion and devotion, who were not allowed by fate and were martyred in prime of their youth

To those who sacrificed their lives and lives for the sake of a decent life and the homeland can accommodate everyone

(The martyrs of the Sudanese state and the martyrs of the Glorious Peaceful December Revolution)

Acknowledgements

Praise be to God and thanks to him duly for the majesty of his face and the greatness of his authority, the number of his creation and the satisfaction of himself and the weight of his throne and the extension of his words that I have to fulfill this message, and prayers and peace be upon the best of mankind, our Prophet Muhammad and his family and companions, and greetings greatly.

No matter how far we progress and the paths of success are opened before us and we have reached everything we dream of, we must remember, who was the cause of our success, those who supported us and held our hand to continue on our path to success and progress. They are the ones whose existence created success and creativity, to you, the one who was a pioneer in riding knowledge and education to you.

It gives me great pleasure to thank my father and mother, who worked hard and watched out for raising me and teaching me from childhood, and I thank everyone who studied for me or contributed to my teaching from the doctors of the Sudan University of Science and Technology and all the professors to whom the credit goes to God Almighty.

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At the end, I sincerely thank my brothers, friends and companions, and my push, they have always been my motivation in my scientific life.

Abstract

Gamma rays interaction with matter is important from the perspective of shielding against their effect on biological matter.They are considered as ionizing radiation whose scattered by electrons and nuclei leads to the creation of a radiation field containing negative electrons and positive ions.The main modes of interaction of gamma rays with matter are the photo effect both in its photoelectric and photonuclear forms, Compton scattering and electron positron pair production. Aim of the research was the effect of gamma rays on matter, Study of optical properties of $Baco_3$0.01gram gum Sudan and Study the behaviors of composite Nanomaterial when gamma rays exposure.

In this research dealt with a scientific study to Been studying the effect of radiation on a substance $Baco_3$ 0.01gram gum Sudan in different periods of time, and the results were clear on the material in the absorption and excitation processes, as well as the absorption and excitation coefficients, and the results indicated that the more time the effect of radiation on the material increased, the absorption process was The material and its excitation are weak and equally the absorption and excitation coefficients. On the other hand, the results of the energy gaps indicate that the longer the time of the effect of radiation on the material, the greater the energy gaps in the excited material. The effect of rays is greater, and the shorter the period of exposure, the less the effect of radiation on the material.

المستخلص

تفاعل أشعة قاما مع المادة مهم من منظور الحماية من تأثيرها على المادة البيولوجية اشعة قاما بمثابة إشعاع مؤين يؤدي تشتت الإلكترونات والنواة إلى تكوين مجال إشعاعي يحتوي على إلكترونات سالبة وأيونات موجبة .تتمثل الأنماط الرئيسية لتفاعل أشعة قاما مع المادة في التأثير الضوئي في كل من الظاهرة الكهروضوئية والنووية الضوئية ، وتشتت كومبتون وإنتاج زوج الإلكترون والبوزيترون .الهدف من البحث هو تأثير أشعة جاما على المادة ودراسة الخواص الضوئية لمركب $Baco_3$و0.01جم من الصمغ السوداني ودراسة سلوكيات المواد النانوية المركبة عند التعرض لأشعة جاما.

في هذا البحث تم دراسة علمية لتاثيرالاشعة على مادة كربونات الباريوم مع 0.01 جم من الصمغ السوداني في فترات زمنية مختلفة وكانت النتائج التاثير واضح على المادة في عمليتي الامتصاص والاثارة وايضا معاملي الامتصاص والاثارة وكانت النتائج تشير الي كلما زاد زمن تاثير الاشعة على المادة كانت عملية إمتصاصية المادة وإثارتها ضعيفة وبنفس القدر معاملي الامتصاص والإثارة وفي المقابل تشير نتائج فجوات الطاقة على ان كلما زاد زمن تاثير الاشعة على المادة كلما زادت فجوات الطاقة في المادة وبهذه النتائج تمالتاكد من تاثير الاشعة على المواد اي كلما تعرضت المادة الي اشعة في فترة زمنية طويله كلما كان تاثر الاشعة اكبر وكلما قلل من فترة التعرض قلت تاثير الاشعة على المادة.

