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Physical characteristics of nanobiomaterials and their medical effect on cancer cell line

A Thesis

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Chapter one
Introduction and literature review

1-1 Introduction

Nano is a "extremely small" prefix. When measurable, it translates into one billionth, as in the nanosecond. Nano is from the Greek word "nanos" which means "dwarf"[1]. The expression "nanotechnology" is being used as an all-encompassing term for engineering, science, and technology of a nanoscale nature. Nanotechnology is the understanding, manipulating and controlling of matter at dimensions of approximately 1 to 100 nanometers, It means atomic manipulation. At the size-scale between individual atoms and bulk materials, where unique phenomena allow for novel uses. A nanometer is one-billionth of a meter, or about the width of 10 side-by side arranged hydrogen atoms in a line. Nanotechnology involves the imaging, measurement, modeling and manipulation of material at this size[2].

Nanotechnology is a multidisciplinary science branch covering a wide range of technology and science from pharmaceutical, biomedical, environmental, gricultural, advanced materials, physics ,chemistry, electronics, information technology, and so forth. Nanoparticles' smaller size and high volume-to-volume ratio are the key features that make them beneficial in biomedical fields due to the development of so many new properties, ease of functionalization, biomolecular conjugation etc. Nanoparticles can serve as an excellent bridge between molecular or atomic structures and bulk materials. The advent of nanoparticles along with other nanomaterials has opened up new avenues in many different fields of research and study [3].

Equally influenced has also been the field of biomedical engineering. The main advantages of nanoparticles over larger particles are their high surface-to - volume ratio and therefore higher surface energy, different optical, electronic, and outstanding magnetic properties, etc[4].

1-2 Classification of Nanomaterial's

Nanomaterials are most often broken down into four groups:

- **zero-dimensional materials:**

Materials which are all less than 100 nm in size. Examples of such substances (quantum dots) .

- **One-dimensional materials**:

Materials with length only and in the form of chips with a thickness of more than a hundred nanometers, used with old materials for painting them, in order to optimization their mechanical and electrical properties.

- **Two - dimensional materials**

Materials with width and length of one hundred nanoseconds and more. such as wires and pipes and most significant carbon tubes, as in the figure (1) below

- **Three dimensional materials**

Are the materials of more than one hundred nanometers in length and width and height of examples of gold granules used with cancer tumors for treatment[5].

Figure (1-1) shows the types of Nanomaterials .

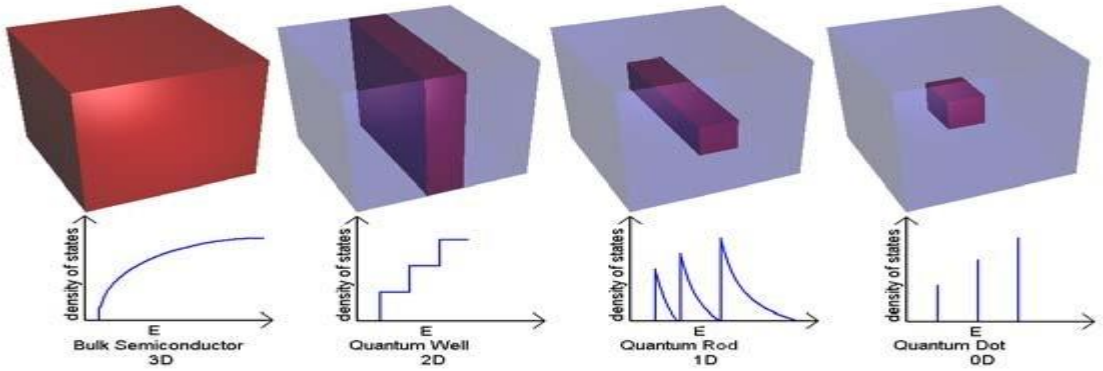

Fig. (1-1): Simplified representation of the density of states in 3D, 2D, 1D and 0D semiconductors[6]**.**

1-3 Properties of Nanomaterials

- **Ratio of surface area of volume**

Due to volume, nanomaterials have very large surface area

- **Melting point**

The melting point of the substance drops as the particle size decreases due to the growth in the surface area due to volume. For example, the gold melting point is 1064 ° C, reducing to about 200 ° C when the granule size is 5 nm.

- **Magnetic and Electrical Properties**

Small nanomaterials sizes mean higher electrical conductivity and greater magnet strength and intensity[7].

1-4 Principles of nanomaterials production

Nanomaterials are prepared according to two main principles:

• From top to bottom, where the nanoscale size can be achieved, for the original material by broken it down. Several methods are used, such as milling, cutting, and grinding.

• From bottom to top Reversing the first method, where nanoparticles are built from atoms and molecules arranged until we reach the desired shape and size. This method is often a chemical method[8].

1-5 Methods for nanomaterials preparation

1- Mechanical method

Crushing of material, if either solid or powder, until nanoparticles are reached. This method is cheap and needs no complicated device.

2- Physical method

It is prepared by heating the material from the material's vapour. The steam is then refrigerated to become more satisfying by a neutral gas shock. It is then positioned on a cold surface. Afterwards the nano materials are created using a laser[9].

1-6 Applications of Nanoscience

- ✓ **In medicine field**
- Diseases Detection and Treatment
- Offer new drug delivery options 'nanosized carrier'
- Allow the delivery of drugs to the right place in the body
- Localize and release medical drugs at the site of the illness (tumour of cancer).Detecting and controlling diseases at a new level.

- ✓ **In the industry field like**: Glass industry, paint and color screen manufacturing Industry
- ✓ **In the agriculture field:** Increasing the fertility of soil leading to increased agricultural output
- ✓ **In the energy field:** Reduce electricity consumption by making solar energy production more efficient[10].

1-7 Nano-oxides

Oxides are considered as a chemical compounds which combine one or more oxygen atoms with some other element (e.g. Li O). Oxides are binary oxygen compounds with other components, such as CO, SO, CaO, CO, ZnO, BaO, H O, and so on. These are called oxides, because, oxygen is combined with just one element. The oxides are classified as acidic, basic, amphoteric or neutral based on their acid-based properties:

1. An acid oxide is an oxide that combines with water to produce an acid
2. A basic oxide is the oxide that gives a base in water
3. An amphoteric solution is a substance that can chemically react as either acid or base.
4. However, an oxide can also not be acidic or basic, and is just a neutral oxide[11].

There are various properties that help to clarify the three types of oxides. The term anhydride ("without water") indicates to compounds which assimilate H O by adding water to form either an acid or a base.

1-8 Oxide types

There are different types of oxides as illustrated in table (1-1)

Table (1-1): illustrates types of oxides[12].

Types of oxides			
Acidic Oxides	**Basic Oxides[a] (Alkaline oxides)**	**Amphoteric Oxides[b]**	**Neutral Oxides**
• Lead dioxide • Chromium trioxide • Carbon dioxide • Sulphur dioxide • Sulphur trioxide • Silicon dioxide • Phosphorus Pentoxide	• Sodium oxide • Magnesium oxide • Copper oxide • Calcium oxide • Potassium oxide	• Zinc oxide • Aluminium oxide	• Water • Carbon monoxide • Nitrogen oxide

1-9 Preparation of Oxides

- By heating the element directly with oxygen
- By oxygen reaction at higher temperatures with the compounds
- By oxidation of nitric acid in some metals
- By oxidation of nitric acid in some non-metals

1-10 Cadmium oxide

Cadmium oxide with formula CdO is an inorganic compound. It is one of the principal forerunners of other cadmium compounds. It crystallizes as sodium chloride, with octahedral cation and anion centers in a cubic rock salt lattice. It occurs as the rare monteponite mineral, naturally. Cadmium oxide can be found as amorphous colorless powder or as red or brown crystals. Cadmium oxide is a semiconductor of n-type .it has a band gap of 2.18 eV (2.31 eV) at the temperature of the room (298 K)[13] .

1-11 Nanobiotechnology

Nanobiotechnology is a newly coined concept that defines the integration of the two worlds between engineering and molecular biology, however separate they may be. For the past three decades, engineers have been working on reducing the dimensions of manufactured structures to allow faster and higher density electronic chips that have really achieved feature sizes as tiny as 20 nm. In the same line, molecular biologists have been active in the field of molecular and cellular dimensions ranging from nanometers to micrometers for many years[14]. A combination of these disciplines is believed to result in a new category of multipurpose systems and devices for biological and chemical analysis defined by improved specificity and sensitivity and higher classification rates compared to current solutions. Analysis of signaling pathways using nanobiotechnology strategies could provide new insights into the mechanisms of disease, so that addressing extra efficient biomarkers and knowing the mechanisms of drug action. Advances in nanomaterial

processing allow the binding of various biomolecules, like toxins, proteins, bacteria, and nucleic acids. Nanotechnology is relatively young, and while the full range of significant contribution to these advances in human health care technology stays undiscovered, recent developments recommend that nanobiotechnology will have a deep effect on disease preventing the spread, diagnosis, and treatment[15].

1-11-1 Nanobiotechnology Applications

- Medical Applications
- Tissue Engineering
- Pathogen Detection
- Food Safety
- Biosurfactants

1-12 Silver

The word silver originates from the Anglo-Saxon word seolfor. It is a chemical element (number 47, symbol Ag), which takes place in the ores of copper nickel, gold, copper, lead zinc, lead, and argentite. Sliver is a transition metal can be gained from brittle silver and dark ruby, and light ruby silver. It was used in the history of making coins and ornaments, and was obtained by isolating silver from lead. Along with gold, platinum, iridium, osmium, ruthenium, and palladium it is a noble metal. Silver is a precious metal known from prehistoric times. But today the element silver uses something more than decorative elements either as a way of monetary exchange. Table (1-2) shows some of sliver properties[16].

Table (1-2): Sliver properties[17].

Symbol	Ag
Atomic no.	47
Atomic wt	107.88
Specific gravity	10.55
Valence	1,2
Melting point	961˚C
Boiling point	2212˚C
Crustal abundance	0.07 ppm
Preferred analysis method	Atomic absorption spectroscopy
Routine detection limit	0.2 ppm

1-12-1 Properties and Usages

The element contains several isotopes, among them Ag-111, Ag-110, Ag-109, Ag-107 and others. Known isotopes are 11. Others have a half-life of approximately 25 seconds, someone else over 130 years, and some are steady. The element has high electrical and thermal conductivity and is ductile and malleable. That metal, in fact, has the largest electrical conductivity. It is water and air stable, and it has a metallic luster. Silver is ruined by hydrogen sulfide and ozone. The point of boiling is 2.212 ° C (4.013.6 ° F) and the point of melting is 962 ° C (1763.6 ° F). Although silver is not chemically active, it interacts with nitric acid and sulfuric acid. Sulfides, fluorides, and oxides and other exploding compounds such as silver fulminate that are susceptible to pressure and heat are present. The metal itself remains water-stable[18].

Silver and its compounds have numerous commercial uses. It is used to make jewellery and silverware, along with ornaments, pendants and

necklaces. Silver has been used in the electronic, photographic, electrical and other industrial sectors. Electrical Silver contacts are used to make keyboards. Printed circuits contain paints made from silver. The material has also been used to make batteries, contacts, brazing alloys, and mirrors. It has application areas within the clothing, medicine, and optics industries. It will also be used for the production of endotracheal respiratory tubes and urinary catheters and for its antibacterial activity. E174 is a food additive and it includes silver and it is placed to the cookies decorative items and coatings[19].

1-13 Plasma

Plasma is treated as the fourth state of matter. The other basic states of matter are liquids, solids, and gases. While the other states of matter are usually found in everyday life, plasma is relatively uncommon or rare. It is typically produced by heating a gas until its electrons have enough energy to escape the control of the positively charged nuclei. The ions form as molecular bonds break and atoms gain or lose electrons. Plasma could be created using a laser, microwave or any powerful electromagnetic field[20].

Plasma is a matter in which the gas phase is excited until atomic electrons aren't longer linked to any particular nucleus atomic. Either heating a gas until it is ionized or subjecting it to a strong electromagnetic field can produce plasma. The term plasma originates from a Greek word, meaning jelly or moldable material. Plasma is considered one of the four fundamental states of matter, along with solids, liquids, and gases[21]. Fig. (1-2) shows the four states of matter.

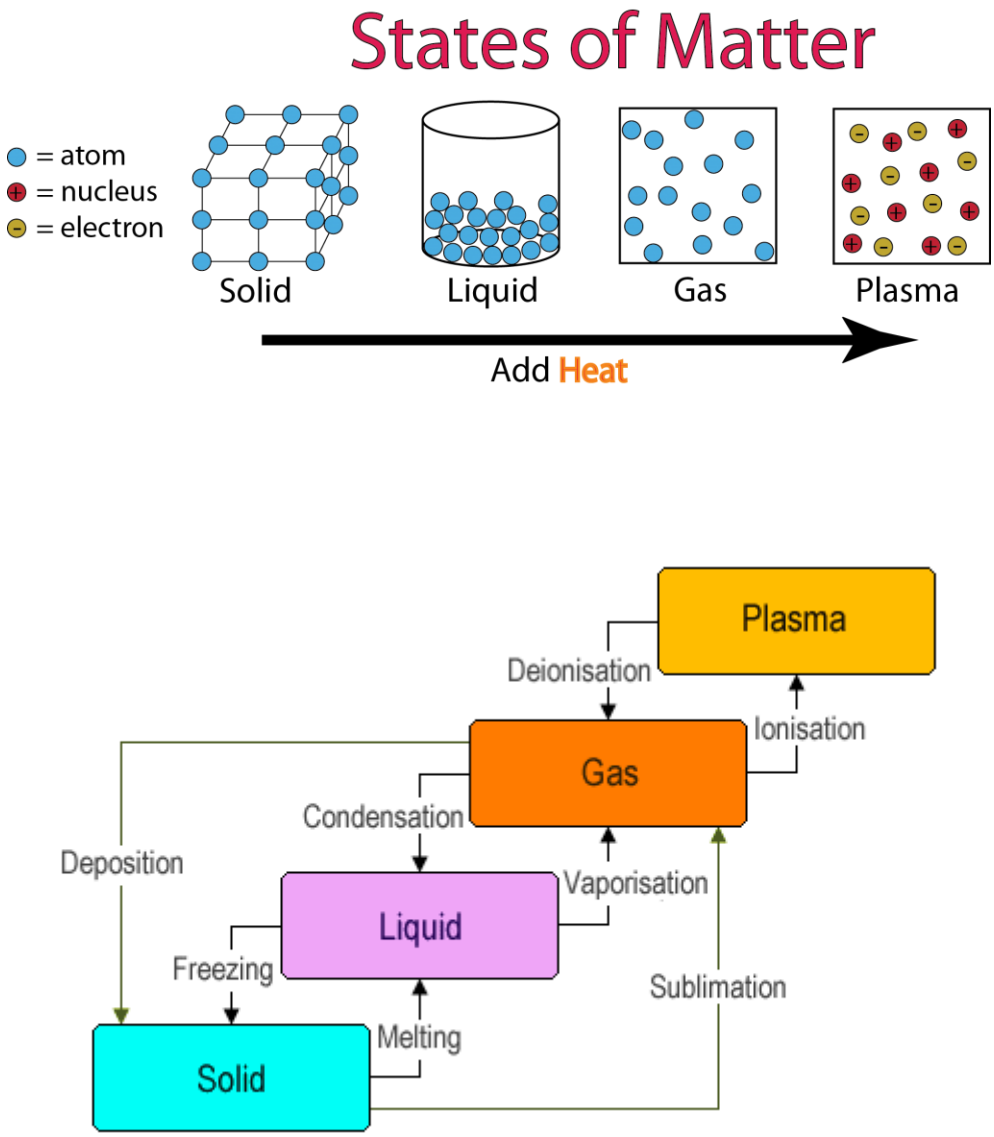

Fig. (1-2): Schematic shows the states of matter[22]

1-13-1 Properties of Plasma

In a manner, plasma is just like a gas in that it implies its container shape and volume. But plasma is not as free as gas, since its particles are charged electrically. Opposite charges attract one another, often leading to plasma retaining a general form or flow. The charged particles as well mean that electric and magnetic fields may shape or contain plasma. In general, plasma is much less pressurized than gas[23].

1-13-2 Medicine and hygiene

The possibility of generating and exploiting rather low temperature plasma at atmospheric pressure in the air has led to the rapid growth of applications not only for the treatment of non - living matter but also with the exposed of living cells and tissues. An evident use is The impeding of harmful microorganisms situated on temperature-sensitive surfaces.. The high antimicrobial efficacy of plasma has already been demonstrated for low-pressure plasma which requires objects to be put into a vacuum system and is therefore of limited practical use[24].

1-14 The cancer and its treatments

Cancer can be treated with surgery, chemotherapy, radiation treatments, hormone treatment, targeted treatment (as well as immunotherapy like monoclonal antibody treatment) and synthetic lethality. The choice of treatment count on the location and level of the tumor and the disease stage, and also the patient's general condition. Sequencing of the cancer genome helps to determine which cancer the patient has exactly to determine the best cancer therapy. There are also a number of experimental cancer treatments under way. According to current estimates, two out of five people will have cancer later in life in

their lifetime[25]. Complete cancer removal without damage to the remainder of the body (i.e. cure with almost zero adverse effects) is the ideal treatment goal and it is also the goal in practice. This can sometimes be accomplished by surgery, but the predisposition of cancers to attack surrounding tissue or spread by microscopic metastasis to distant sites almost always restricts its efficacy; and chemotherapy and radiotherapy could have an adverse effect on normal cells. Thus, cure with no marginal negative effects can in some cases be accepted as a workable goal; and besides curative intention, practical goals of therapy canals involve. Suppressing subclinical cancer and maintaining it for years of good quality of life (mean, cancer treating as a chronic disease) and sedative do not have curative will. (For advanced metastatic cancers). Because "cancer" relates to a group of diseases, it is doubtful there can ever be a solitary "cancer cure" except for a single treatment for all infectious diseases. Angiogenesis inhibitors were once thought to have potential as a "silver bullet" treatment for many cancer types, but this was not the case in practice[26].

1-15 Literature Review

In 2020, Shrey Sindhwani et al., Showed that the concept of nanoparticle transports through gaps between endothelial cells (interendothelial gaps) in the tumor blood vessel is a central paradigm in cancer nanomedicine. The size of these gaps was found to be up to 2,000 nm. This justified the development of nanoparticles to treat solid tumors as their size is small enough to extravasate and access the tumor microenvironment. They showed that these inter-endothelial gaps are not responsible for the transport of nanoparticles into solid tumors. Instead,

they found that up to 97% of nanoparticles enter tumors using an active process through endothelial cells. This result is derived from analysis of four different mouse models, three different types of human tumors, mathematical simulation and modelling, and two different types of imaging techniques. These results challenge the current rationale for developing cancer nanomedicine and suggest that understanding these active pathways will unlock strategies to enhance tumor accumulation[27].

In 2019,Minakshi Jhaet al., prepared Ag:CdO nanocubes and nanosphere. They synthesized them via ultrasonic assisted green approach using Citrus lemon leaves and applied for photo degradation. Nanocubes and nanosphere morphology were evident from SEM and TEM. The degradation time and apparent rate constant (from pseudo-first-order) for (2%) Ag:CdO@MB, (2%) Ag:CdO@Rh-B, (5%) Ag:CdO@MB and (5%) Ag:CdO@Rh-B system were t=33 min (K=0.088 min-1), t=42 min (K=0.032 min-1), t= 18 min (K=0.11 min-1), t= 24 min (K= 0.0759 min-1), respectively. (5%) Ag: CdO conserve 92% of its activity after five repeated cycle. Generation of HO and O -radicals lead photo degradation. Photo catalytic mechanism was elucidated and degradation pattern followed pseudo-first order kinetics[28].

In 2019, Shohrh Hemmati et al., developed an environmentally friendly technique to produce metal nanoparticles using green synthesis methods. In this study, silver nanostructures were synthesized using different sugar substitutes and artificial sweeteners as green reducing agents in an aqueous solution at low temperature[29].

In 2019, Roy van der Meel et al., proposed four strategic directions to improve nanomedicine translation and exploitation. (1) Patient

stratification has become common practice in oncology drug development. Accordingly, probes and protocols for patient stratification are urgently needed in cancer nanomedicine, to identify individuals suitable for inclusion in clinical trials. (2)Rational drug selection is crucial for clinical and commercial success. Opportunistic choices based on drug availability should be replaced by investments in modular (pro) drug and nanocarrier design. (3) Combination therapies are the mainstay of clinical cancer care. Nanomedicines synergize with pharmacological and physical co-treatments, and should be increasingly integrated in multimodal combination therapy regimens. (4) Immunotherapy is revolutionizing the treatment of cancer. Nanomedicine can modulate the behavior of myeloid and lymphoid cells, thereby empowering anticancer immunity and immunotherapy efficacy. Alone and especially together, these four directions will fuel and foster the development of successful cancer nanomedicine therapies[30].