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CHAPTER ONE

INTRODUCTION

1.1 preface

Gamma rays interaction with matter is important from the perspective of shielding against their effect on biological matter.They are considered as ionizing radiation whose scattering by electrons and nuclei leads to the creation of a radiation field containing negative electrons and positive ions.The main modes of interaction of gammarays with matter are the photo effect both in its photoelectric and photonuclear forms, Compton scattering and electron positron pair production. To a minor extent,photo-fission, Rayleigh scattering and Thomson scattering also occur.Each of these processes occurs in different forms.Different types of scattering can occur depending on the quantum-mechanical properties of the gamma photons. Electron positron pairs can be formed in the field of a nucleus and in that of an electron. The photoelectric effect can knock out atomic electrons, whereas the photonuclear reaction would knock out elementary particles from the nucleus.Gamma rays are emitted in the decay process of radioactive isotopes. On a cosmic scale, Gamma Ray Bursts (GRBs) or Magnetars generate intense gamma radiation fields that could affect space travel and exploration. In addition, bursts of Terrestrial Gamma Ray Flashes(TGFs)occur relatively high in the atmosphere as a result of thunderstorms and are not from the same sources of gamma rays seen on the ground. About 15 to 20 such events are observed per month.Gamma ray bubbles were discovered at the center of the Milky Way Galaxy [1].

A knowledge of gamma-ray interactions is important to the nondestructive assayistin order to understand gamma-ray detection and attenuation. A gamma ray must interact with a detector in order to be “seen [2].

The study of mineral formation in biological systems, bio mineralization, provides inspiration for novel approaches to the synthesis of new materials. Bio mineralization relies on extensive organic-inorganic interactions to induce and control the synthesis of inorganic materials. In recent years, bio inspiredmorph synthesis of crystals with hierarchical forms in the presence of organic templates having complex functionalizing patterns have been explored widely so as to mimic natural bio minerals. Among a variety of construction methodologies of functional materials, patterned crystal arrays of organic, inorganic and their hybrid crystals, have received considerable attention in recent years for their diverse application potential in areas such as catalysis, medicine, pigments, cosmetics, separation technology, Nano-devices and find diverse applications in nanotechnology. Nano structural materials have become attractive because of their unique characteristics that can hardly be obtained from conventional bulk materials owing to their quantum size and surface effects. So, there has been considerable interest in fabrication of low-dimensional Nano sizedmaterials such as nanowires, Nano rods and nanotubes. Several processes have been explored in the literature for the synthesis of

nanomaterial. These processes involve both physical and chemical methods.

These modifying agents have also been thought to control the polymorph of the barium carbonate clusters. However, the characterization of these native and modifier agents on the crystal surface is still un-clear. has attracted a lot of recent research due to its close relationship with aragonite, a prevalent and important bio mineral, with many important applications in the ceramic and glass industries as well as its use as a precursor for magnetic ferrites and/or ferroelectric materials.

Barium carbonate ($Baco_3$) is also used as a precursor for producing superconductor and ceramic materials and other important applications in optical glass and electric condensers. Therefore, in the present study, we report the synthesis and characterization of Nano crystallite using natural polymer, gum acacia [3].

1.2 Research Problem

The lack of adequate studies for substances with new for formulations such as barium carbonate with gum Sudan.The lack of studies of the properties of such materials when radiation affects it, such as gamma rays.

1.3 Aim of the Research

1. The effect of gamma rays on matter.
2. Study of optical properties of 0.01gum Sudan.

3. Study the behaviors of composite Nanomaterial when gamma rays exposure.

1.4 Importance of Research

This research is conducted to assess the literature review on 0.01gum Sudan nanomaterial. The optical properties are of the greatest importance, therefore, the study enriches the 0.01gum Sudan technologies.