In 2019, Muhammed H. Elnaggar, et al., showed that the effectiveness of chemotherapy in hepatocellular carcinoma (HCC) is restricted by chemo resistance and systemic side effects. To improve the efficacy and safety of chemotherapeutics in HCC management, scientists have attempted to deliver these drugs to malignant tissues using targeted carriers as nanoparticles (NPs). Among the three types of NPs targeting (active, passive, and stimuli-responsive), active targeting is the most commonly investigated in HCC treatment. Despite the observed promising results so far, clinical research on nanomedicine targeting for HCC treatment still faces many challenges. These include batch-to-batch physicochemical properties' variations, limiting large scale production and insufficient data on human and environmental toxicities. This review

summarized the characteristics of different nanocarriers, ligands, targeted receptors on HCC cells and provided recommendations to overcome the challenges, facing this novel line of treatment for HCC[31].

In (2019),V. Radhika , et al., studied CdO by synthesized Nano crystalline thin films of undoped and Al doped Cadmium oxide by using chemical bath deposition method and were annealed at 500°C. The films were characterized to study their structural, optical and compositional properties. Antibacterial activity of CdO films were assayed by using the agar well diffusion technique. The antibacterial activity of undoped and Al doped CdO solutions were analyzed to the Gram-positive bacteria Bacillus cereus and the gram-negative bacteria Vibrio Cholera. This study reveals that the diameter of zone of inhibition is found to be more for gram-negative bacteria than gram-positive for undoped CdO and Al doped CdO[32].

In (2018), Heerak Chugh, et al., explained the role of gold and silver NPs (AgNPs) in the cancer nanomedicine. The preparation of gold NPs (AuNPs) and AgNPs can be grouped into three categories – physical, chemical and biological. Among the three approaches, the biological approach is growing and receiving more attention due to its safe and effective production. In this review, they have discussed important methods for synthesis of gold and AgNPs followed by techniques employed in characterization of their physicochemical properties, such as UV–visible spectroscopy, electron microscopy (TEM and SEM) and size and surface analysis (DLS). The mechanism of formation of these NPs in an aqueous medium through various stages – reduction, nucleation and growth has also been reviewed briefly. Finally, they concluded their

review with the application of these NPs as anti-cancer agents and numerous mechanisms by which they render cancer cell toxicity[33].

In (2018),AlirezaHeidari., showed the effect of temperature of the ablation environment on the properties of Cadmium Oxide (CdO) nanoparticles produced by synchrotron radiation is investigated. They produced nanoparticles; synchrotron radiation pulse with 1064 (nm) wavelength is used to emit Cadmium in the human cancer cells, tissues and tumors. All test parameters were kept constant and human cancer cells, tissues and tumors temperature was changed to produce samples at 20°C and 65°C. Then, ATR–FTIR, XRD, TEM and UV–Visible spectroscopy analyses were performed to investigate their properties. The results show that the size of nanoparticles is increased by increase in temperature of ablation environment. In addition, in the current experimental research, Gold (Au)–Cadmium Oxide (CdO) alloy is created at the size of nano. In this regard, same volume of Gold and Cadmium Oxide (CdO) solutions were mixed together and emitted by the synchrotron radiation pulse with wavelength of 532 (nm).The Gold and Cadmium Oxide (CdO) solutions have been produced, separately, using synchrotron radiation ablation process. To produce them, synchrotron radiation pulse with wavelength of 1064 (nm) and pulse width of 7 (ns) and repeating frequency of 5 (Hz) was used. The results show that synchrotron radiation emission with wavelength of 532 (nm) is an appropriate method for producing Gold compounds in the size of nano[34].

In (2018), Jyotsna Chauhan, et al., showed that synthesized cadmium doped nickel oxide with diameter range 30.6 nm by the co-precipitation method. Properties of the nickel oxide have been tuned by doping of the

cadmium at different concentration. Different characterization techniques i.e. XRD, FTIR, PL and UV visible have used to study the properties of synthesized nanoparticles. The size of nanoparticles is characterized by XRD also UV visible spectrum shows that absorption capacity of nickel oxide has been enhanced because of cadmium doping[35].

In (2018), F. H. Dowlatababdi, et al., used the Localized Surface Plasmon Resonance (LSPR) effect induced by Cadmium Oxide (CdO) nanoparticles to observe Raman spectrum of human cancer cells, tissues and tumors. The diagnosis and treatment of human cancer cells, tissues and tumors in sample is investigated through Nanomaterial Surface Energy Transfer (NSET) process from human cancer cells, tissues and tumors to the surface of nanoparticles, and Surface Enhanced Raman Scattering (SERS) process, as effective factors for Raman spectrum detection. For interaction of human cancer cells, tissues and tumors with Cadmium Oxide (CdO) nanoparticles, colloidal state and Self-Assembled Monolayer (SAM) methods were used. Both methods have shown good agreement with each other in detecting the Raman spectrum. It should be noted that these methods and techniques can be applied on different types of human's cancer cells, tissues and tumors, respectively[36].

In (2017), F. H. Dowlatababdi, et al., evaluated antibacterial activity properties of silver doped zinc oxide nanoparticles (ZnO: Ag) by synthesizing them. The silver doped zinc oxide nanoparticles (ZnO: Ag) were prepared through the wet chemical method in an aqueous solution, and mercaptoethanol. The physical properties of the samples were investigated with UV, XRD, and TEM techniques. Then, the antibacterial

activity of (50 to 3.12) mg/ml concentrations of the silver doped zinc oxide nanoparticles (ZnO:Ag) was investigated against Escherichia coli, Staphylococcus aureus, Pseudomonas aeruginosa, and Enterococcus faecalis through the well diffusion method. Moreover, the minimal inhibitory concentration (MIC) and minimal bactericidal concentration (MBC) values of these nanoparticles were assessed by micro dilution method. The size of the nanoparticles was obtained as between 12 and 13 nanometers in average. The optical study of the nanoparticles demonstrated that the band gap of the silver doped nanostructures is higher than that of the pure sample. The zone of inhibition diameter in the presence of 50 mg/ml density was 19, 15 and8 mm against Staphylococcus aureus, Escherichia coli, and Pseudomonas aeruginosa, respectively. The results indicate that silver doped zinc oxide nanoparticles prevented Escherichia coli, Staphylococcus aureus, and Pseudomonas aeruginosa, but did not affect Enterococcus faecalis. The zone of inhibition diameter increases as the density of the nanoparticles does[37] .

In (2017), R.V. Mehta, showed that Biomedical and biotechnological applications of magnetic nanoparticles and their dispersions in liquids are found to be potentially useful. An exponential growth in publications of papers, reviews and patents has been observed. Possibilities of their indiscriminate use on individual as well as environmental health hazards are also investigated. Still, there appears to be a good scope for further research work in the field. Even a small improvement either in preparation method or development of novel nanoparticles may prove to be beneficial in longer run. With this aim in mind, the present review discussed the work carried out in author's laboratory on synthesis and

characterization of certain bio magnetic particles and biocompatible fluids composed of these particles. Modified methods were used to synthesize these particles. Notable amongst these are direct binding of biomolecules or drug on magnetic nano particles, low Curie point functionalized magnetic particles, targeted drug delivery system, photo dyne therapy, anti-bacterial activity and bioremediation of marine fungi. Advantages and limitations of these work in light of recent work is also discussed[38].

In (2017), K. Venugopal,et al., showed how the present study tried for a phyto-synthetic method of producing silver nanoparticles (Ag-NPs) with size controlled as an eco-friendly route that can lead to their advanced production with decorative tranquil morphology. By inducing temperature fluctuation of the reaction mixture from 25 to 80 °C the Plasmon resonance band raised slowly which had an ultimate effect on size and shape of Ag-NPs as shown by UV–visible spectroscopy and TEM results. The biosynthesized nanoparticles showed good cytotoxic impact against MCF-7, A549 and Hep2 cells compared to normal cell lines. Compared to control plates, the percentage of cell growth inhibition was found to be high with as concentrations of Ag-NPs becomes more as determined by MTT assay. The AO/EtBr staining observations demonstrated that the mechanism of cell death induced by Ag-NPs was due to apoptosis in cancer cells. These present results propose that the silver nanoparticles (Ag-NPs) may be utilized as anticancer agents for the treatment of various cancer types. However, there is a need for study of in vivo examination of these nanoparticles to find their role and mechanism inside human body. Further, studies we plan to do biomarker fabrication from the green synthesized plant extract nanoparticles like silver, gold

and copper nanoparticles with optimized shape and sizes and their enhancement of these noble nanoparticles[39].

In (2016), Xi-Feng Zhang,et al.,discussed the role of Silver nanoparticles(AgNPs) in Nanoscience and nanotechnology. Radically changed the way of diagnose, treat, and prevent various diseases in all aspects of human life. Silver nanoparticles (AgNPs) are one of the most vital and fascinating nanomaterials among several metallic nanoparticles that are involved in biomedical applications. AgNPs play an important role in nanoscience and nanotechnology, particularly in nanomedicine. Although several noble metals have been used for various purposes, AgNPs have been focused on potential applications in cancer diagnosis and therapy. They discussed the synthesis of AgNPs using physical, chemical, and biological methods. They also discussed the properties of AgNPs and methods for their characterization. More importantly, we they extensively discussed the multifunctional bio-applications of AgNPs; for example, as antibacterial, antifungal, antiviral, anti-inflammatory, anti-angiogenic, and anti-cancer agents, and the mechanism of the anti-cancer activity of AgNPs. In addition, they discussed therapeutic approaches and challenges for cancer therapy using AgNPs. Finally, they conclude by discussing the future perspective of AgNPs[40].

In (2016), Heidari A., studied Cadmium Oxide (CdO)nanoparticles synthesis methods. They studied the applications of Cadmium Oxide (CdO) nanoparticles in some areas such as pharmaceutical and analytical chemistry as anti-tumor drug. In addition, they investigated effect of Cadmium Oxide (CdO) nanoparticles as anti-cancer drug on human

cancer cells which have been obtained from sampling]. Several methods are variable for production of Cadmium Oxide(CdO)nanoparticles. Conventional techniques of particle nanosized reduction include milling grinding jet milling crushing chemical process and air micronization. There are several drawbacks to this techniques. Furthermore, Supercritical Fluid (SCF) technology offers tremendous potential, as it safe, environmentally, friendly and economical. One of the advantages of this technique is that we do not use organic solvents. It has applications in the food industry, separations, chemical processing, pharmaceutical chemistry, analytical chemistry, biopolymers and soon. The thermodynamic and spectroscopic properties such as total entropy and enthalpy in Supercritical Fluid (SCF) were calculated[41].

In (2016), T.V.M. Sreekanth, et al., reported the toxicological effects of synthesized cadmium oxide (CdO) nanostructures via a simple green route using a Polygala tenuifolia root extract on normal and renal tumor cells. First, the formation of cadmium oxide nanostructures were confirmed structurally by Fourier transforms infrared spectroscopy, X-ray diffraction, and X-ray photoelectron spectroscopy (XPS). The powder was crystallized in a cubic structure with a space group of *Fm*-3*m*. The mean crystallize size was approximately 40 and 44 nm from the Scherrer and size-strain plots, respectively. The surface states of the cadmium oxide nanostructure using the O 1s and Cd 3d spectra were analyzed by XPS. Transmission electron microscopy showed that the simple green route resulted in various morphologies of synthesized cadmium oxide, such as trigonal-, tetrahedron-, and sheet-like structures. Finally, the toxic effects of the cadmium oxide nanostructures on Madin-Darby canine kidney epithelial cells (MDCK cells), as well as the human renal cancer

cell line (Caki-2 cells) were investigated using a SRB assay and two-color flow cytometry analysis. The cadmium oxide nanostructures showed significant cell growth inhibition in normal and also tumor cells in a dose-dependent manner. On the other hand, the inhibition was higher in the cancer cells compared to the normal cells[42].

In (2016), A Heidari., showed that Cadmium Oxide (CdO) nanoparticles are one of the most effective ant–cancer drugs. Cadmium Oxide (CdO) nanoparticles coordinate to nucleic acids and this coordination not only inhibits replication and transcription of nucleic acids, but also leads to programmed cancer cell death [1-10]. Cadmium Oxide (CdO) nanoparticles also form a coordination complex with nucleic acids, but unlike Palladium Oxide (PdO) nanoparticles is not an effective chemotherapeutic agent. This editorial was designed to compare the interactions of Cadmium Oxide (CdO) nanoparticles and Palladium Oxide (PdO) nanoparticles with Calf and Salmon thymus nucleic acids in aqueous solution at physiological conditions by Attenuated Total Reflectance Fourier Transform Infrared Spectroscopy (ATR–FTIR), FT–Raman, UV–Vis, HR Mass,1HNMR, 13CNMR and 31PNMR spectroscopies which have used to determine binding constant and the stability of nucleic acids in drug–nucleic acids complexes in aqueous solution at physiological conditions. No biopolymer secondary structural changes were observed upon Cadmium Oxide (CdO) nanoparticles interaction and nucleic acids remain in the A–type conformation in these drug nao compounds. The ant–cancer and ant–viral effects of these nanoparticles are attributed to their potential biomedical, biochemical, biophysical, clinical, pharmaceutical, physiological and photodynamic applications. Molecular systems with pre–organized and effectively

functionalized recognition unit for guest molecules are ideal for host guest interaction. In this regard, nucleic acids provide particular promise due to their complications ability and their applications receptors. While Cadmium Oxide (CdO) nanoparticles interact with nucleic acids; their bindings to nucleic acids are not fully studied. Also, this editorial was presented to test the interactions of Cadmium Oxide (CdO) nanoparticles with nucleic acids in aqueous solution at physiological conditions. Attenuated Total Reflectance Fourier Transform Infrared Spectroscopy (ATR–FTIR), FT–Raman, UV–Vis, HR Mass, 1HNMR, 13CNMR and 31PNMR spectroscopes were used to determine the ligand binding modes, the binding constant and the stability of nucleic acids in Cadmium Oxide (CdO) nanoparticles–nucleic acids complexes in aqueous solution at physiological conditions. No biopolymer secondary structural changes were observed upon Cadmium Oxide (CdO)nanoparticles interaction and nucleic acids remain in the B–type conformation in these drug nanocompounds[43].

In (2016), Balamurugan S. , et al.[ ], synthesized CdO nanopowders by a simple soft chemical method using cadmium acetate as the precursor salt. The as-synthesized nanopowders were characterized by XRD, SEM, EDX and TEM analysis. Polycrystalline nature with a (1 1 1) preferential orientation is revealed by the XRD analysis, which was confirmed from the SAED pattern. The presence of Cd and O in the nanopowders is confirmed from the EDX spectrum. The presence of peaks at 417, 499, 620 and 669 cm^{-1} observed in the FTIR spectrum corresponds to the bonding between Cd and O. Antimicrobial activities were performed against three bacteria and fungi strains by the agar well diffusion method, and from the observed zones of inhibition, it is confirmed that the as-

synthesized CdO nanopowders act as an effective antimicrobial agent against pathogenic microorganisms[44].

In (2015), Harshita Sharma, et al., developed new anticancer strategies. Theranostics is a strategy that combines treatment with diagnosis and monitoring. Metal nanoparticles are proposed as one of the most promising theranostic agents for the treatment of cancer. Thus, metals including iron, gold (Au), silver (Ag), zinc (Zn), and titanium, havepotential as anticancer agents, either inherently or as a result of surface modifications. As a functional component of theranostic tools, metal nanoparticles have crucial dual roles as a diagnostic and active therapeutic agent for the treatment of cancer. Advances in cellular and molecular imaging have led to the development of various nanoparticle-based diagnostic and/or imaging agents for the detection of cancer. Nanocarrier-based formulations have already been reported to increase the effectiveness of chemotherapy and have been approved for clinical applications. Hence, efforts are now being made to combine both therapy and imaging in one particle to increase the effectiveness of a single approach. As theranostic agents, metal nanoparticles have advantages over other nanoparticles because of their inherent anticancer activity, which overcomes the requirement of other carriers for the delivery of therapeutic and diagnostic agents. Furthermore, they are biocompatible in nature and can be easily excreted from the body[45].

In (2014), Guo, Dawei , showed that Several studies have suggested that silver nanoparticles (AgNPs) have the potential to treat human cancers, including leukemia. However, the detailed cellular mechanisms for AgNPs to inhibit the growth of leukemic cells and their efficacy on

clinical isolates of leukemia patients are not elucidated. In this study, the cellular uptake and cytotoxic mechanism of AgNPs in chronic myeloid leukemia (CML) cells were investigated. AgNPs were synthesized with a modified polyol method, which were stable under cell culture conditions with fetal bovine serum (FBS). AgNPs were demonstrated to be able to enter K562 cells (a CML cell line) in a dose-dependent manner and locate in endosomes. Reactive oxygen species (ROS) could be generated upon AgNPs exposure and cause cytotoxicity and apoptosis. It was also found that AgNPs treatment inhibited the viability of cells from CML patients (n=4). The cell cycle status and several critical regulators were altered upon AgNPs treatment as well. All these cellular and molecular alterations caused by AgNPs exposure could be reversed by the addition of Vitamin C (an antioxidant). These results suggested that proper usage of AgNPs would be of great significance for CML treatment in future[46].

In (2014), Enzo Agostinelli, et al., showed that Nanotechnology for cancer gene therapy is an emerging field. Nucleic acids, polyamine analogues and cytotoxic products of polyamine oxidation, generated in situ by an enzyme catalyzed reaction, can be developed for nanotechnology-based cancer therapeutics with reduced systemic toxicity and improved therapeutic efficacy. Nucleic acid-based gene therapy approaches depend on the compaction of DNA/RNA to nanoparticles and polyamine analogues are excellent agents for the condensation of nucleic acids to nanoparticles. Polyamines and amine oxidases are found in higher levels in tumors compared to that of normal tissues. Therefore, the metabolism of polyamines spermidine and spermine, and their diamine precursor,putrescine, can be targets for antineoplastic therapy since these

naturally occurring alkylaminesare essential for normal mammalian cell growth. Intracellular polyamine concentrations are maintained at a cell type-specific set point through the coordinated and highly regulated interplay between biosynthesis, transport, and catabolism. In particular, polyamine catabolism involves copper-containing amine oxidases. Several studies showed an important role of these enzymes in developmental and disease-related processes in animals through the control of species (ROS), H2O2 in particular, by these oxidases suggests a mechanism by which amine oxidases can be exploited as antineoplastic drug targets. The combination of bovine serum amine oxidases (BSAO) and polyamines prevents tumor growth, particularly well if the enzyme has been conjugated with a biocompatible hydrogel polymer. The findings described herein suggest that enzymatic ally formed cytotoxic agents activate stress signal transduction pathways, leading to apoptotic cell death. Consequently, super paramagnetic nanoparticles or other advanced nanosystem based on directed nucleic acid assemblies, polyamine-induced DNA condensation, and bovine serum amine oxidase may be proposed for futuristic anticancer therapy utilizing nucleic acids, polyamines and BSAO. BSAO based nanoparticles can be employed for the generation of cytotoxic polyamine metabolites[47].

in (2014), Monalisha Rath, et al, showed that Nanotechnology involves the tailoring of materials at the atomic level to attain unique properties, which can be suitably manipulated for the desired applications. Among them silver nanoparticles draw attention due to its unique physical, chemical and biological properties. Green principle route of synthesizing have emerged as alternative to overcome the limitation of conventional methods among which plant and microorganisms are majorly exploited. Employing plants towards synthesis of nanoparticles are emerging as

advantageous compared to microbes with the presence of broad variability of bio molecules in plants can act as capping and reducing agents and thus increases the rate of reduction and stabilization of nanoparticles. This review focused on the green synthesis of silver nanoparticles using various plant sources and its applications in cancer treatment. Generally surgery, chemotherapy and radiation treatment are the most prevalent therapeutic option for cancer. Unfortunately these treatments have various side effects due to lack of targeted delivery and cancer specificity. To overcome these limitations, nanoparticle could ensure targeted drug therapy having very little side effects. This review was focused to silver nanoparticle, synthesized from natural plant extracts, as it is cost effective, eco-friendly, stable and safe in cancer treatment[48].

In (2013),Chisato Nagata , et al., reported the Non-occupational exposure to cadmium which has been suspected to be a risk factor for breast cancer. The present study examined the association between urinary cadmium level and the risk of breast cancer in a case–control study among Japanese women. Cases were 153women newly diagnosed and histological confirmed with breast cancer at a general hospital in Gifu, Japan. A total of 431 controls individually matched to cases by age, menopausal status, and the period of urine sampling were selected from those who attended a breast cancer mass screening at this hospital. Urinary cadmium levels were measured using spot urine samples. Spot urine samples were collected from cases after surgery but before any cancer therapy. For controls, spot urine samples were obtained at the date of the screening visit. Information on known or suggested breast cancer risk factors was obtained by a self-administered questionnaire. The odds ratios (ORs) and 95 % confidence intervals (CIs) of breast cancer

according to the tertile of the creatinine-adjusted cadmium level were calculated using conditional logistic regression models. Women in the highest tertile of the creatinine adjusted cadmium level ([2.620 lg/g) had significantly elevated OR of breast cancer relative to those in the lowest tertile (\1.674 lg/g) after controlling for covariates [OR = 6.05, (95 % CI 2.90, 12.62)]. The trend of increase in risk with increasing cadmium level was also statistically significant [OR = 1.67, (95 % CI 1.39, 2.01) for every1.0 lg/g increase in urinary cadmium level, P-trend\0.01]. These data suggested that exposure to cadmium was associated with a risk of breast cancer in Japanese women[49].

in (2013),Christian Pfeiffer, , showed that the synthesis of different Ag NPs with difference in size, optical properties, stability and surface chemistry was done in a defined way. These particles could be taken up by cells and show that intracellular Ag is more toxic than extracellular and that the Ag NPs are an efficient carrier to bring the silver inside the cells. In addition to the silver nanoparticles commercial gold nanoparticles were used to show that the here used methods to increase the stability of a particle against salt can be used in a general way. It could be shown that the coating of particle increased the stability it than using hydrophilic ligand molecules. By replacing the weak citrate ligand molecules with strong binding thiol-PEG molecules, the stability could also be increased showing comparable results like the coated particles. For using the coating procedure, the commercial particles first were transferred to the organic phase by replacing hydrophilic ligand molecules with hydrophobic molecules in two steps. First, the weak hydrophilic ligand was preplaced by a weak phase transfer ligand, which was replaced by a strong binding thiol ligand in a second step. Afterwards

the gold nanoparticles showed the same surface chemistry like the silver nanoparticles and could be used in the same manner[50].

In (2012), Hekmat , et al., showed the structural changes in DNA caused by the combined effects of silver nanoparticles (Ag NPs) and doxorubicin (DOX) was investigated along with their corresponding inhibitory roles in the growth of T47D and MCF7 cells. The UV-visible titration studies showed that DOX + AgNPs could form a novel complex with DNA and this interaction is in the interface between the value induced by electrostatic and intercalative binding. The values of binding constants revealed that DOX + AgNPs interact more strongly with DNA as compared to Ag NPs or DOX alone. Their CD data revealed that although Ag NPs and DOX alone could alter DNA structure, this combination leads to transition of DNA conformation to an ordered and compact molecular form so called &phis-type, considering that DNA is relatively thermally stable in the condition used. Thus, they observed that DOX + AgNPs induces conformational change on DNA. The anticancer property of DOX + AgNPs by MTT assay, DAPI stain and flow cytometry analyses demonstrated that this combination can tremendously diminish proliferation of T47D and MCF7 cells compared to DOX or Ag NPs alone. Furthermore, this combination was comparatively non-toxic towards the human endometrial stem cells proliferation. Collectively, these results reveal that DOX + AgNPs could proffer a novel strategy for the development of promising and efficient chemotherapy agents[51].

In (2011), G. Singhet al., investigated the synthesis of nanocrystalline cadmium oxide (CdO) and its characterization by X-ray diffraction (XRD) and transmission electron microscopy (TEM). Its catalytic activity was investigated on the thermal decomposition of 1,2,5,7-tetranitro-

1,3,5,7-tetraazacyclooctane (HMX), ammonium per chlorate (AP), hydroxyl terminated polybutadiene (HTPB) and composite solid propellants (CSPs) using thermo gravimetric analysis (TG),simultaneous thermogravimerty and differential scanning calorimetry (TG–DSC) and ignition delay measurements. Kinetics of thermal decomposition of AP + CdO has also been investigated using model free (is conversional) and model-fitting approaches which have been applied to data for isothermal TG decomposition. All these studies show enhancement in the rate of decomposition of AP, HTPB and CSPs but no effect on HMX. The burning rate of CSPs has also been found to be increased with CdO nanocrystals[52].

In (2011),Loreta Strumylaite ,et al., studied , determined and compared cadmium (Cd) concentration in different biological media of breast cancer and benign breast tumor patients. Concentration of Cd was determined in breast tissue, urine, and blood of 57 breast cancer and 51 benign tumor patients. Two samples of breast tissue from each patient, i.e., tumor and healthy tissue were taken for the analysis. Cd in biological media was determined by atomic absorption spectrometry (Perkin–Elmer, Zeeman 3030). The mean Cd concentration in breast cancer patients was 0.053 lg/g (95% confidence intervals, CI 0.042–0.065) for tumor sample and 0.02 lg/g(95% CI 0.014–0.026) for healthy breast tissue sample(P\0.001). In benign tumor patients, the figures were as follows: 0.037 lg/g (95% CI 0.023–0.051) and 0.032 lg/g(95% CI 0.018–0.047) (P[0.05). Cd content in malignant tumor significantly differed from that in benign tumor (P\0.01). Cancer patients with positive estrogen receptors (ERs) had significantly greater concentration of breast tissue Cd compared to patients with negative ERs (P = 0.035).Adjusted for creatinine, Cd in urine was significantly higher in cancer patients than in

controls (P\0.001). In cancer patients, a positive Spearman's correlation was found between Cd in tumor and healthy breast tissue, blood(r = 0.44 and r = 0.39, respectively, P\ 0.01). Correlation between Cd in urine of cancer patients and number of cigarettes smoked during lifetime was suggestive (r = 0.59,P = 0.075). The data obtained show higher concentration of cadmium in breast tumor and urine of cancer patients and support a possible relationship between cadmium and breast cancer. This study demonstrated greater Cd concentration in breast cancer than that in benign breast tumor tissue. These findings are in line with those reported by other authors[53].

In (2010), Rajiv Saini, et al.,showed by an open-access article the importance of nanotechnology and their applications in medicine. These applications include fluorescent biological labels, drug and gene delivery, bio-detection of pathogens, detection of protein, probing of DNA structure, tissue engineering, tumor detection, separation and purification of biological molecules and cells, MRI contrast enhancement and phagokinetic studies. They concluded that, nanotechnology or systems / device manufacture at the molecular level, is a multidisciplinary scientific field undergoing explosive development. The genesis of nanotechnology can be traced to the promise of revolutionary advances across medicine, communications, genomics and robotics[54].

In (2008), Mritunjai Singhet al., showed through a study the major mechanism through which silver nanoparticles manifested antibacterial properties is by anchoring to and penetrating the bacterial cell wall, and modulating cellular signaling by dephosphorylating putative key peptide substrates on tyrosine residues. Silvernanoparticles act primarily in three ways against Gram-negative bacteria: **(1)** nanoparticles mainly in the

range of 1–10 nm attach to the surface of the cell membrane and drastically disturb its proper function, like permeability and respiration; **(2)** they are able to penetrate inside the bacteria and cause further damage by possibly interacting with sulfur- and phosphorus-obtaining compounds such as DNA;**(3)** nanoparticles release silver ions, which have an additional contribution to the bactericidal effect of the silver nanoparticles . Although bacterial cell lysis could be one of the reasons for the observed antibacterial property, nanoparticles also modulate the phosphotyrosineprofile of putative bacterial peptides, which could thus affect bacterial signal transduction and inhibit the growth of the organisms. The effect is dose dependent and is more pronounced against gram negative organisms than gram-positive ones. The antibacterial effect of nanoparticles is independent of acquisition of resistance by the bacteria against antibiotics. However, further studies must be conducted to verify if the bacteria develop resistance towards the nanoparticles and to examine cytotoxicity of nanoparticles towards human cells before proposing their therapeutic use[55].

In (2008),Amanda M Schrand, et al.,showed through their study that Silver (Ag) nanoparticles have unique Plasmon-resonant optical scattering properties that are finding use in nonmedical applications such as signal enhancers, optical sensors, and biomarkers. In this study, they examined the chemical and biological properties of Agnanoparticles of similar sizes, but that differed primarily in their surface chemistry(hydrocarbon versus polysaccharide), in neuroblastoma cells for their potential use as biological labels. They observed strong optical labeling of the cells in a high illumination light microscopy system after 24 h of incubation due to the excitation of Plasmon resonance by both

types of Agnanoparticle. Surface binding of both types of Ag nanoparticle to the plasma membrane of the cells was verified with scanning electron microscopy as well as the internalization and localization of the Ag nanoparticles into intracellular vacuoles in thin cell sections with transmission electron microscopy. However, the induction of reactive oxygen species (ROS), degradation of mitochondrial membrane integrity, disruption of the actin cytoskeleton, and reduction in proliferation after stimulation with nerve growth factor were found after incubation with Ag nanoparticles at concentrations of 25 μg ml-1 or greater, with a more pronounced effect produced by the hydrocarbon-based Ag nanoparticles in most cases. Therefore, the use of Ag nanoparticles as potential biological labels, even if the surface is chemically modified with biocompatible material, should be approached with caution[56].

In (2005), David D. Evanoff Jr. et al., examined optical properties of silver nanoparticles as a function of size. Extinction, scattering, and absorption cross-sections and distance dependence of the local electromagnetic field, as well as the quadrupolar coupling of 2Dassemblies of such particles are experimentally measured for a wide range of particle sizes. Such measurements were possible because of the development of a novel synthetic method for the size-controlled synthesis of chemically clean, highly crystalline silver nanoparticles of narrow size distribution. The method and its unique advantages are compared to other methods for synthesis of metal nanoparticles. Synthesis and properties of nanocomposite materials using these and other nanoparticles are also described. Important highlights in the history of the field of metal

nanoparticles as well as an examination of the basic principles of plasmon resonances are included[57].

Aim of the Work

- To produce nano product using plasma technique.
- Characterize the nanoproduct using different confirmation techniques like: FTIR, SEM, UV-vis, XRD, EDX, AFM, …… *etc*.
- Applying the product for detecting tumor.
- Check the role of the nanoproduct on the tumor by making the pathological study.

2-1 Biomaterials

The better definition of 'biomaterials' includes the materials of both synthetic and natural origin in contact with tissue , blood and biological fluids that are designed for use in prothetic, diagnostic , therapeutic and storage applications without negatively affecting the living organism as well as its components. A biomaterial is a synthetic material that used substitute a part of a living system or to work in intimately with living tissue[58].

Biomaterials are materials engineered or made to be useful for use as medical implants (or components of same) and usually intended to be in contact with biological materials in the long term. Examples of biomedical materials should be part of the living system, should be used to guide the course of any therapeutic or diagnostic procedure by managing interactions with living system components. In addition, biomaterials may be categorized as natural or synthetic, living or lifeless material forms and typically made up of multiple components interacting with biological systems. The biomaterials are either used for medicinal purposes (treatment, augmentation, repair or replacement of a tissue function) or for diagnostic purposes (sensors, cancer models, animal test replacement)[59].

Synthetic biomaterials (ceramics, metals, polymers and composites) are prepared using a large variety of different processing methods. There are several industrial processing methods for producing synthetic biomaterials. Sterilization is an important process of biomaterial development, whereby harmful substances (e.g. bacteria) are eliminated through the use of physical, chemical and physicochemical means (e.g. high temperature, intense radiation, concentrated toxic chemicals.

Biomaterials are often used in medical applications to increase or replace a natural function[60].

2-1-1 Features of biomaterials are as the following

1. It is an immutable substance, a non-viable substance or substance combination. In other words, this material can't generally develop, grow or live frankly.
2. This substance could be derived naturally or synthetically, and may be a solid or maybe even a liquid.
3. The substance has been used to replace, regenerate, repair or enhance any part of the body, tissue or organ in terms of structure and/or function (partially or completely).
4. The substance is utilized to enhance or maintain an individual's quality of life.
5. The substance is NOT a medicine

The term biomaterial is also sometimes used with regard to aesthetics (such as braces) but some times it is not. Consequently, certain definitions avoid using the concept non-viable, allowing the possibility of things such as tissue engineering[61].

2-1-2 Examples of Biomaterials

Despite, biomaterials have been used as part of the medical devices and in biological systems. Examples of biomaterials encompass things that you have certainly heard about before:

- Metals
- Ceramics
- Glass
- Polymers
- Animal-derived biomaterials [62].

Fig.(2-1): Hip replacements are made from biomaterials[63]**.**

A biomaterial is an inviolable substance that has been used in medical equipment for engagement with biological systems. With the removal of the word "medical," this definition will become more general and also very useful. When the word 'nonviable' is removed, the definition becomes even broader and can resolve new applications of tissue engineering and artificial organ hydride in which living cells are being used. Biomaterials can be used in a wide variety of areas of the human body for diverse applications. After all, the commonly required feature for each of these applications is the degree of toleration of such biomaterials when it is in contact with organs and tissues[64].

2-2 Silver Nanoparticles

Silver was known to have antibacterial activity for a long period of time, and was used till chemical antibiotics came on the scene. Metallic silver and the most inorganic silver compounds ionize in humidity, body fluids and mucus to launch biologically active Ag+, which the silver ions used as an antimicrobial agent for the toxicological and pharmacological properties[65].

Silver nanoparticles (AgNPs) are widely used with strong antimicrobial activity as one of the main ingredient in industrial, daily and health-related products. For illustration, AgNPs-based products are being used in the coatings of washing machines, water purifiers, toys and packaging materials. They were also used in textiles as well as some cosmetics, along with sunscreen.

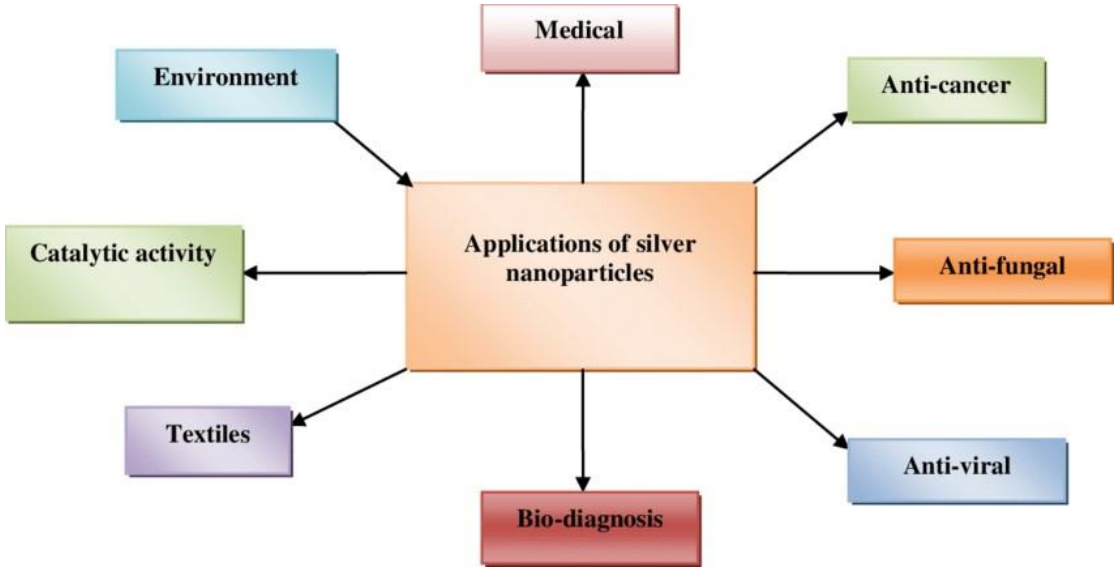

Fig.(2-2): Applications of silver nanoparticles in diverse sectors[66] .

They have also been coated or embedded in medicinal products such as wound dressings, urinary catheters, surgical instruments and bone prostheses. Their antimicrobial capacity is attributed to the high oxidative behavior of AgNP surfaces and the launch to biological environments of silver ions[67].

Silver nanoparticles (AgNPs) form a class of materials with sizes ranging from 1-100 nm. Due to its special and attractive physical, chemical and biological properties, interest in the study of AgNPs regarding their different behaviors has recently increased. AgNPs are also recognized to have specific toxicity, surface resonance to Plasmon and electrical resistance functions. Depending on these, advanced research work has been carried out to investigate their features and possible applications for several reasons, such as antimicrobial agents in anticancer agents, wound dressings, water treatment and electronic devices too[68].

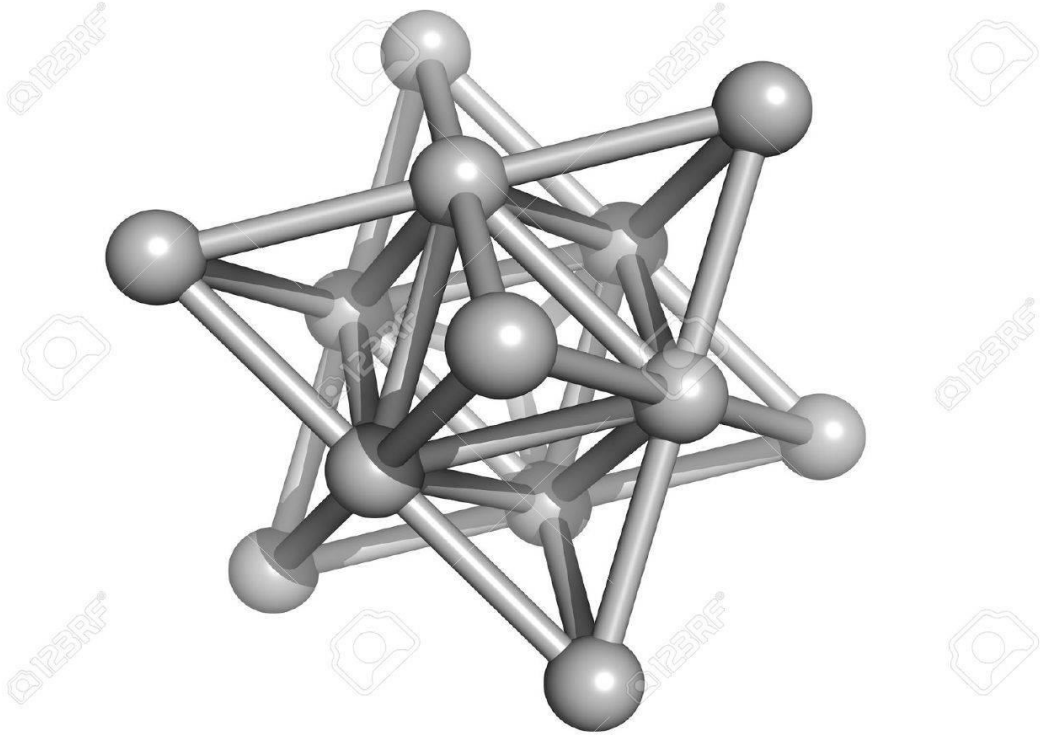

Fig.(2-3): Ag crystal with face centered cubic structure[69]

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2-3 Anticancer activity of silver nanoparticles

There have been numerous attempts to use silver nanoparticles as an anti-cancer agent, all of which have been positive. Silver nanoparticles' role as an anti-cancer agent should open up opportunities in the medicine sector. AgNPs have also recently been identified as having an effective role in tumor control through their cytotoxic effects[70].

Many types of cancer are not sensitive or susceptible to platinum drugs but there are many toxic side effects, besides the hematological and gastrointestinal toxicity. In addition, several cancer cells have inherent or Resistance acquired against other platinizing agents and cisplatin. As a

result , current research on anticancer has also been dedicated to creating new transition metal compounds. While silver was at first examined because of its beneficial antibacterial activities, its anticancer functions have been of recent interest. (Table 2-1) shows AgNPs against several cancer cells.

Table(2-1): Silver nanoparticles from different sources against several cancer cells[71].

AgNPs Synthesis Route	**Tested Cancer Cell**
plant dandelion-*Taraxacum officinale*	human liver cancer cells (HepG2)
Plant Extract-*Commelina nudiflora L*	HCT- 116 colon cancer cells
plant extracts of guava and clove	human colorectal adenocarcinoma, the human kidney, human chronic myelogenous, leukaemia, bone marrow, and human cervix
Plant Extract- Nostoc linckia	MCF-7
Chemical synthesis	A549 (Human lung carcinoma), HeLa (Human cervical adenocarcinoma), MCF7 (Human breast adenocarcinoma), MDAMB231 (Human breast adenocarcinoma), and SKBR3 (Human breast adenocarcinoma) cells
Plant Egtract-ethanolic extract of rose(Rosa indica) petals	human colon adenocarcinoma cancer cell line HCT 15

Ag NPs are a promising tool in diagnosis and testing as anticancer agents, with powerful effects on various lines of cancer cells providing many benefits. Their improved penetration and the ability to track Ag NPs in the body can make them the much more efficient tool for treating cancer with much less risk compared with standard treatment applications. The

remarkable Ag NP properties, like easy surface modification, optical characteristics, reproducible synthetic routes and large surface area: volume ratio makes them well suited for treatment for cancer[72].