1.5 Thesis Layout

The thesis consists of the four chapters, chapter one is the introduction. Chapter two is Literature review. Chapter three is concerned materials and method .chapter four is devoted results, analysis, discussion, conclusion beside recommendations and reference.

CHAPTER TWO
LITERATURE REVIEW

2.1 Introduction

There are many studies carried scientists in this area in order to identify some of the results you get and review the results and summary of the results.

2.2 Shape Controlled Synthesis of Barium Carbonate Micro clusters and Nano crystallites using Natural Polysaccharides – Gum Acacia

Different morph synthesis strategies for using natural polysaccharide-gum acacia (GA) as templating species are presented. The influence of GA with different functionalities such as –, – and - on the crystallization and structure formation was investigated. Some interesting morphologies, including rods, dumbbell, double-dumbbell and flower like clusters, can be readily generated by using GA as cooperative modifier in the mineralization process, under the conditions of 0.5%, 1% of templating species and at ambient temperature. The modifier GA and its concentration is the key factor in this system. In continuation, morphology was also examined for mixed metal carbonates (-, -). The possible formation mechanism of the Nano crystallites is discussed. Structural characterization of the synthesized materials was investigated by Powder X-ray diffraction (XRD), Scanning Electron Microscopy (SEM), Energy Dispersive Analysis (EDAX), Transmission

Electron Microscopy (TEM), Thermogravimetric analysis (TGA) coupled Mass (MS) and Fourier Transform Infrared spectroscopy (FT-IR) [3].

2.3 Preparation and physical properties of functional barium carbonate nanostructures by a facile composite-hydroxide-mediated route

Recently, barium carbonate nanomaterial has been shown to be a proven versatile candidate for the catalysis and sensor applications. The catalytic and sensing efficiency can be improved by making barium carbonate composite with a suitable transition element. In this regard, the preparation of barium carbonate and its composite with nickel during the synthesis process is presented with the composite-hydroxide-mediated method, an effective, feasible, and low-temperature synthesis route. The nanomaterial produced is monitored for the structural and optical properties with various diagnostic methods. The X-ray diffraction results show the presence of orthorhombic structure of barium carbonate in both pure and 5% nickel samples. A mixed structure is formed with the phases of barium carbonate, and for the sample with 15% nickel. The average crystallite size estimated is in the range of 14–22 nm. The scanning electron microscope pictures captured on silicon (Si) covered with the product material reveal interesting rods, needle, and flower-type morphological features. The band gap energy obtained by diffused reflectance spectroscopy is in the expected range of 5.48–5.71 eV. The proposed method seems effective to provide a feasible route for the synthesis of a broad range of nanomaterial for research purposes [4].

2.4 Interaction with Matter of Ionizing Radiation and Radiation Damages (Radicals)

Interaction of matter with "ionizing radiation," that is, high-energy electromagnetic radiation (X- or gamma rays) or α- or β-particles, can promote chemical change which commonly involves free radicals. Free radicals formed by high-energy radiation in solids can then be identified by analysis of their EPR spectra[5].

2.5 Interaction of Radiation with Matter

The effects of interactions of the various kinds of nuclear radiation with matter are summarized with special emphasis on relations to nuclear chemistry and possible applications. The Bethe–Bloch theory describes the slowing down process of heavy charged particles via ionization, and it is modified for electrons and photons to include radiation effects like bremsstrahlung and pair production. Special emphasis is given to processes involved in particle detection, the Cherenkov Effect and transition radiation. Useful formulae, numerical constants, and graphs are provided to help calculations of the stopping power of particles in simple and composite materials[6].

2.6 Interaction of Gamma Rays and X-Rays with Matter

Gamma rays are electromagnetic radiation either emitted from a nucleus or an annihilation reaction between matter and antimatter. X-rays are electromagnetic radiation emitted by charged particles (usually electrons) in changing atomic energy levels or in slowing down in a Coulomb force field. X-rays and gamma rays have identical properties,

only differing in their origin. The two used to be distinguishable by energy of the particle, but now linear accelerators are able to produce high-energy X-rays that have the same or higher energy as gamma rays. The practical range of photon energies emitted by radioactive atoms extends from a few thousand eV up to over 7 MeV. On the other hand, linear accelerators are able to produce more energetic photons. The energy ranges of X-rays in terms of generating voltage are given in Table (3.1) [7].