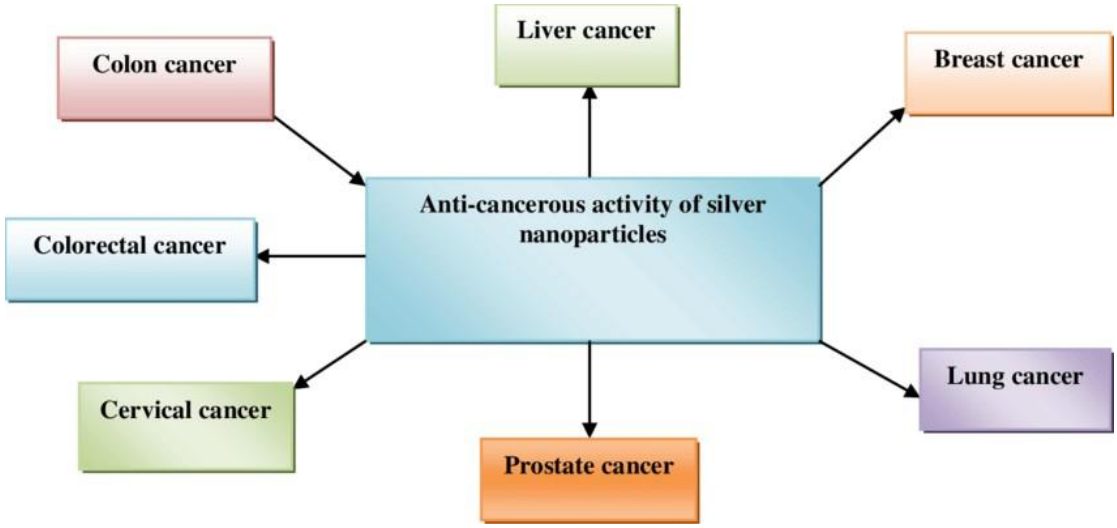


Fig.(2-4): Anticancer activity of silver nanoparticles[73]

While scientists are introducing new medicine to treat a number of conditions. Nanotechnology is pushing the limits of how we produce them to patients-targeting delivering to cancer cells and administering a dose of drugs once a month rather than daily. For some time now there has been the use of nano-sized carriers to deliver medicine[74]. Chemotherapy drug liposomal doxorubicin (Doxil brand name in the US) was accepted almost 20 years ago for the treatment of Kaposi's sarcoma. It is uncommon or a rare cancer frequently observed in AIDS patients. The anti-cancer drug doxorubicin molecules are held in a liposome, a fatty particle that lets the nanomedicine last longer time. And it has been available with liposome technology since the 1960s. Particles of nanosilver are also used to form dual imaging / immunotarized nanoshells

to pinpoint cancer cells and can absorb energy and selectively devastate targeted cancer cells through phototherapy[75].

2-4 Cadmium oxide

Cadmium oxide is a common by-product of zinc refining since cadmium compounds were mostly discovered in gatherings with zinc ores. It is produced by burning elementary cadmium in air. This oxide is also afforded by pyrolysis of other cadmium compounds, such as nitrate or carbonate. It is red when pure, but CdO is uncommon because of its ability to build defect structures leading from anion vacancies to be available in many different colours. Cadmium oxide is commercially prepared by oxidizing airborne cadmium vapors[76].

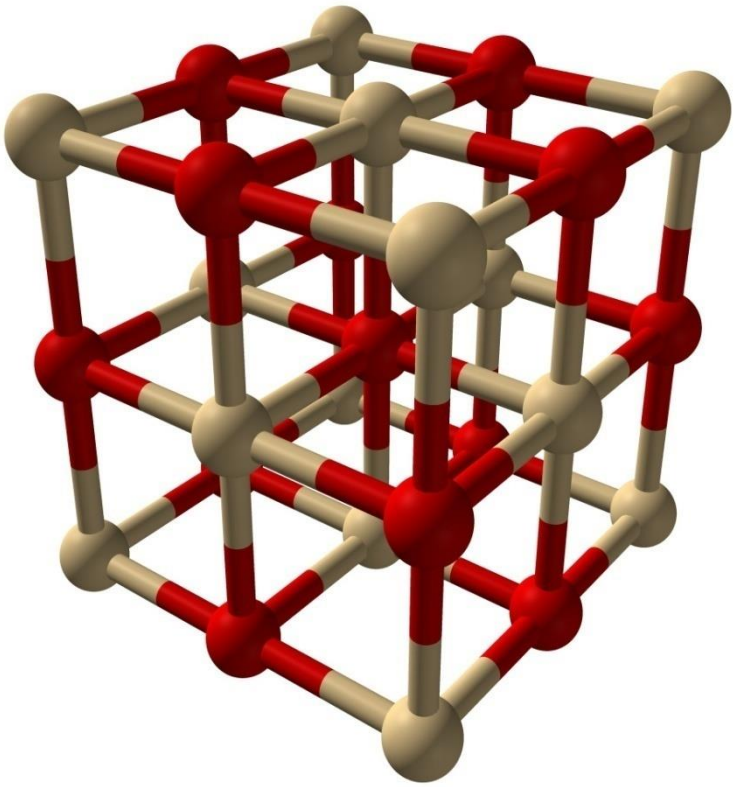


Fig.(2-5): Cd0 crystal with face centered cubic structure[77]**.**

2-4-1 Usages of Cadmium oxide

Cadmium oxide is used in baths with cadmium plating, storage battery electrodes, catalysts, cadmium salts, ceramic glazes, phosphorous and nematocide. Main uses for cadmium oxide are ingredients in galvanizing baths and in dye[78]. as a transparent conductive material, CdO has been used. Prepared by Karl Baedeker as early as 1907 as a transparent conducting film. For applications such as photodiodes, phototransistors, photovoltaic cells, transparent electrodes, liquid crystal displays, IR detectors, and anti-reflective coatings, cadmium oxide in the form of thin films was used. When exposed to UV-A light, CdO microparticles undergo bandgap excitation, and are also choosy in phenolphotodegradation[79] .Table (2-2) shows the physical and chemical properties of Cadmium oxide.

Table (2-2) shows the Physical-chemical properties of Cadmium oxide[80]**.**

Property Name	**Property Value**
Compound Formula	CdO
Molecular Weight	128.4
Appearance	White Powder
Melting Point	900-1000 °C (1652-1832 ° F)
Boiling Point	1,559° C (2,838° F)
Density	8.15 g/cm^3
Solubility in H2O	N/A
Exact Mass	129.898 g/mol
Monoisotopic Mass	129.898274 Da
Crystal Structure	Cubic
Band gap	2.18 eV
Refractive index (n_D)	2.49
Electron mobility	531 cm2/V·s

Magnetic susceptibility (χ)	-3.0·10−5 cm3/mol
Physical state at 20°C and 1013 hPa	Solid ,Form: powder Colour: red ochre Odour: odourless
Melting/freezing point	The melting point of the substance was de termined by thermo gravimetrical (TGA) measurements. There is no melting and no decompositio n, sublimation starts in nitrogen at ca. 870 °C and in air at ca. 950°C.
Vapour pressure	The vapour pressure of cadmium oxide is considered negligible at 25°C.
Water solubility	The experimentally determined average water solubility at 20 °C is 2.1 mg/L at p H 7.2-7.79. The calculated value for cad mium oxide is 6.1 mg/L.
Relative density	The density of the substance is 8.26 g/cm 3
Oxidising properties	Cadmium oxide has no oxidizing properti es
Granulometry	The D50 of the substance is 129 µm, the D80 is 215 µm.

2-4-2 Reactivity Cadmium oxide

CdO is a basic oxide, and is therefore assaulted by aqueous acids to provide $[Cd\ (H2O)_6]^{2+}$ solutions. $[Cd\ (OH)_4]^{2-}$ forms, after treatment with powerful alkaline solutions. A skinny coat of cadmium oxide shapes on the surface of cadmium in damp air at the temperature of room. At room temperatures, cadmium will oxidise to form CdO. In a reversible reaction, the cadmium vapor and steam will form CdO and hydrogen[81].

2-5 Plasma

Plasma is the fourth basic state of matter, in addition to gas, liquid and solid. Plasma originates from a Greek word, meaning jelly or moldable material. The word had been introduced by chemist Irving Langmuir in the 1928s.It is actually an ionized gas composed of free electrons and positive ions. It is the most frequent state of things on earth. Plasma generally consists of electrons, positive ions, and neutral atoms or molecules mixing together. It has an essential role in so many processes; from astrophysical solar activity to energy applications of nuclear fusion devices[82].

Plasma may accumulate to shape a gas. Plasma often also generates from gas ionization, and it is presumably possible for a liquid or solid to ionize directly into a gas when there is energy available and with enough space available. When observing a situation, changes in phase aren't always clear. For example, if you show the transference of dry ice into carbon dioxide gas, the white vapor that is noticed has been mostly water that condenses into fog droplets from water vapor in the air. Multiple phase changes can occur at once. For example, frozen nitrogen will form both the liquid phase and the vapor phase when exposed to normal temperature and pressure[83].

In 1879, Sir William Crookes made the first scientific description of the plasma, referring to what he called "radiant matter" in a Crookes cathode ray tube. Sir J.J., British physicist Homson’s experiments with a cathode ray tube directed him to introduce an atomic model consisting of positively charged subatomic particles (protons) and negatively charged ones[84].

By adding energy to a gas, plasma is generated .some of its electrons depart its atoms. This is known as ionisation. This result in electrons charged negatively, and ions charged positively. The charged particles in plasma will respond highly to magnetic and electrical fields (i.e. electromagnetic fields) as opposed to other state of matter. If plasma misses heat, the ions will re-form into a gas, releasing the energy that had ionized them. Plasma can be produce either by heating a gas till it becomes ionized or by submitting it to a powerful electromagnetic field, which means that the plasma consists of positive ions (cations) and free electrons. [85].

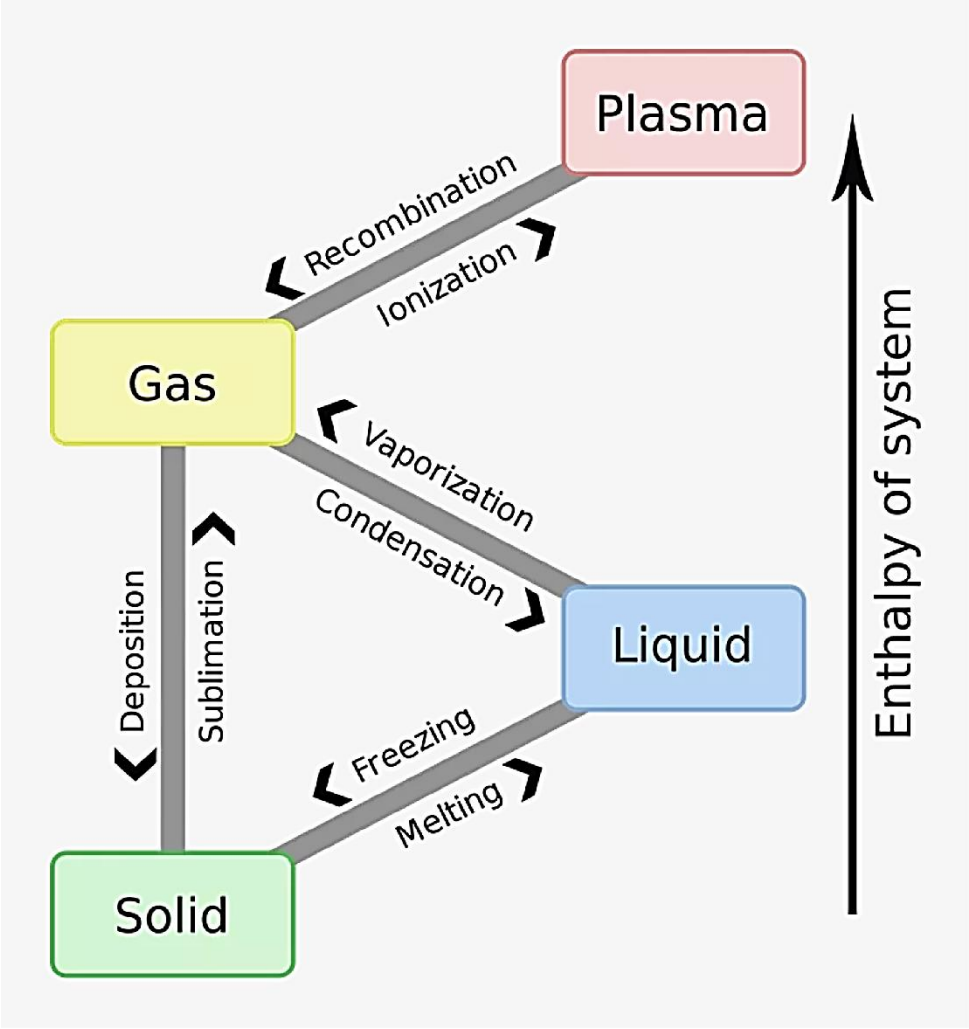


Fig.(2-6) :the Phase Changes of Matter[86] **.**

Plasma can be produced by either heating a gas once it becomes ionized or by implementing it to a powerful electromagnetic field, which means that the plasma consists of free electrons and positive ions (cations).

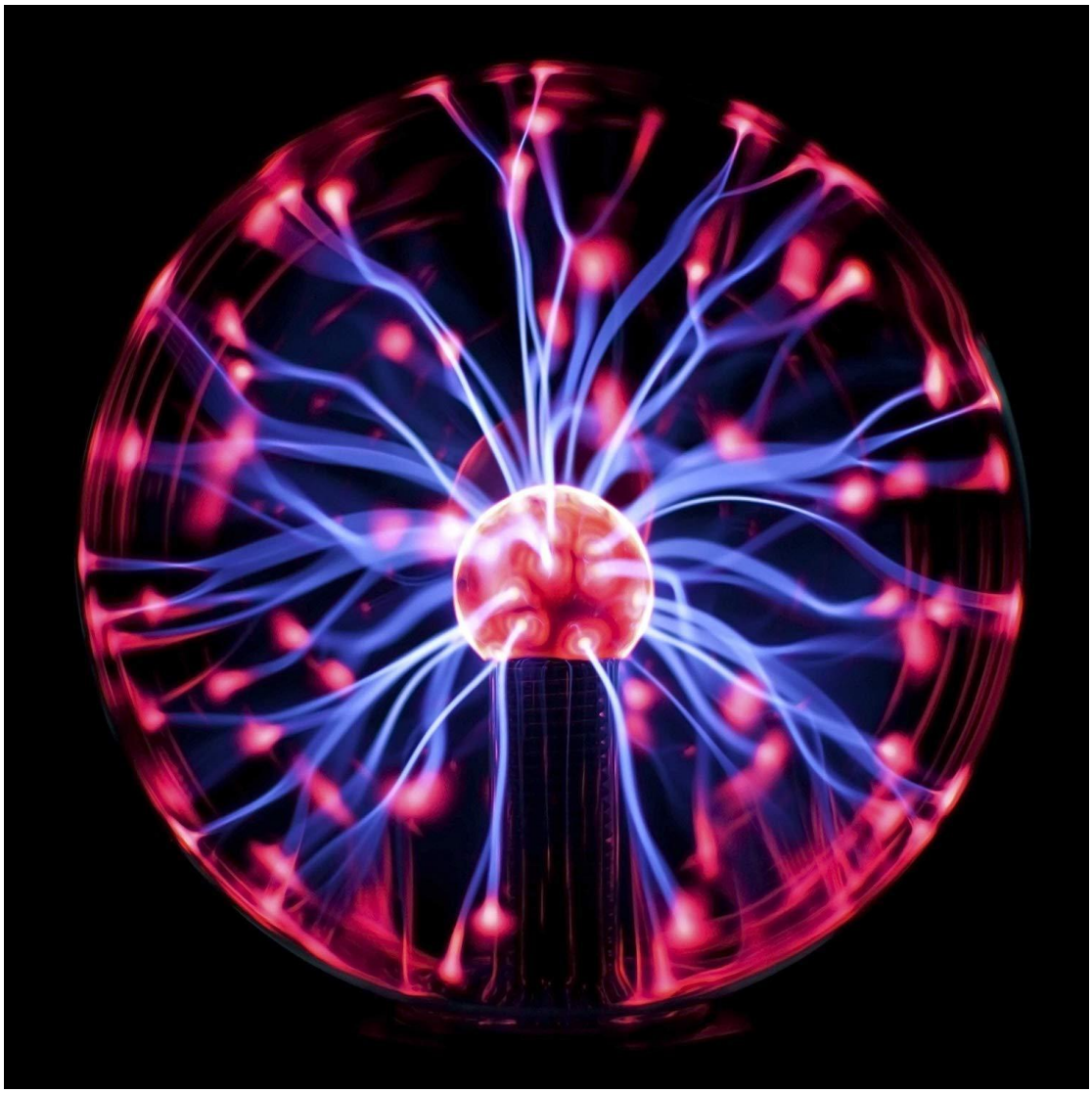


Fig. (2-7): A Plasma Ball Lamp. Each type of gas makes a different color[87]**.**

2-5-1 Properties of Plasma

- Plasma consists of charged particles and therefore responds to electromagnetic fields and conducts electricity. Conversely, most gasses are electric insulators.
- Similar to gas, plasma has no defined shape or volume.
- Once plasma is subjected to a magnetic field, structures, including layers, filaments and beams, can be assumed. A clear example can be observed of some of these structures in a plasma ball[88].

Many countries are teaching that there are three states of matter; solid, liquid, and gas, but in fact there are four, the fourth state of matter is Plasma. As we mentioned earlier, the other fact that plasma is the most common state of matter in the universe as we previously mentioned[89]. Since the plasma is a gas derived to the level that several electrons are able to break away from their nucleus, but travel with it. We can turn gases into plasmas in various ways, but all of them require condition and pump the gas with energy[90]. Plasma in a gas may be created from a spark. Plasma can be created by moving a hot gas via a large spark and transforming the gas stream into plasma which can be useful. In industry such plasma torches are used for cutting metals. The sun is the largest chunk of plasma that you'll see. The huge heat of the sun tearing electrons off the molecules of hydrogen and helium which make up the sun. The sun, like many other stars, is essentially a great big plasma ball[91].

2-5-2 Purposes and applications of Plasma

Plasma has been used in television, fluorescent lights and neon signs. Lightning, stars, and some flames are made of Plasma. One probably meets plasma more frequently than we think. More unusual plasma sources are including particles in nuclear fusion reactors and weapons, but the Sun, lightning, fire and neon signs are everyday sources. Other plasma examples are including static electric power, plasma balls, and ionosphere[92].

2-5-3 Categories of Plasma

Plasma is the outcome of the atoms being ionised. Since it is possible to ionize either all or a portion of atoms, there are varying degrees of ionization. The ionization level is essentially affected by temperature, where the temperature increase increases the degree of ionisation. Matter in which only 1% of the particles are ionized may exhibit plasma characteristics, but not plasma[93].

Plasma can be classified as "hot" or "completely ionized" if almost all of the particles are ionized, or "cold" or "completely ionized" if a small fraction of the molecules are ionized. Note that cold plasma temperatures can still be incredibly hot (thousands of degrees Celsius). Another way of classifying plasma is as non-thermal or thermal. The electrons and heavier particles in thermal plasma are in thermal balance or at the same temperature. The electrons are at a much higher temperature in nonthermal plasma than the neutral particles and ions (which can be at room temperature)[94].

So, we can say there are two types of plasma

Thermal plasma: That we can find in the light and the stars, at high temperatures and identified by the atom and the amount of energy that passes through it.

Non-thermal plasma (Cold plasma): It can be found in lower temperatures then in thermal plasma, and used in medical research. It can be found in Auroras and Fluorescent bulbs[95].

2-6 Toxicity of Nanomaterials

Nanotoxicology is the research or study of toxicity of nanomaterial Due to quantum size effects and large surface area to volume ratio, nanomaterials have a special properties compared to their larger counterparts. Nanomaterials are being used in a wide range of commercial products, including electronic components, sport equipment, sun creams, and biotechnological applications[96].