2.7 Interaction of Radiation with Matter

All particulate and electromagnetic radiations can interact with the atoms of an absorber during their passage through it, producing ionization and excitation of the absorber atoms. These radiations are called ionizing radiations. Because particulate radiations have mass and electromagnetic radiations do not, the latter travel through matter longer distance before losing all energy than the former of the same energy. Electromagnetic radiations are therefore called penetratingradiations and particulate radiations no penetrating radiations.The mechanisms of interaction with matter, however, differ for the two types of radiation, and therefore they are discussed separately[8].

CHAPTER THREE

MATERIAL AND METHOD

3.1 Introduction

In recent years, nanotechnology has given birth to numerous nanomaterial due to their increased use in various sectors of research and development. To produce these nanomaterial, nanotechnology further has opened several rooms for the potential novel methods. Composite hydroxide-mediated (CHM) method is one of the recent chemical synthesis routes that have gained considerable importance in research due to their effortlessness and versatile nature, covering a broad range of nanomaterial to prepare [4].

3.2 Material

3.2.1 Barium Carbonate

Synonyms Barium carbonate occurs in nature as the mineral witherite. A code designation for commercial barium carbonate is C.L-77,099. The CAS registry no. is 513-77-9 [9].

3.2.2 Physical and Chemical Properties Barium Carbonate

Has the empirical formula and a molecular weight of 197.37. It is a tasteless, odorless, heavy white powder with a density of 4.2865. At about 1300~ it decomposes into and. Its vapor pressure is negligible. Barium carbonate is almost insoluble in water. It is slightly soluble

(1:1000) in water saturated with carbon dioxide, soluble in dilute hydrochloric or nitric acid or in acetic acid, and soluble in solutions of ammonium chloride nitrate. Formulations and Uses Barium carbonate is a rat poison. It also is used in ceramics, paints, enamels, rubber, and certain plastics. The technical product is 98-99% pure. Rodenticidal baits contain 20-25 % of the compound [9].

3.2.3 Gum Sudan (GS)

Gum Sudan (GS) is most important commercial poly-saccharine and it is probably the oldest food hydro-colloid in current use. GS is naturally obtained from Acacia Senegal and seyaltrees, which are known to grow in the sub-Sahara region of the Sudan.

GS is the dried, gummy exudation obtained from various species of Acacia trees of the *Leguminosae* family. About 500 species of *Acacia* are distributed over tropical areas of Africa, India, Australia, Central America and south west North America. The composition of GS is dependent to someextend on the location and age of the tree. Even though there are over 1,100 *Acacia* species worldwide, *A. senegal* and *A. syal* remain the most commercially exploited species.GS is high molecular weight polymeric compounds, composed mainly of carbon core mixed in heterogeneous manner, including some materials in tonic forms as salts of macromolecules.

There are many studies carried out using GS, but most of them were focused on food, hydrocolloid and adhesive material. In this study, we

will examine the structure and physical properties such as electrical and optical properties for two types of GS [10].

3.2.4 physical properties

Gum Sudan (GS) is a heterogeneous material having both hydrophilic and hydrophobic affinities. GS physicochemical responses can be and led depending on the balance of hydrophilic and hydrophobic interactions. GS functional properties are closely related to its structure, which determines, for example, solubility, viscosity, degree of interaction with water and oil in an emulsion, microencapsulation ability, among others .