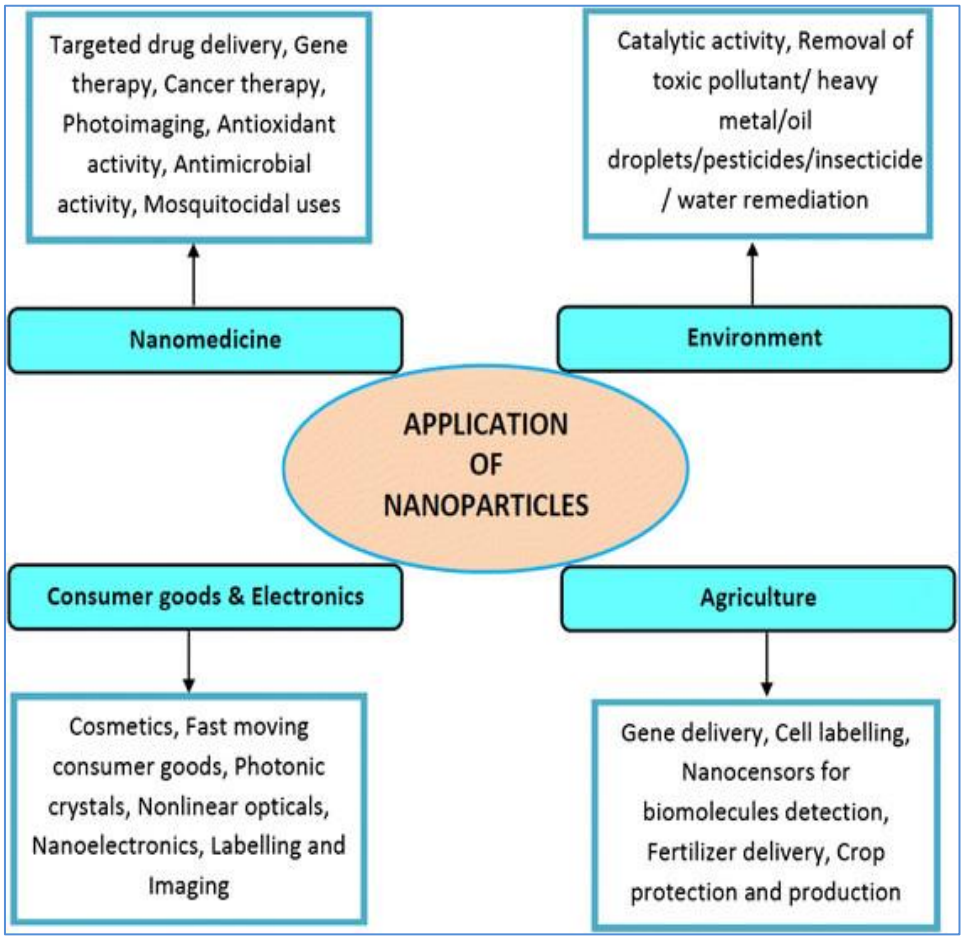


Fig.(2-8): Application-of-fabricated-nanoparticles-in-cutting-edge-areas[97]**.**

The broad usage engineered nanoparticles in many fields, ranging from environment, agriculture, biomedicine and cosmetics, has encouraged the scientific community to understand the conditions behind to their toxic potential in order to develop better human safety strategies. There is, in fact, a large inconsistency between the increased classes of nanoparticles and the resulting applications as against the assessment of their toxicity[98].

Nanotoxicologyis is defined as the scientific field that studies the effects of nanodevices and nanostructures engineered in living organisms. The toxic effects of abase material differs from that of the same material in the form of nanoparticles At the nanometer scale, the physical-chemical properties of the materials are strongly dependent on the shape and size of the unit, and their contacts with biological systems may differ greatly from those of solution chemicals and larger particles[99].

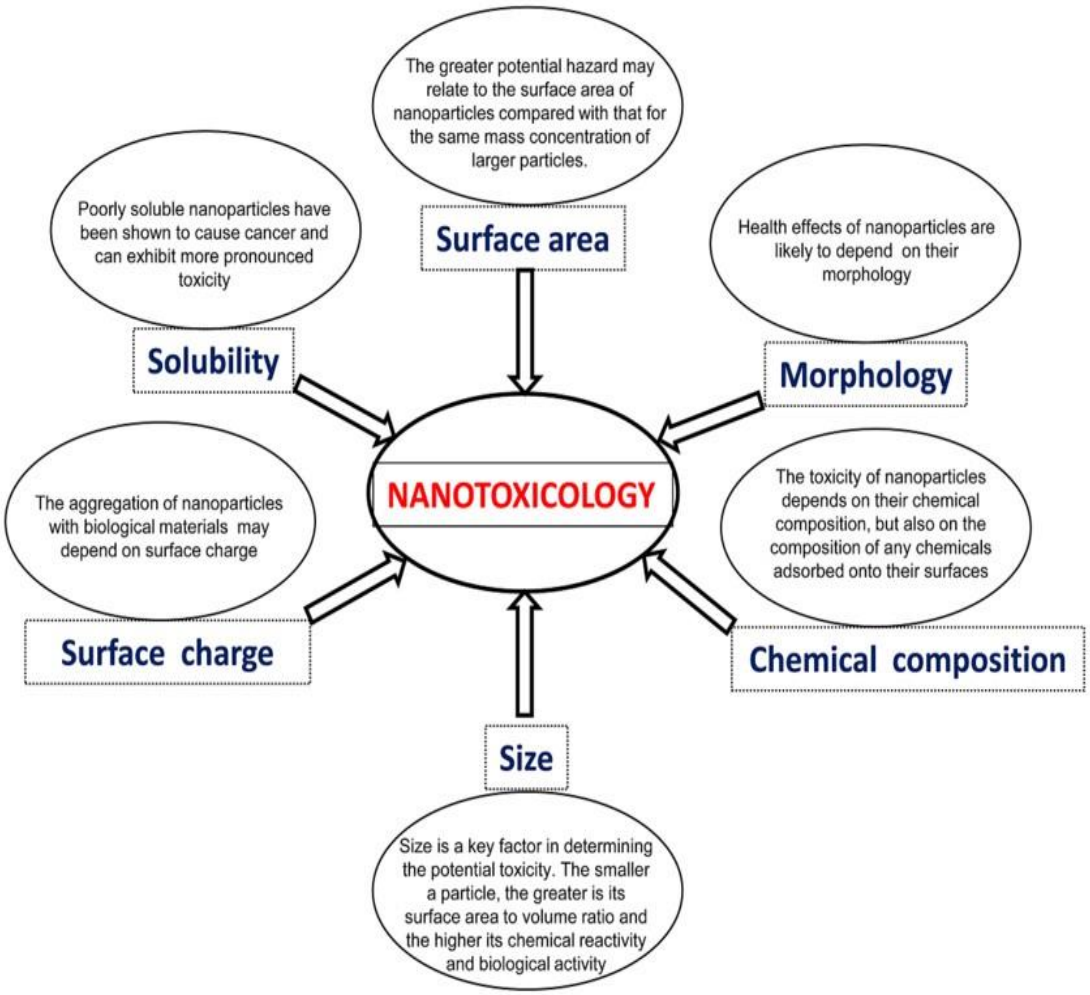


Fig.(2-9): Physicochemical properties of engineered nanomaterials leading to nanotoxicology[100]

Use of nanomaterials in so many aspects of human life has led to the study of the toxic effects of materials coming into contact with living organism through various entry routes (ingestion, respiration, and penetration of the skin). Nevertheless, toxicological data are conflicting in several cases, so that many research works are still required to assess the critical factors contributing to toxicity of NPs, in vitro and in vivo. This challenge is essential for consolidating the methods of analysis and for creating a database that included the risks associated with NPs that will be reachable to scientists, manufacturers and consumers alike[101].

2-6-1 toxicity of silver nanoparticles

Silver nanomaterials are fine metallic silver particles of less than 100 nm, having at least one dimension. Suspensions of Nanosilver or nanosilver refer to colloidal silver. A positive electric current is applied to produce colloidal silver through pure silver bars suspended in water, going to result in colloidal silver particles with a range of sizes of 15–500 nm. Colloidal silver was used to treat many infections and illnesses before the invention of penicillin in 1928[102].Nanosilver mainly has unique characteristics. The high surface area is attributed to the volume ratio, which leads many industrial sectors to integrate silver nanomaterial into their products. For the synthesis of metallic nanoparticles a variety of chemical and physical procedures might be used. Silver is commonly used as catalysts to formaldehyde oxidize methanol, and ethylene to ethylene oxide. Given its distinctive properties, such as good conductivity, chemical stability, catalytic and antibacterial activity, colloidal silver is of particular interest[103].

Silver has long been known for its antibacterial effect. Silver had been used to handle infections in ancient Greece, Rome, and Macedonia. These days, silver has been used for bactericidal applications, for example, water treatment, wound healing and flower protection. Other silver nanoparticles application fields are including catalysis, optics, electronics, as well as other science and technology areas. The most effective application for silver nanoparticles currently seems to be their use as an antifungal / antibacterial agent[104]. It is of great interest to manufacture bactericidal cotton fibers containing silver nanoparticles for the textile industry because regular cotton fabrics give a good appropriate environment for microorganisms. Other applications for silver nanoparticles include paints; for example, nanosilver-based paint should prevent algae from growing on outside walls. Current concerns about the environmental impact of nanoparticles and the possible human exposure have been brought up, nevertheless. The mobility of nanoparticles is mainly influenced by nanomaterial risk assessment. Additionally, pollutants can be adsorbed to nanoparticles due to the large surface area. There may be accumulation of nanoparticles in the ground water or in the air during the development of nanomaterials. The particles can reach the food chain because nanoparticles such as silver nanoparticles can be absorbed by plants or other living organisms[105]. A lot of research papers report the results of research studies into the antibacterial properties of silver nanoparticles. Sotiriou and Pratsinis evaluated the antibactericidal activity of silver ions and nanosilver particles and concluded that the antibacterial properties against gram-negative Escherichia coli bacteria are controlled by Ag+ ions and not by the silver nanoparticles itself.

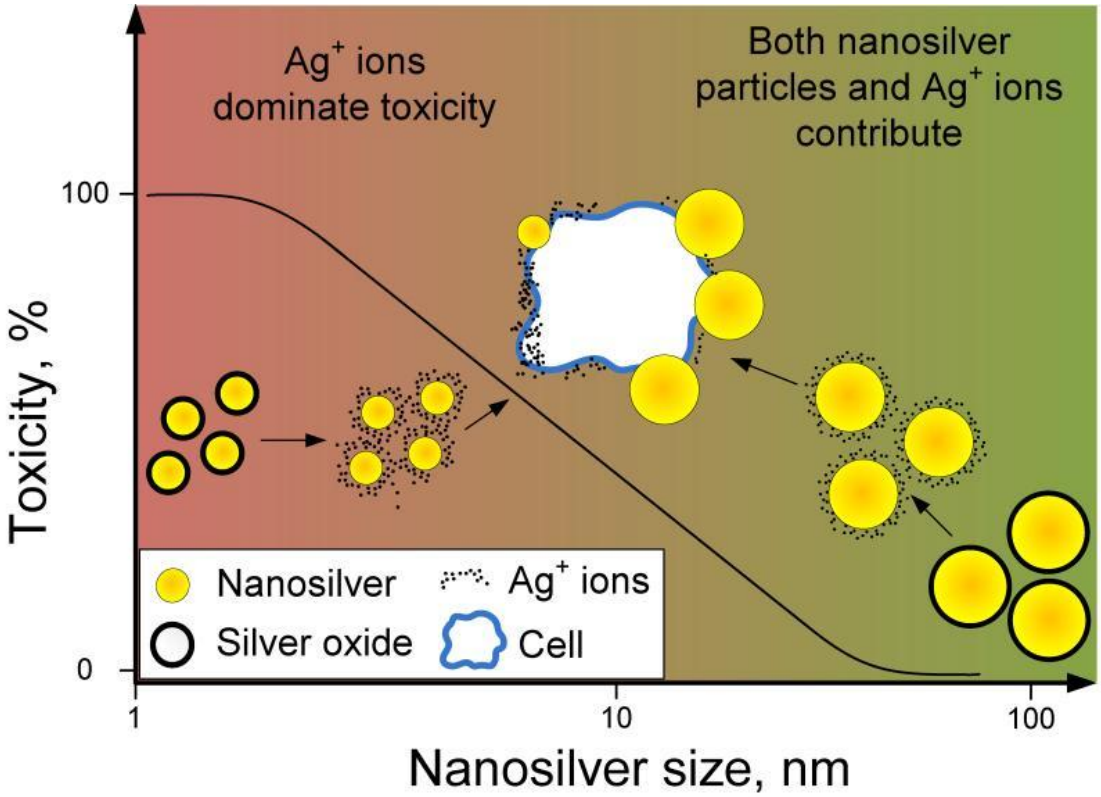


Fig.(2-10): Physicochemical properties of engineered nanomaterials leading to nanotoxicology[106]**.**

Different research conducted to investigate the effect of silver nanoparticles on aquatic organisms. Till around ten years ago, silver was assumed to be non-toxic to mammalian cells, except for agrarian, a blue skin color provoked by colloidal silver.

In recent years, the number of products that contain engineered nanomaterials has spread to various fields partially due to our increased ability to form and manipulate these materials. Amongst these nanomaterials, silver nanoparticles (AgNPs) are classified to become one of the most significant due to their exceptional wide spectrum bactericidal properties, low manufacturing costs of AgNPs, special properties and the capacity to form diverse nanostructures[107]. AgNPs are increasingly

used in a wide variety of commercial consumer products such as coating materials, fabrics and clothing, food storage containers, liquid fabric softeners and detergents, sports goods, cosmetics, wound dressings, toothbrushes and antimicrobial coatings[108]. However, there are growing concern about the widespread applications of NPs and the rapid growth of NP-enabled products that may result in high release into the environment and cause harmful effects on the organisms that are repeatedly subjected to such materials. The environmental impacts of AgNPs including their effects on different organisms within the aquatic environment are still largely unknown. NP's toxicity to organisms depends on the physicochemical properties of NPs. Because of their green and environmentally friendly characteristics, organic coatings are widely investigated for NPs especially in biomedical research. NPs also undergo physical and chemical transformation (e.g., settling, agglomeration) in aquatic systems, and thus the organisms are not subjected merely to dissolved chemicals which that test protocols were originally designed in ecotoxicology[109]. Therefore the fate and behavior of NPs in the test medium must be characterized and assessed. Ag ions toxicity that may be emitted from AgNPs is a concern, as Ag ions have traditionally been considered the most toxic form of silver in water before interest in NPs. Uncertainty over what s causing their toxicity has been one of the main problems when evaluating AgNP effects. While the toxicity of AgNPs is explained in part by the release of Ag ions, AgNPs' contribution remains unclear. Some studies showed evidence that toxicity is primarily resulting in the release of Ag ions, but some others confirmed a specific effect of nanoparticles that could not be explained simply by the Ag ions dissolution. Importantly, some research

has begun to point out that metal nanoparticles may in fact become more toxic than the respective metal ions in certain cases[110].

2-6-2 Toxicity of cadmium oxide nanoparticles

The Cadmium Oxide, its applications and properties have been highly noticed by researchers in recent years in optoelectronic devices such as: solar cells, optical transistors, glassy electrodes, gas sensors etc. These implementations of Cadmium Oxide were the result of its specific electrical and optical characteristics.

Recently, a large number of researches have been carried out to improve the antibacterial characteristic of nanoparticles, along with the increasing importance of healthcare. However, the application of certain antimicrobials was restricted because of their lesion or toxicity. Inorganic antibacterial characteristics display a really high resistance to bacteria and thermal stability. Cadmium (Cd), identified as human carcinogen, is an incredibly toxic heavy metal source of pollution, and cadmium exposure by anthropogenic sources, including cigarette smoke, is increasingly a concern for the environment.[111].

Nanoparticles of cadmium oxide (CdO NPs) are one of the nanoparticles of metal oxide most used in industry. They were commonly used for medical diagnostic imaging, therapeutics, industrial uses and quantum dot manufacturing. CdO nanoparticles have not been well described for toxicity. Experimental studies were carried out to determine the toxicity of CdO nanoparticles using zebrafish as model. The present study thus clearly demonstrates the toxicity of CdO nanoparticles in an aquatic animal and also indicates that carbon coverage could significantly reduce the toxicity[112]. Research uses several different in vitro assays to measure the cytotoxicity of CdO NPs, including MTS assay, ATP content

detection assay, lactate dehydrogenase (LDH) assay, and glutathione (GSH) luciferase assay. Before the toxicity assays, the endotoxin content was measured using the kinetic chromogenic assay Limulus Amebocyte Lysate (LAL). The revealed that the level of endotoxin inside CdO NPs was below the detection limit. CdO NPs inducted concentration-dependent cytotoxicity in MTS, ATP, and LDH assays in TK6 and HepG2 cells. Exposure of CdO NPs to cells also lowered the reduced glutathione content significantly, suggesting that CdO NPs insult cells by raising cellular oxidative stress. These studies indicate that the CdO NPs are toxic to human cells, leading to lower viability of cells and death of cells. Perhaps the mechanism underlying these toxicity of CdO NPs is through the production of oxidative stress in the cells exposed[113].

2-7 Cancer

Cancer refers to any of a wide range of diseases resulting in the development of abnormal cells that uncontrollably divide and are capable of infiltration and destruction of normal body tissue. Cancer is often capable of spreading all over your body.

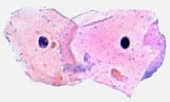
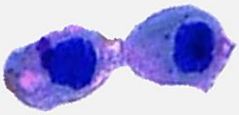
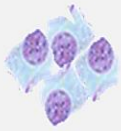
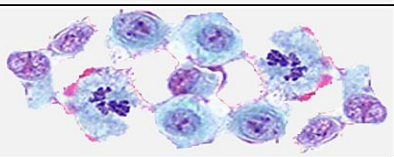
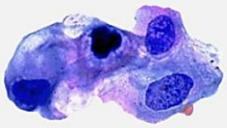
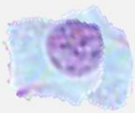
Normal	Cancer	
		Large, variably shaped nuclei
		Many dividing cells; Disorganized arrangement
		Variation in size and shape
		Loss of normal features

Fig. (2-11):characteristics of cancer cell [114]**.**

Cancer develops in the body when the normal means of control stops functioning. The old cells will not die in this case, but it will develop and spread in uncontrolled way, without halting, building new, abnormal cells. All of these cells can form a tissue that is called a tumor or a solid tumor. A few cancers would not form tumors such as leukemia (blood cancer).Most of the body's cells have specific functions and fixed

lifespan, and cell death is part of a natural and beneficial phenomenon called apoptosis. So cancer can start anywhere in the body and can cause an abnormal development of normal body cells[115].

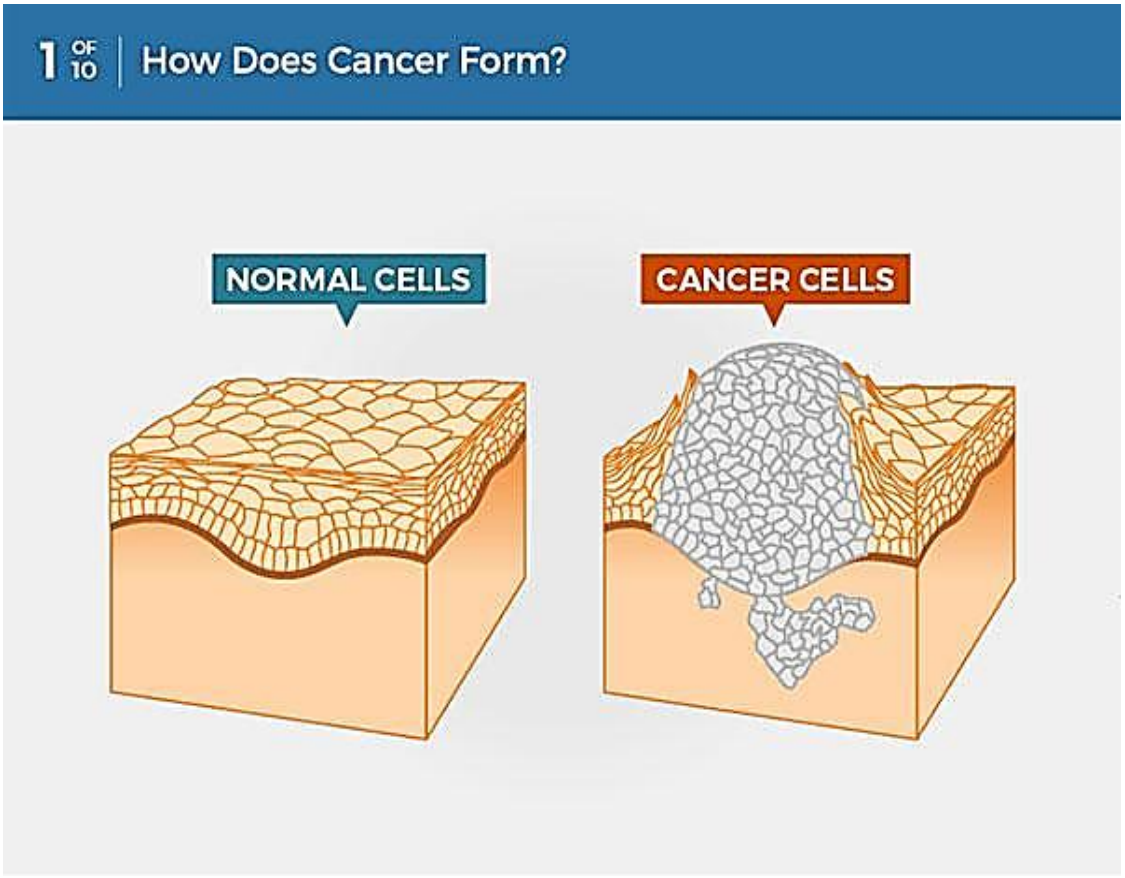


Fig. (2-12): cancer is a disease caused when cell divided uncontrollably and spread into surrounding tissues[116]**.**

Cancerous tumors are deceitful which means “to move” to nearby tissues, or assault them. Additionally, while these tumors grow, a few other cancer cells may split off and take trips via the body's blood or lymph system, forming new tumors far away from its original tumor. But this is not done by benign tumours. Mean, even sometimes these tumors are not large and sometimes they do not grow back when they remove them, in

contrast to cancerous tumors. Like benign tumors, brain tumors can be dangerous, and life threatening[117].

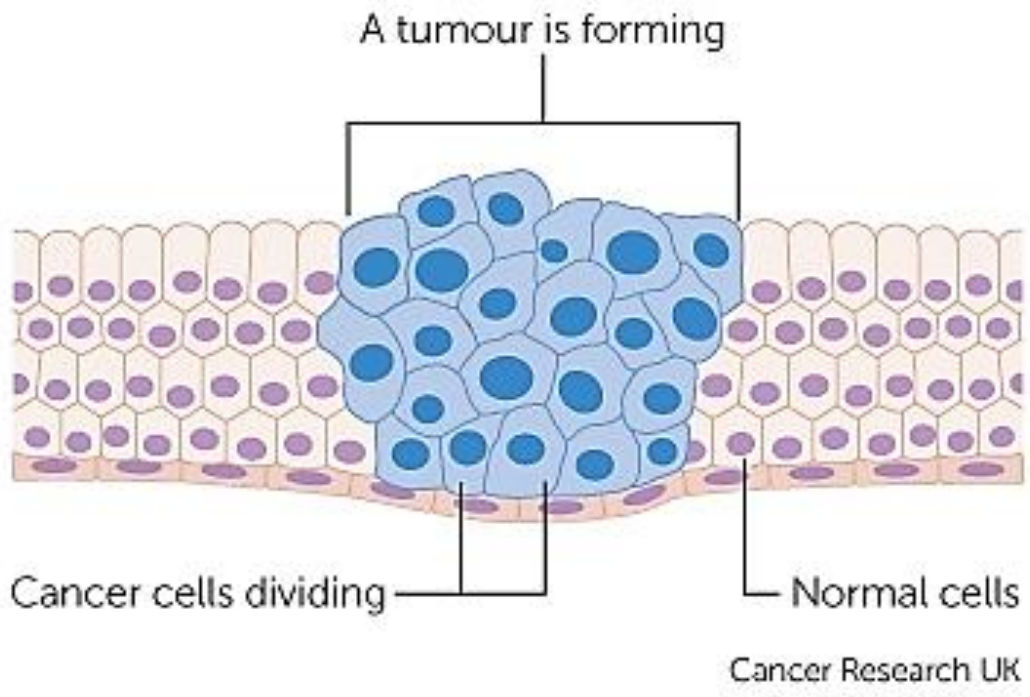


Fig.(2-13): cancer cell vs. normal cell [118] **.**

There are so many types of cancers, for example: lung, breast, colon, or even blood cancers. In some ways, cancers are alike, but differ in the way they grow and spread. Breast cancer is the most prevalent among women. It's prostate cancer in men while lung cancer and colorectal cancer .Actually impact men and women in large numbers. Cancer is world's second-largest cause of death. Survival rates for many types of cancer are continuing to improve, thanks to advances in cancer screening and cancer treatment.

Some particular and related signs and symptoms, related with, but not specific to cancer[119], include:

- Fatigue
- Lump or thickening area, which can be felt beneath the skin
- changes in weight which include unintentional loss or gain
- Changes in skin, for example yellowing, darkening or skin redness
- Sores that will not heal, or change the existing moles
- Changes in intestine and/or bladder habit
- Lasting cough or difficulty breathing
- Difficulty swallowing
- Hoarseness
- Permanent indigestion or unease after eating
- Sustained, inexplicable muscle or joint pain
- Sustained, inexplicable fevers or even sweats at night
- Inexplicable bleeding or bruising[120]

There are five major categories, most common, of cancer:

1. Carcinomas begin in the tissues or skin that form the internal organs.
2. Sarcomas start in bone, fat, muscle, cartilage, and other connective tissue.
3. Leukemia starts in the bone marrow and blood.
4. Lymphomas start in the system of immune.
5. Cancers of the central nervous system start in the spinal cord and brain[121].

2-8 Breast Cancer

Breast cancer is a disease that starts with abnormal breast cell growth. There are a number of different types of breast cancer. The type of breast cancer relies into which breast cells transform into cancer. The breast consists of three major parts: ducts, lobules, and connective tissue. Most of the breast cancer is in the lobules or ducts. Cells of the breast cancer typically form a tumor which can often be shown on an x-ray or looked as a lump. Breast cancer usually affects women but also breast cancer can occur in rare cases to men. It's important to know that so many breast lumps are not cancer (malignant) but benign. Non-cancerous breast tumors are anomalous growths but do not expand outside the breast[122].

They aren't life-threatening; however some kinds of benign breast lumps could enhance the risk of breast cancer in a woman. A health care professional needs to check any breast lump or change to evaluate whether it is benign or malignant (cancer) and if it could affect your future risk of cancer. It has spread worldwide in the most recent years. Thus the working on different strategies for improving the therapy of this cancer is important. Therefore it is imperative to introduce a biocompatible and inexpensive cancer treatment technique[123]. Nanomedicine formulations are nanometer-sized carrier materials designed to improve bioavailability of the drug tissue, thus enhancing the treatment of chemotherapeutic drugs that are applied systemically. Nanomedicine is a latest approach to delivering pharmaceuticals with safer and more efficient therapies compared to conventional methods through different routes of administration[124]. For hundreds of years, silver nanoparticles (AgNPs) have been among the nanomaterials most

commonly used in our health care system. Lately, because of their antibacterial, antifungal, antiviral, and anti-inflammatory activity AgNPs have become of intense interest in biomedical applications. Among biological techniques (e.g. the use of enzymes, microorganisms and plant extracts), the synthesis of AgNPs using plant extracts is the best option for traditional chemical and physical techniques accessible[125].In recent decades, Gold (Au) and silver (Ag) nanoparticles (NPs) have been the center stage of improving cancer treatments and therapies, due to their shape and size, tunable optical, chemical, and photonic properties.

Breast cancer amongst women is the second leading cause of death. Various treatments such as chemotherapy, radiation, and mastectomy are used to subdue the high risk of breast cancer. It is known that existent treatments have many negative effects. Research on nano-medicine has emerged as a powerful adjuvant therapy for making Silver Nanoparticle (AgNPs) an effective treatment for breast cancer[126]. We detected in vitro the green effect evaluation of cytotoxicity processed with green AgNP synthesis by Spirulina platensis against breast cancer cell lines using the secondary data. The result indicated that AgNPs caused apoptosis due to its anti-proliferative impact of AgNPs green synthesis. The study was conducted an influence of AgNPs green synthesis on MCF-7 breast cancer cell as compared to the normal breast cell line HBL-100. Morphological changes were also noted. The breast cancer cell cured with AgNPs green synthesis had shown the effect of apoptosis such as cell shrinkage, condensed cell, as well as nuclear chromatin aggregation into dense masses. It is concluded that green AgNP synthesis could be used as an additive for breast cancer therapy. This research needs further research to improve the green AgNP synthesis anti-cancer effect[127].

Cancer starts when mutations allow genetic changes which regulate cell growth take place. The mutations allow uncontrolled division and multiplication of the cells. Breast cancer is breast cancer that grows in breast cells. The cancer typically forms either in the lobules or in the breast ducts. Lobules are the milk-producing glands, and ducts are the channels that carry milk from the glands into the nipple. Cancer may also occur within your breast in the fatty tissue or in the fibrous connective tissue. The abnormal cancer cells often attack other healthy breast tissues and can take trips under the arms to the lymph nodes. The lymph nodes are a main way of moving cancer cells to all other parts of the body[128].

Breast cancer can be causing symptoms like a lump. A lump isn't the only cancer though. The diagnosis is made of earlier breast cancer, the easier and safer it is to control and treat. That means women must regularly check their breasts and inform any abnormal changes to their GP (General practitioner).Breast cancer mainly affects older women people. Most women who have breast cancer diagnoses are over 50 years old. It can happen, though, in younger women too. The majority of men who have breast cancer are older than 60. Yet breast cancer is extremely rare in adolescents[129]**.** It is not fully understood exactly why some people get breast cancer and others don't. Research shows that a combination of lots of different factors is causing breast cancer. A small number of breast cancers occur because somebody inherited one of their parents from an altered version of a gene.

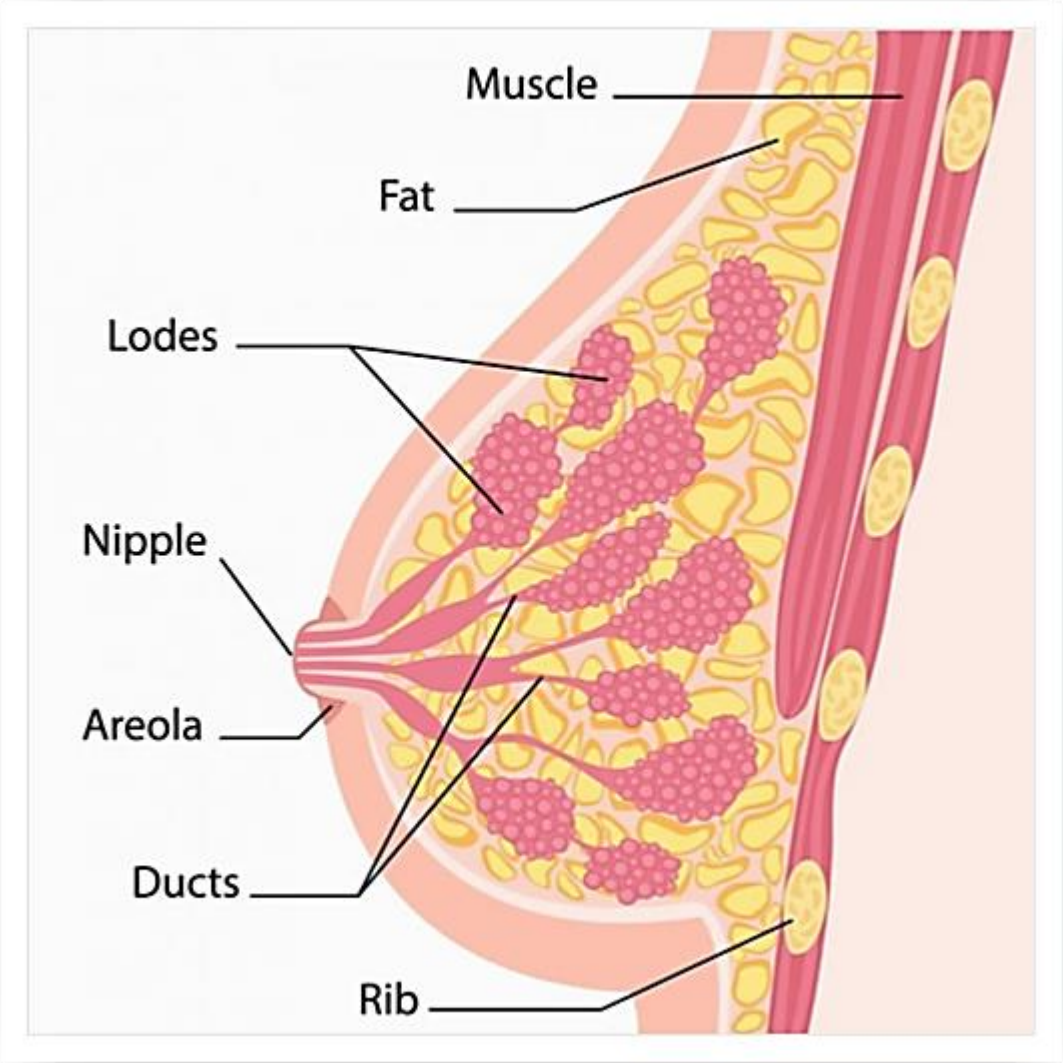


Fig. (2-14): Breast anatomy[130]**.**

2-8-1 Breast cancer symptoms

Breast cancer may not cause any symptoms in its early stages. A tumor may be too small to be felt in many cases but a deformity on a mammogram can still be seen. When a tumor are being felt, the first mark is actually a new lump in the breast which was previously absent[107]. Not all lumps however are cancer. Every type of breast cancer can cause

a wide range of symptoms. Many of the symptoms are similar, but some may differ[131].

The most common symptoms for breast cancers are including:

- A thickening of the breast lump or tissue that feels different from surrounding tissue and has recently developed
- A pain in the breast
- Pitted red skin all over the breast
- Swelling throughout or in part of breast
- A discharge from a nipple other than breast milk
- nipple has bloody discharge
- Peel, scale, or flake the skin on nipple or breast
- A unexpected, unexplained change to breast size or shape
- Overturned nipple
- Skin appearance changes on breasts
- A swelling or a lump under arm[132]

It doesn't necessarily mean you have breast cancer if you have any of these symptoms. For example, a benign cyst can cause pain in the breast, or a lump in the breast. Nevertheless, if the woman finds a lump or has some symptoms in her breast, she needs to see her doctor for more testing[133].

2-8-2 Types of breast cancer

There are several types of breast cancer, and they are broken into two main categories: “invasive” and “noninvasive,” or in situ. While invasive cancer has spread from the breast ducts or glands to other parts of the breast, noninvasive cancer has not spread from the original tissue.

These two categories have been used to define the most prevalent types of breast cancer, which including:

❖ ***A non-invasive cancer***

- ***Ductal carcinoma in situ (DCIS).*** Known as pre-invasive or intraductal carcinoma breast cancer. (DCIS) is the main noninvasive type. With DCIS, the cancer cells are restricted to breast ducts and have not attacked or invaded the breast surrounding tissue.also Unlike DCIS, LCIS is not treated a cancer, but that does mean a woman has a great risk of developing breast cancer[134].
- ***Lobular carcinoma in situ (LCIS).*** Is cancer that starts grows in breast’s milk-producing glands. Like DCIS the breast surrounding tissue has not been invaded by cancer cells[135].

❖ ***Invasive cancer***

- ***Invasive ductal carcinoma (IDC).*** Is the most prevalent type of breast cancer. Sometimes, it's also called infiltrating ductal carcinoma. This type of breast cancer starts in the milk ducts of breast, and then invades and attack

surrounding breast tissue[136]. Once its grows and spread outside breast ducts to the tissue, it can start to move to other nearby tissues and organs. (IDC) accounts for 70-80 percent of all breast cancers. IDC's risk also increases as humans gets older. The treatment options useable for IDC depends upon the type of breast cancer it is, what genetic changes it does or does not have, how hostile it is and other conditions. One of those other factors most important is the stage of cancer[137].

- ***Invasive lobular carcinoma (ILC).*** First begins to develop in the lobules of woman breast then it will invaded breast surrounding tissue[138].

Other types of breast cancer which are less common include:

- ***Paget disease of the nipple*.** This cancer of breast starts in the nipple ducts but as it starts growing it starts affecting the nipple's skin and areola[139].
- ***Phyllodes tumor*.** This very uncommon type of breast cancer starts growing within the breast's connective tissue. Many of these are benign tumors, but some of are cancerous[140].
- ***Angiosarcoma*.** This is cancer that starts to grow on the breast's blood vessels or lymphatic vessels[141].

Special types of invasive breast cancers

Some of invasive breast cancers have special characteristics or develop in various ways which actually effect their treatment and outlook. These cancers are less usual but can be more severe than other breast cancer types[142].

Triple-negative breast cancer. Is an offensive type of invasive breast cancer representing around 15% of all breast cancers. It is a challenging cancer to treat[143].

Inflammatory breast cancer. Is a rare kind of invasive type of breast cancer. It represents around 1 to 5% of all breast cancers[144].

Less common types of breast cancer

There are other types of breast cancers which impact other cell types in the breast. These cancers are less popular, and they sometimes require different treatment types[145].

Paget disease of the breast. Breast Paget disease begins in the breast ducts and gets spread to the nipple skin and then to the areola. It is uncommon and only accounts for about 1-3% percent of all breast cancer cases[146].

Phyllodes tumor. Tumors of the Phyllodes are uncommon breast tumors. In contrast to carcinomas which develop in the ducts or lobules, they develop in the breast's connective tissue (stroma). Most of them are benign, but other is malignant (cancer)[147].

Angiosarcoma. Breast sarcomas make up less than 1% of all breast cancers in rare cases. Angiosarcoma begins in cells which line lymph vessels or blood vessels. It may constitute breast tissue, or breast skin. Some might have to do with previous radiation treatment in that area[148].

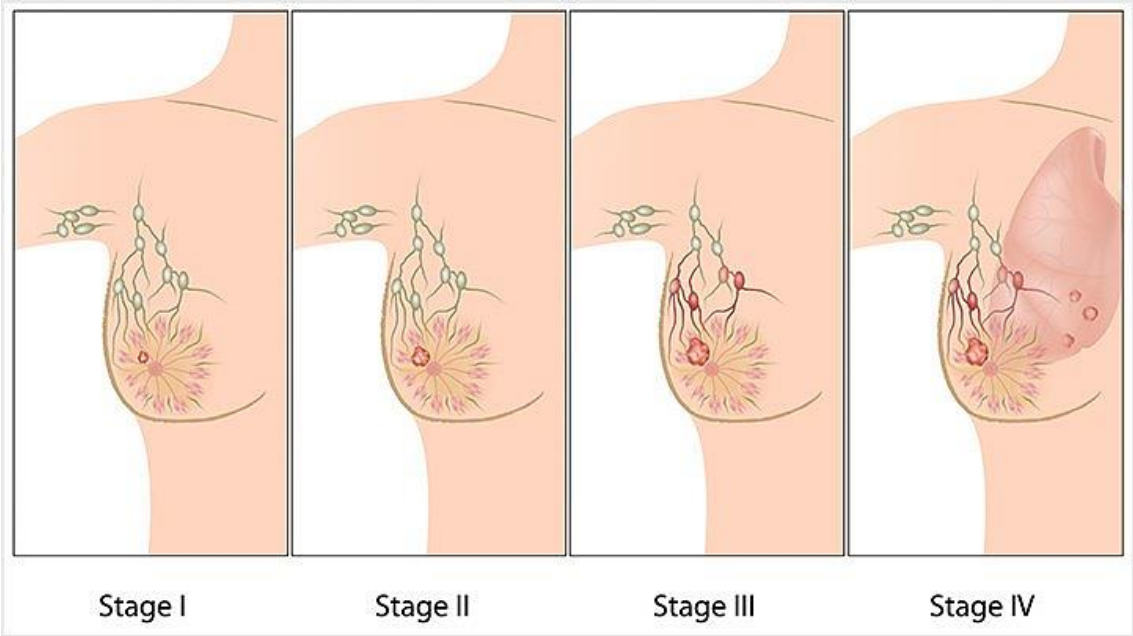


Fig.(2-15): stages to breast cancer to describe how far advanced it is and to help guide treatment options[149]**.**

Stages of cancer of the breasts are numbers that used identify how far a cancer has progressed and where it has expanded in the body. Cancer which has not expanded beyond breast shall be regarded as local. Regional cancer is spreading to the skin of the breast, to structures of the chest and to lymph nodes. When cancer spreads to other parts of the body, it is known distant , as it exists far from the breasts[150].