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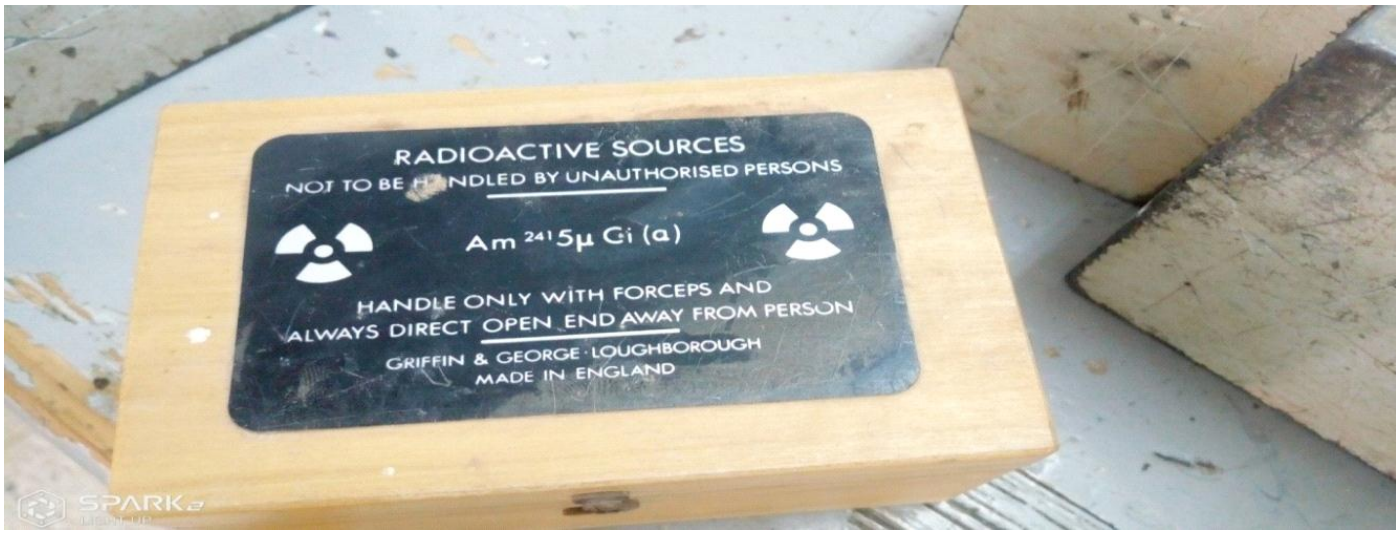

Figure (3.1)Radioactive Sources (gamma rays)

Figure (3.2)) Barium Corbonate with 0.01g gum Sudan ($Baco_3$0.01gram gum Sudan)

3.3 Method

3.3.1 The sol-gel method

Sol-gel processing is a soft-chemistry method to obtain function materials at low temperatures. This route can be used to produce very sophisticated nanomaterial and to tailor the materials to very specific applications. Adsorption and detection of pollutants, water purification and soil remediation represent challenging fields of application that can be exploited by sol-gel materials.

0.01g gum Sudan powder were prepared by the sol-gel method with different concentrations.

The optical properties of $Baco_3$0.01g gum Sudan powder investigated. In particular, optical parameters such as the optical band gap, absorption coefficient, refractive index and extinction coefficient, were comprehensively studied of effect radiation to the matter in different time order to investigate the effects on the Barium carbonate 0.01g gum Sudan.

Figure (3.3) the samples inside the test tubes.

Figure (3.4) the samples of $Baco_3$0.01g gum Sudan After being Effected by Gamma Rays the inside test tubes.

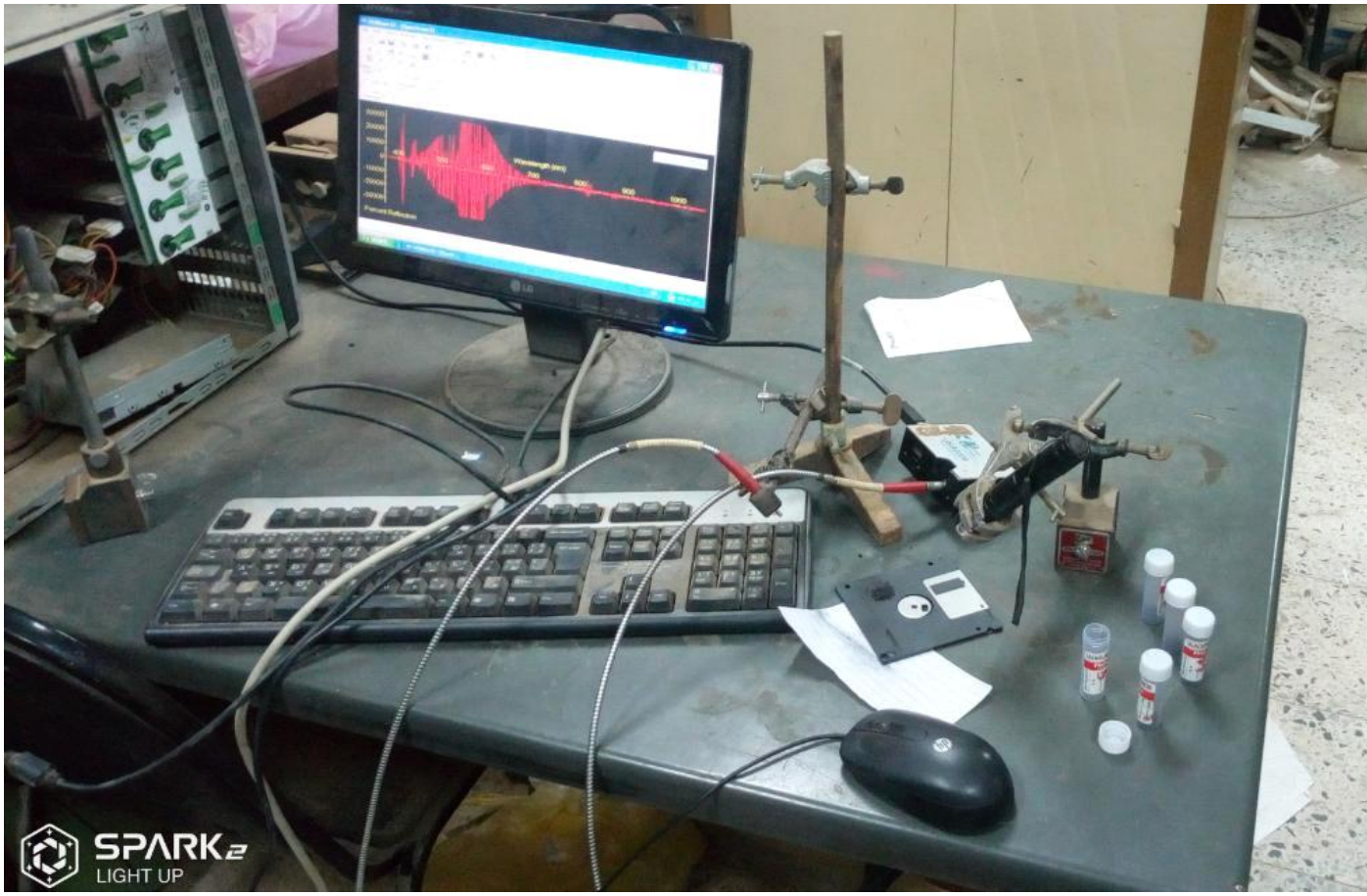

Figure (3.5) work tools

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Introduction

In this part of research, we view the results that have been obtained from the experiments made of $Baco_3$ with 0.01g Gum Sudan when effected radiation in times (0, 5, 10, 15, and 20) min are prepares usingThe sol-gel method to ensure better quality of the samples.