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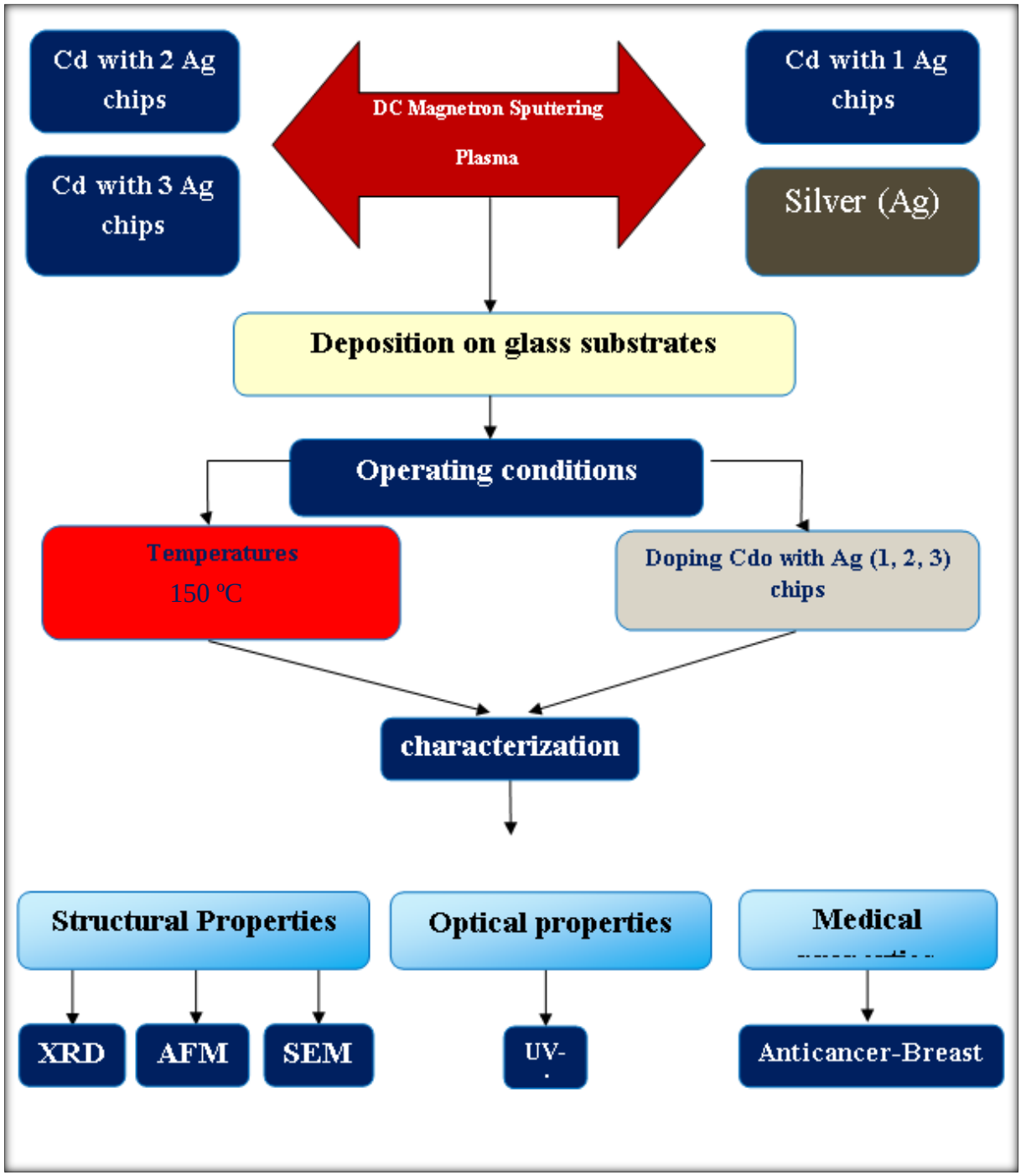
Chapter Three

Experimental part

3-1 Introduction

This chapter focuses on the experimental part. Includes a description of those steps. Starting with the method of preparing the cadmium target, preparing glass substrates, deposition CdO on those substrates of glass, and doping CdO NPs with Ag NPs at different concetrations(1 chip,2chips and 3 chips) by D.C magnetron sputtering method**.** Also a description of those devices used in this study. X-ray diffraction (XRD) has been used to test the structure of CdO NPs and CdO:Ag NPs on a thin films. Atomic force microscope (AFM) used to investigate the film surface top scan, scanning electron microscope (SEM) and Transmission electron microscopy (TEM) used to specify the nanostructure of the films.The optical measurements of the thin films are presented by Uv. Vis. Spectroscopy[151].



Scheme (3-1): the steps used in the practical part.

3-2 DC reactive Magnetron Sputtering system

Magnetron sputtering is a deposition technology involving gaseous plasma which is generated and confined to a space containing the material to be deposited – the 'target'. The surface of the target is eroded by high-energy ions within the plasma, and the liberated atoms travel through the vacuum environment and deposit onto a substrate to form a thin film[152].

The CdO-Ag thin films were deposited on glass substrates by using DC reactive magnetron sputtering method. The deposition chamber was evacuated in the first step to a base pressure of 4×10^{-2} mbar by a mechanical rotary pumps, and the second step was by the Turbo molecular that works directly to achieve the vacuum to 10^{-4} mbar. High purity (99.995% pure) argon and oxygen were used as sputtering and reactive gases(argon 90% and oxygen 10%). Cadmium metal of 99.999% pure was used as a sputtering target. The specific flux of argon to oxygen was controlled at 1/9. The sputtering pressure, which is the total pressure of oxygen and argon, maintained at 8×10^{-2} mbar .The distance of target to substrate was 4 cm. The sputtering current and sputtering voltage were maintained during the deposition process at 18 mA and 1300 V, respectively. Substrate temperature was fixed. The CdO-Ag thin films prepared on glass substrates at 150 ºc by using electronic temperature controller, at different concentration of doping Ag NPs

(1chip,2chip and 3 chips). The sputtering time was kept 120 min for all samples.

Fig. (3- 1)(a) DC reactive magnetron sputter system, (b) plasma discharge, (c) film deposited on a glass substrate, (d) Cd target with 3attached Ag chips, and (e) Ag chips

3-7 Cadmium Target Preparation

Cadmium as a Metal target with a purity of 99.999 made by USA Torr International Inc, Diameter 50 mm, thickness 3 mm. Silver as a metal has been used in disc shape (chips) with purity 99.9996made by USA, Torr International Inc, both two faces of the target has been polished to look like mirror to achieve good conductivity for the target and high purity to the deposited films. Figure (3-2) shows Cd metal target.

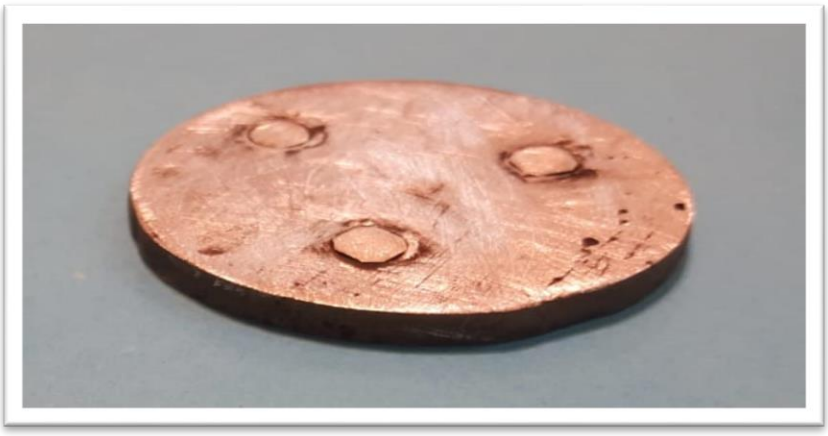


Fig.(3-2) shows cadmium metal target.

3-8 Silver Chips Preparation

Sliver metal rod manufactured in made by USA, Torr International Inc, with a purity of 99.9996, has been used as a dopant material with Cadmium metal target. The silver rod has been cut into three small pieces with a diameter of 2.5 mm and 3 mm height as shown in the Figure (3-3).

Figure (3-3): Silver Chips

3-9 Doping Processes

The sliver chips have been static to the target surface by pressing the chips of the sliver in a Suitable hole that made on the target surface, At the first stage we

insert one sliver chip on the target surface as shows in figure (3- 4a).In the second step we add another silver chip to the target surface(the total number of silver chips is two) as shows in figure (3- 4b), in the third step we add another and last silver chip (the total number of silver chips is three), as in the Figure (3-4c). It is so important to polish both the two faces of the target after each deposition (sputter) process.

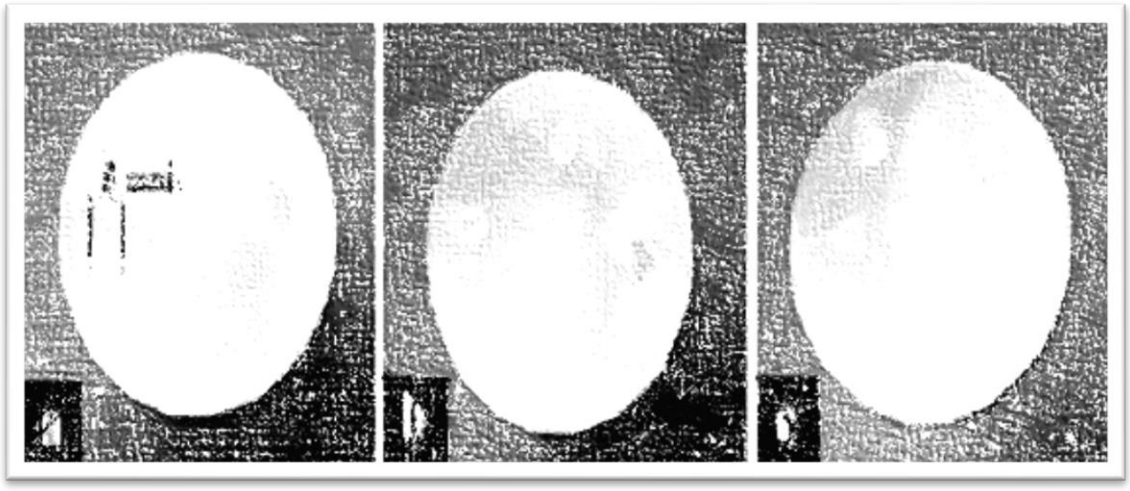


Fig. (3-4) Doped cadmium oxide Targets (a) one silver Chips (b) two silver Chips(c) three silver Chips

3-10 Preparation of Substrate

We use glass microscope slides with dimension (2.5×2.5) cm^2 as the substrate upon which the films were deposited. The glass slides were completely cleaned before we use it. The purpose of cleaning procedure was to remove surface contamination by dust and grease. The following procedure was used to prepare a slide for thin film deposition.

1- Set two microscope slides, which are totally free from any surfaces defects or scratches and tied it to the holder.

2-The glass substrates were wiped with detergent to remove any contamination.

4-Eventually, the substrates are dried and exposed to blowing nitrogen.

3-11 The Deposition of CdO: Ag Thin Films

1- Cadmium Target without any add chips has been fixed in the cathode pole by the holder in the DC sputter system as shown in Figure (3-5), The substrate temperature was fixed at 150 °C.

2-Turn on the vacuum system that consist of two levels, first level the rotary vacuumed the chamber until 10^{-3} torr and in the second level the Turbo molecular that works directly to achieve the vacuum to 10^{-5} torr. The pressure inside the chamber monitoring by using Adixen ACC 2009 Pirani- Penning gauge.

3-As the pressure inside the chamber reaches to the desired limit 9×10^{-4} torr, once Argon gas with a flow rate of 90% sccm and Oxygen gas with a flow rate of 10 % sccm was admitted through the flow controller into the chamber to get a sputter pressure limit 8×10^{-2} torr.

4-The applied DC sputter volt set to 1300 volts and the current on 18 mA,

5-As the sputtering processes countenance, watching the pressure counter, temperature, reflected power and chillier, very important to avoid any change in the sputter parameters.

6-Once we get the required sputter time 2 hour the shutter has to be closed, turn the DC power and the vacuum system off, and venting the chamber.

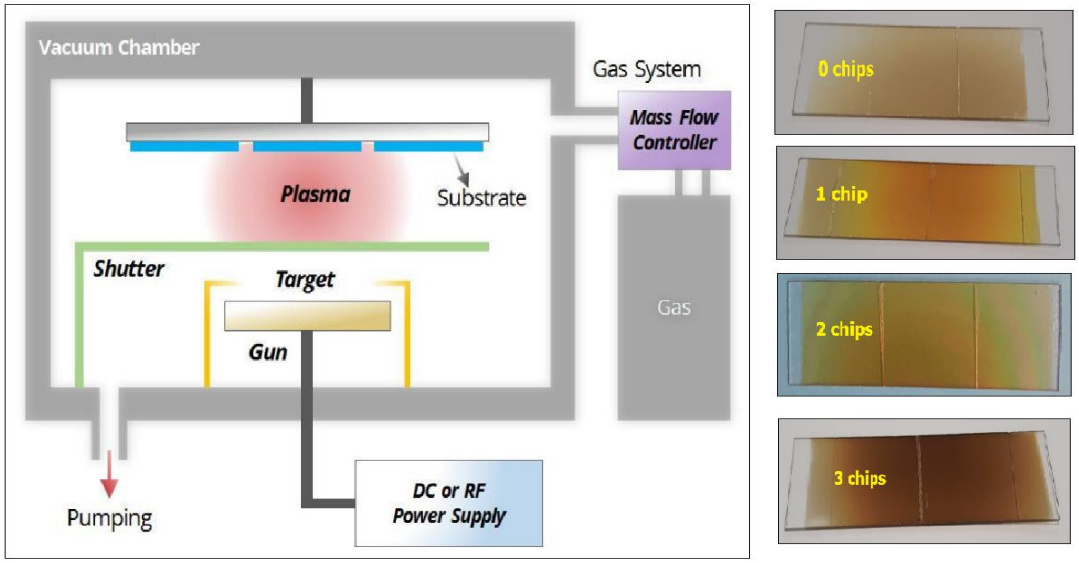


Fig. (3-6): Reactive DC Magnetron Sputtering System.

3-12-Ray Diffraction (XRD)

X-ray diffraction (XRD) Analysis is an analytical tool and microstructural analysis methods to provide more comprehensive knowledge on crystalline phases, including the detection and quantification of crystalline phase morphology[153]. XRD analyzes, a very important analytical technique to describe the crystalline phases in a material as well as provide detailed information on chemical formation, crystal structures, orientation and various defects in a crystalline material through the study of the crystalline structure. Phase identification is achieved by comparing the data acquired with that referred to in reference databases[154].

3-14 Scanning Electron Microscopy

Scanning electron microscopy is a good tool for observing the surface of organs and cells, and offers precise surface projections.

Scanning electron microscopy (SEM) has become an effective multifunctional tool for describing materials. Particularly in past years, because of the material dimensions, the continuous shrinking that was used in various applications.

Scanning-electron-microscopes are using a high-energy electron beam, combined with various detection systems to view very small areas- or to evaluate the surface physics. These kinds of microscope are very effective and has an average resolution of 7 nm to 3 nm. Consequently, larger prints can show magnifications up to 500'000:1, or even higher[155].

3-15 Atomic Force Microscopy (AFM)

The atomic force microscope (AFM) is a scientific instrument of the scanning probe. Atomic force microscopy (AFM) the most powerful and versatile microscopy techniques for nanoscale study of samples. Enables three-dimensional characterisation with a resolution of a subnanometer. It also offers the scientists and engineers with different types of surface measurements. This technique can define NPs as small as 0.5 nm, making them advantageous compared to other traditional techniques such as DLS microscopy. Another benefit of AFM is their willingness to identify various NP geometries. Besides measuring the NP size; AFM could be used to achieve other particle physical features in the sample, like the magnetic properties, electrical properties, and thermal conductivity. It is effective because an AFM can create atomic resolution images with height resolution information of the angstrom scale, with lowest sample processing[156].

3-16 Ultraviolet spectroscopy (UV)

Ultraviolet visible spectroscopy (UV) is regarded as an important instrument in analytical chemistry. It is the techniques most commonly used in both chemical and clinical laboratories. This tool is used to analyze chemicals qualitatively and to identify them. The other name of UV (Ultra Violet) spectroscopy is Electronic spectroscopy as it includes rising the electrons from the ground state to the excited state

This tool is used for qualitative analyzes of and identification of chemicals. Some other name of UV (Ultra Violet) spectroscopy was also Electronic spectroscopy, since it requires electrons starting to rise to the excited state from ground state. The absorption of energy from the ultra-violet radiation is equivalent to the difference between the excited state and ground state[157].

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Chapter four
Result and Dissection

4-1 Introduction

This chapter presents the results and discussion of structural, optical measurements and morphological of CdO NPs, Ag NPs, and CdO - Ag nanostructures, which are prepared by DC reactive magnetron sputtering. These characterizations represented by morphological features by Scanning Electron Microscopy (SEM), Atomic Force Microscope (AFM), Transmission Electron Microscopy (TEM), photoluminescence (PL) measurements and the most relevant section and discuss the antibacterial activity of CdO NPs, and CdO - Ag NPs against Gram-positive bacteria ( ) and Gram-negative bacteria ( ).

4-2 The Energy Dispersive X-Ray Spectroscopy(EDXS)

Energy dispersive X-ray spectroscopy is carried out during SEM analysis to determine the elemental composition of the film, Figure (4-1) shows the silver contents in CdO:Ag films with varying numbers of Ag chips as measured by energy dispersive X-ray spectroscopy (EDXS) by atomic percentage (at. %). It is found that the Ag content in the films increases almost linearly with the increase number of Ag chips. The Ag content in the CdO: Ag film of the cadmium target with 1 bonded Ag chips is 0.4 at. %. It increases to 1.04 at. % as 2 Ag chips is bounded on the cadmium target. Further increasing the number of Ag chips to 3 the Ag concentration in CdO: Ag composite films are further increased to 1.20 at. %.

The detailed elemental composition information with respect to atomic percent has been listed in Table (4-1).

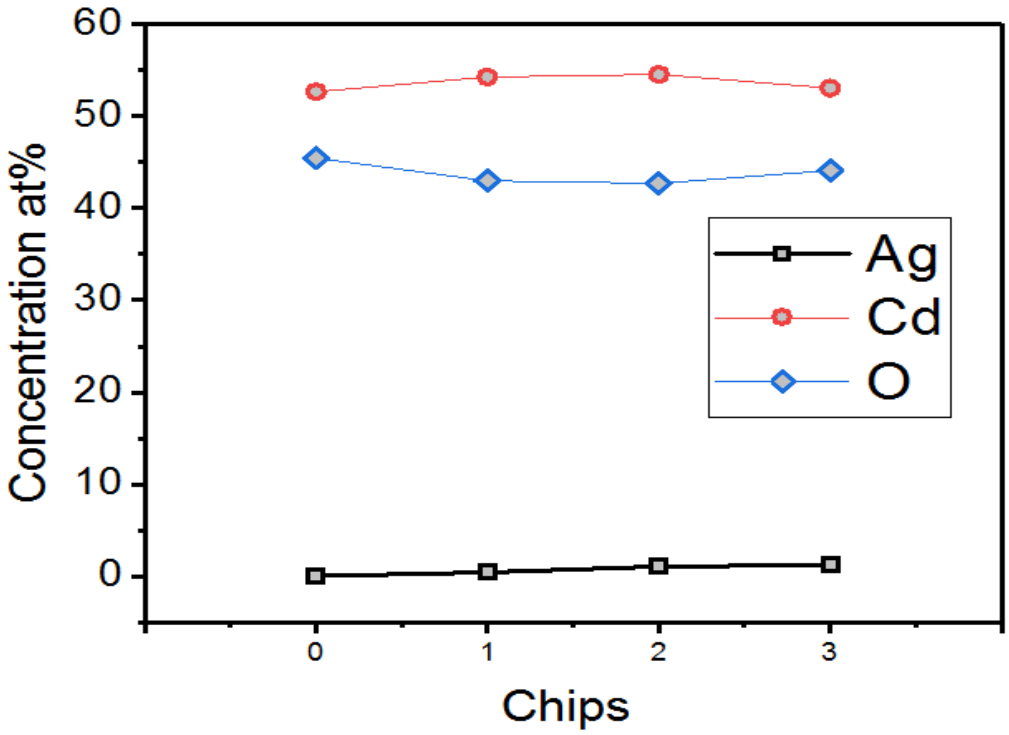


Fig. (4-1): Silver, cadmium and Oxygen Concentration in the CdO: A g Films Deposited by DC Reactive Magnetron Sputtering

Table (4-1) the detailed elemental composition information with respect to atomic percent has been listed in

Element at%	0 chips	1 chip	2chips	3chips
Cd	52.66	54.28	54.56	53.07
O	45.47	42.99	42.71	44.11
Ag	0	0.4	1.04	1.20
Si	1.87	2.33	1.69	1.62

Figure (4-2, 3, 4 and 5) Shows elemental composition of the films is determined by energy dispersive X-ray spectroscopy (EDS) and the results confirm that all the deposited pure and silver doped CdO films consist of Cd (cadmium spectrum (K_β= 3.1 keV), silver spectrum (K_α= 2.91 keV) and oxygen spectrum (K_α=1.05 keV) only, also we can see silica (substrate) spectrum (K_β1=2.8 keV), it can be indicate two things from (EDS), first one there is no contamination in the deposited film and the second one is CdO phase formation.