4.2 Result

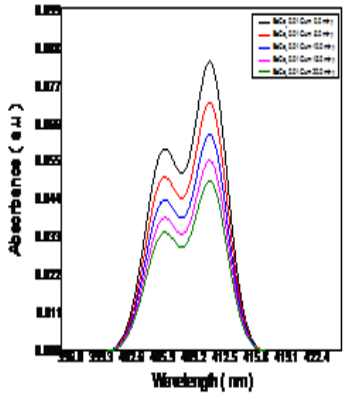

Figure (4.1) relation between absorbance and wavelength of $Baco_3$ with 0.01 Gum Arabic (0,5,10,15, 20) min samples

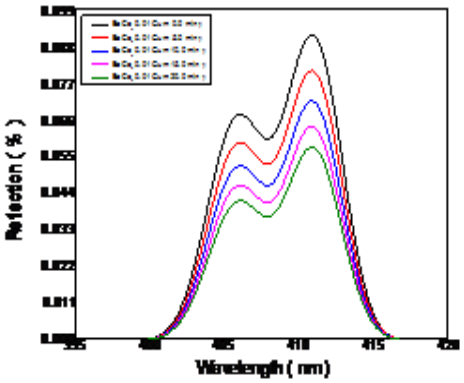

Figure (4.2) relation between reflection and wavelength of $Baco_3$ with 0.01g Gum Sudan (0,5,10,15, 20) min samples

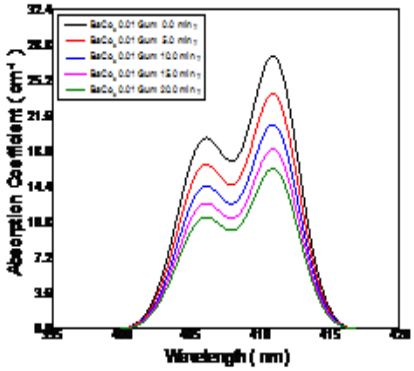

Figure (4.3) relation between absorption coefficient and wavelength of $Baco_3$ with 0.01g gum Sudan (0,5,10,15, 20) min samples

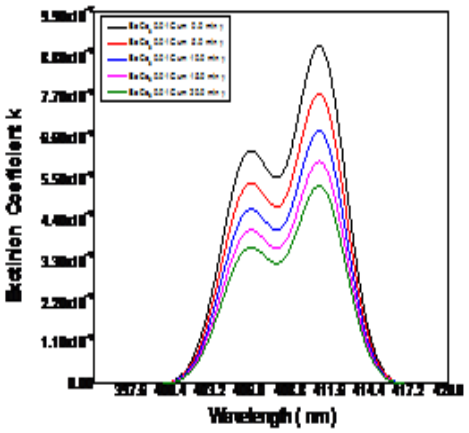

Figure (4.4) relation between extinction coefficient and wavelength of $Baco_3$with 0.01g gum Sudan (0,5,10,15, 20) min samples.

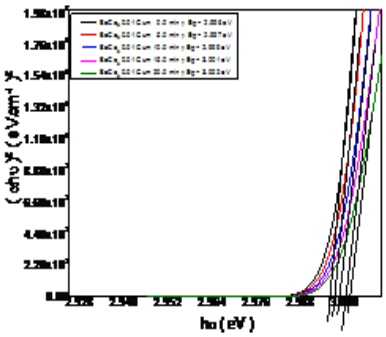

Figure (4.5) optical energy band gap of $Baco_3$with 0.01g gum Sudan (0,5,10,15, 20) min samples

4.3 Discussion

4.3.1 Absorbance

An absorbance we found the behavior of curves is the same with five samples of with 0.01g Gum Sudan When effected radiation type or gamma ray at times (0, 5, 10, 15, and 20) min. Show all resolute of absorbance in fig (4.1 in fig (4.1) shows the relation between absorbance and wavelengths f or Five samples of with 0.01g Gum Sudan. The rapid decrease of the absorption at wavelengths 454 nm. The mean effects on the absorbance value was rated of exposure time, when the rated of exposure time increased the absorbance value decrease.

4.3.2 Reflection

In fig (4.2) show that relation between reflection and wavelengths of with 0.01g Gum Sudan When effected radiation type or gamma ray at times (0, 5, 10, 15, and 20) min samples, and in fig (4.2) high value of reflection in the ranged (406 to 414) nm.

4.3.3 Absorption coefficient (α)

The absorption coefficient (α) of five prepared $Baco_3$ with 0.01g gum Sudan (0, 5, 10, 15 and 20) Min samples by equation where (A) is absorbance and (t) is the optical length on the samples. In fig (4.3) shows the plot of (α) with wavelength (λ) of five samples was treatment by $Baco_3$ with 0.01g gum Sudan (0,5,10,15 and 20) min, which obtained that the value of $\alpha = 27.7x10^2\ cm^{-1}$ for $Baco_3$ with 0.01g gum Sudan 0 min in the Visible region(454 nm),but for $Baco_3$ with 0.01g gum Sudan

20 min equal 16.00 x10^{2} cm^{-1} at the same wavelength , this means that the transition must corresponding to a direct electronic transition, and the properties of this state are important since they are responsible for electrical conduction. Also, fig.(4.3) shows that the value of (α) for the five samples of with 0.01g gum Sudan increase while the exposure time of with 0.01g gum Sudan decreased .

4.3.4 Extinction coefficient (α)

The extinction coefficient (α) of five prepared with 0.01g gum Sudan (0, 5, 10, 15 and20) min samples by equation k= αλ/4π. The variation at the (K) values as a function of (λ) are shown in fig. (4.4) of five sample was treatment by $Baco_3$with 0.01g gum Sudan (0, 5, 10, 15 and 20) min, and it is observed that the spectrum shape of (K) as the same shape of (α). In fig (4.4) which obtained that the value of k = 8.80 x10^{-7} for $Baco_3$ with 0.01g gum Sudan 0 min in the Visible region (454 nm), but for $Baco_3$ with 0.01g gum Sudan 20 min equal 5.50 x10^{-7} at the same wavelength. Also, fig.(4.5) shows that the value of (α) for the four samples of $Baco_3$ with 0.01g gum Sudan increase while the exposure time of $Baco_3$ with 0.01g gum Sudan decreased.

4.3.5 The optical energy gap (E_g)

The optical energy gap (E_g) has been calculated by the relation (α hυ) 2 = C (hv–E_g) where (C) is constant. By plotting (αhυ)2 vs photon energy (hυ) as shown in fig.(4.5) with five prepared sample was by $Baco_3$ with 0.01g gum Sudan (0 ,5,10 ,15 and 20) min. And by extrapolating the straight thin portion of the curve to intercept the energy axis, the value of the energy gap has been calculated. In fig (4.6) the value of (E_g)0 min

$Baco_3$with 0.01g gum Sudan sample was (2.996) eV while for 5 Min Baco3 with 0.01g gum Sudan sample was (2.997) eV and while for 20min $Baco_3$ with 0.01g gum Sudan sample was (3.002). The value of (E_g) was increased from (2.996) eV to (3.002) eV. The increasing of (E_g) related to increase of exposure Time on the samples. It was observed that the different exposure time confirmed the reason for the band gap shifts.

4.4 Conclusion

$Baco_3$ 0.01g gum Sudan powder deposited by Sol-gel method with an effect $Baco_3$ 0.01g gum Sudan by gamma rays.

The powder exhibits high absorbance values at ultraviolet region which they decrease rapidly in the visible/ near infrared region, the film shows a direct transition which was the value of (E_g) was increased from (2.997) eV to (3.002) eV for allowed energy gap. The film has high values of absorption coefficient which obtained that the value of α = 27.7x102 cm-1 for $Baco_3$ 0.01g gum Sudan 0 min in the Visible region (454 nm), but for $Baco_3$ 0.01g gum Sudan 20min equal 16.00 x102 cm-1 at the same wavelength. The sol-gel method for the production of thin solid filed is a good method for the preparationof thin films which are suitable for scientific studies and for many applications in technology and industry, equally.

4.5 Recommendation

1. Encouraging the scientific researcher to discover and innovate.

2. The state should pay attention to scientific research because it has thebenefits to state and science.

3. Universities should create the appropriate scientific environment for the researcher.

4. The state and universities should like to provide practical equipment that enables the researcher to complete his scientific research.

5. The state and international organizations should establish special centers for scientific research.

6. Establishing the foundations and regulations of universities that students conduct scientific research in multiple stages.

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