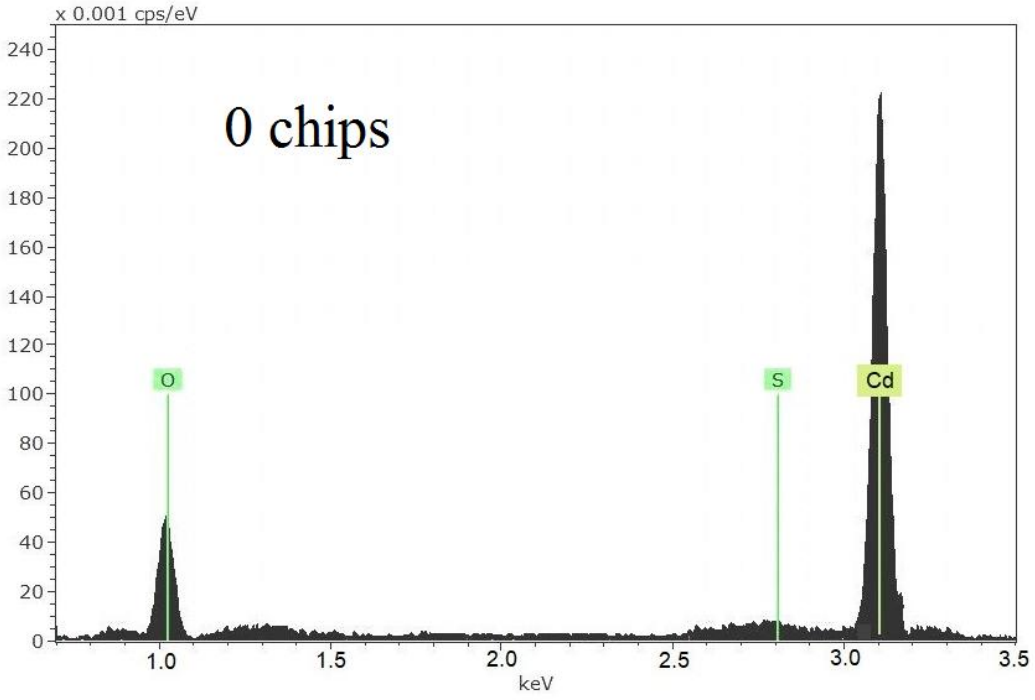


Fig.(4-2): Energy Dispersive Spectrometry of undoped CdO films deposited by DC reactive magnetron sputtering

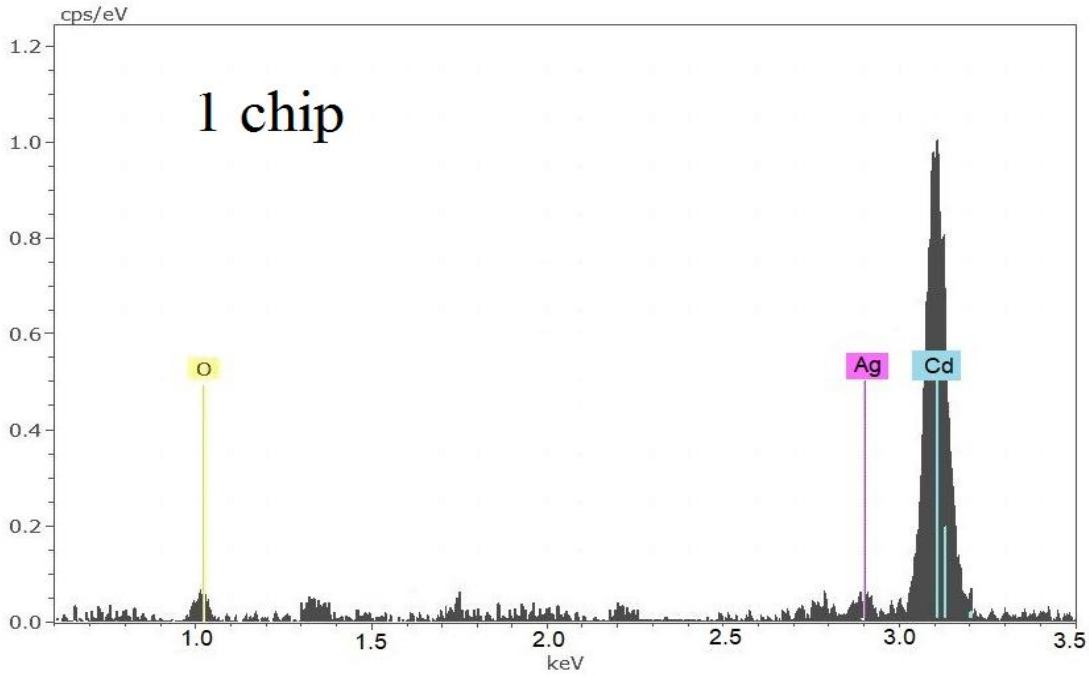


Fig.(4-3): Energy Dispersive Spectrometry of one chip of silver doped cadmium films deposited by DC reactive magnetron sputtering

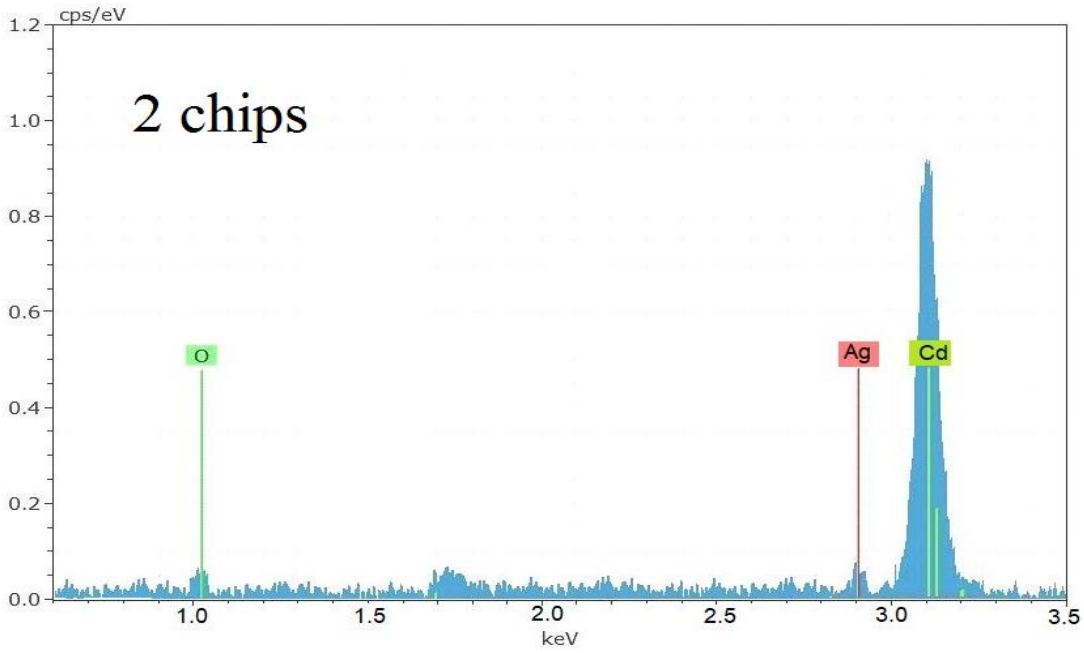


Fig.(4-4): Energy Dispersive Spectrometry of two chips of silver doped cadmium films deposited by DC reactive magnetron sputtering

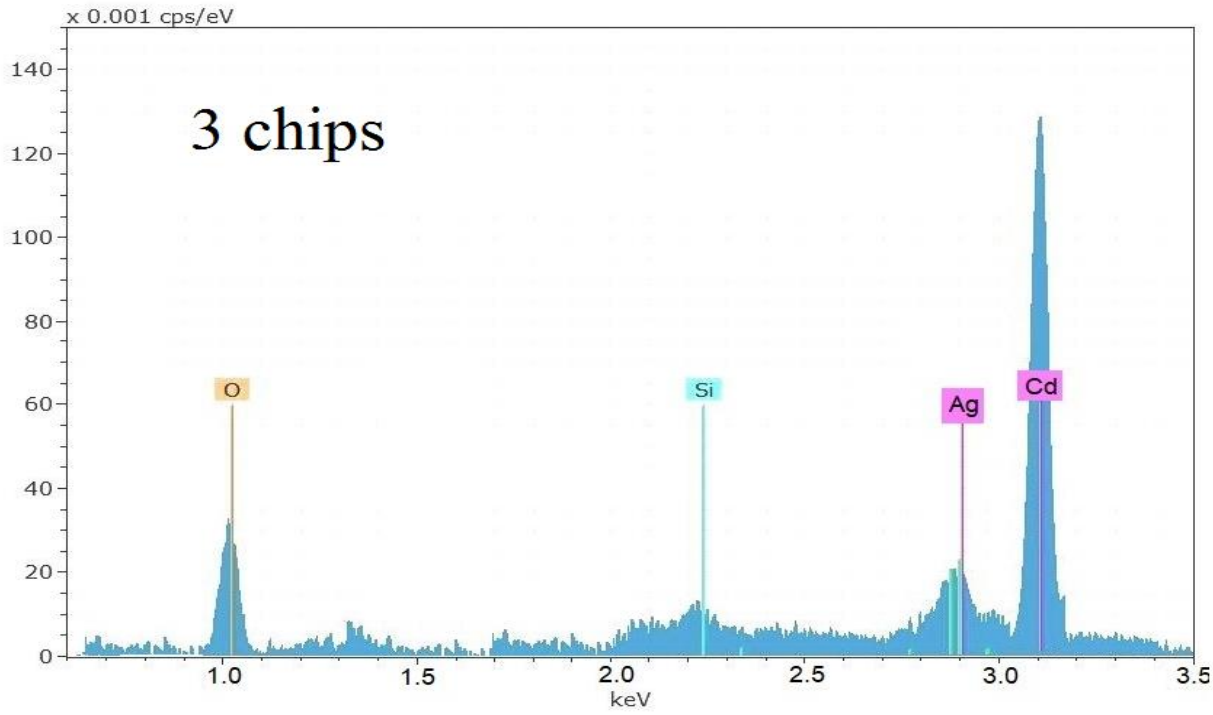


Fig.(4-5): Energy Dispersive Spectrometry of three chips of silver doped cadmium films deposited by DC reactive magnetron sputtering

4-3 X-Ray Diffraction

Figure (4-6) shows the X-ray diffraction (XRD) pattern of undoped CdO NPs and CdO NPs doped with Ag NPs, at different concentration (0.4,1.04,1.20) at%, which prepared by DC reactive magnetron sputtering method and deposited on glass substrate . It is noted from the figure that all prepared films have a polycrystalline reflection pattern, and the Prevailing reflection is (111) at the angle $2\theta=33.35^{o}$ and the intensity of the reflection increases with increasing of the doping concentration (1chip, 2chips and 3 chips) of Ag NPs that implanted to the target surface of cadmium oxide. The crystallite size D, was calculated from the Scherer equation (4-1) which increased from 17.17 nm to 19.03 nm by increasing the doping from 0.4 at % to 1.2 at %. As can be seen from Figure (4-7), which

represents a set of mathematical statistics of the Prevailing reflection (111), through the application of origin analysis graphing software.

$D = k\lambda/\beta \cos \theta$ (4-1)

It is noted from the figures increasing of the intensity of the reflection, which is represented by the variable (Y_o) and a decrease the full-width at half maximum (FWHM). Also we note the shifting of the reflection angle to less 2Θ, which represented by the variable X_C.

The Figures (4-8-a),(4-8-b) and (4-8-c) which represents both the crystalline size D, Micro strain (ε) and the Dislocation density (δ), respectively. Were calculated using the following equations (4-2),(4-3) and (4-4) respectively.

$D = k\lambda/\beta \cos \theta$ (4-2)

$\varepsilon = \lambda/D \sin\theta - \beta /\tan\theta$ (4-3)

$\delta = 1/D2$ lines / m2 (4-4)

. It noticed a decrease of micro strain (ε) and the Dislocation density (δ), with the crystalline size increasing due to the reduction of crystal defects in the lattice. The results of crystalline size, Microstrain and dislocation density values are shown in Table (4-2).

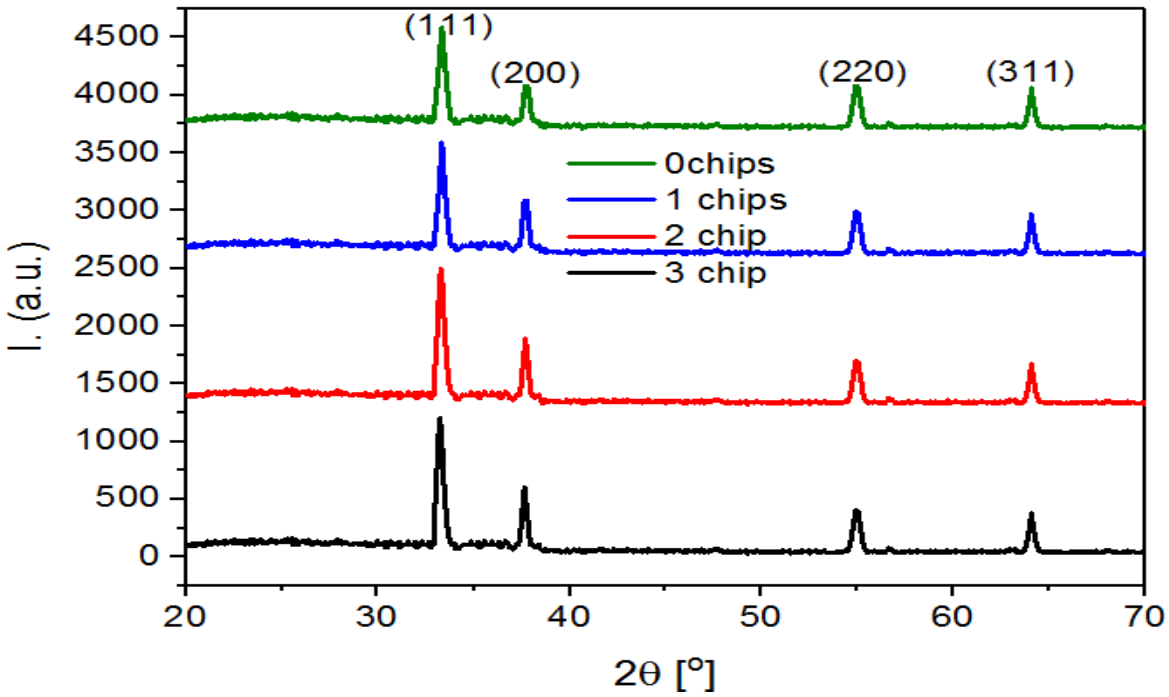


Fig. (4-6): X-Ray diffraction pattern of undoped CdO and CdO: Ag

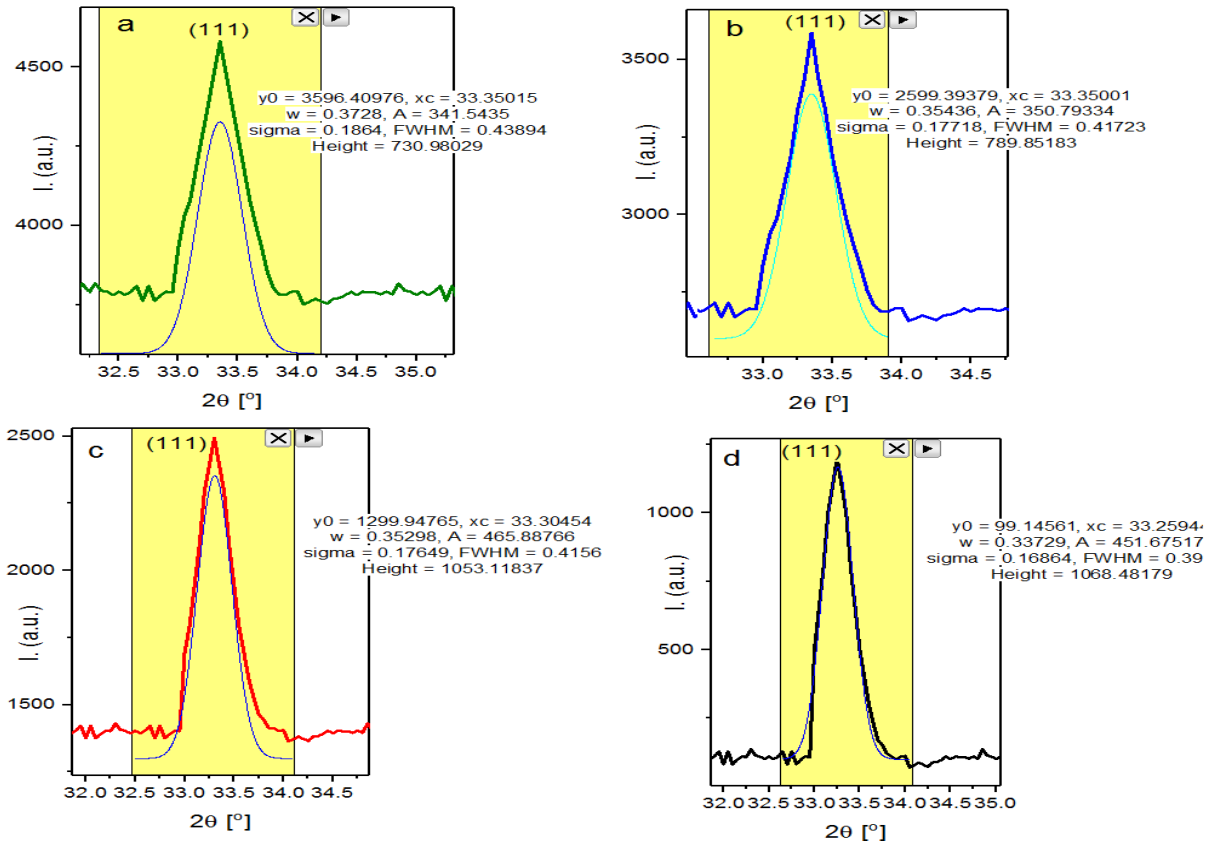


Fig. (4-7): Represents a set of mathematical statistics of the Prevailing reflection (a) 0 at%, (b)0.4at%, (c) 1.04 at% and (d) 1.20 at%.

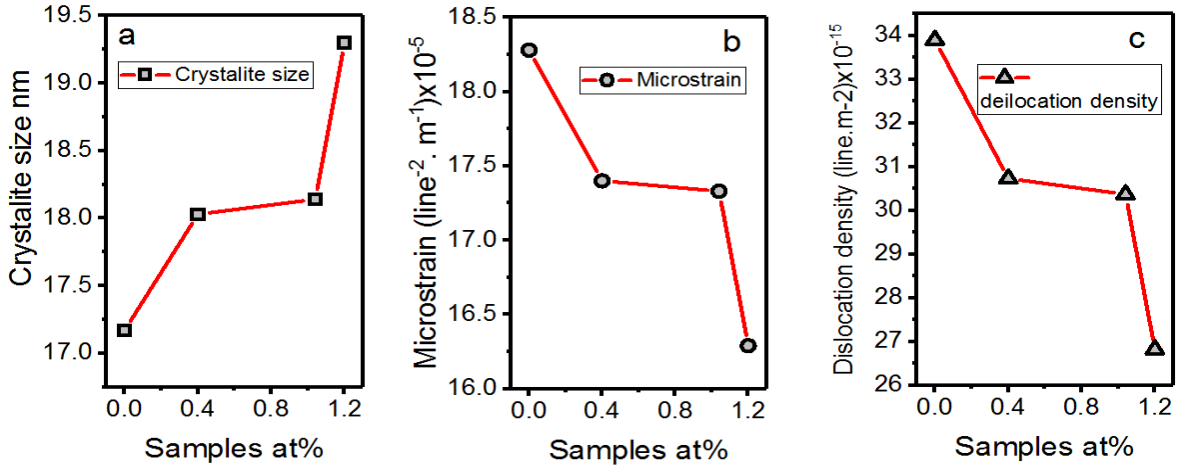


Fig.(4-8): structural properties of the Prevailing reflection (a) crystallite size (b) Microstrain and (c) Dislocation density

Table (4-2) structural parameters for CdO doped Ag films prepared by reactive DC sputter

Ag concentration at%	2θ [°]	hkl	FWHM [°]	2θ JCPDS	Crystallite size D (nm)	micro strain $x10^{-5}$ m	dislocations density $x10^{-15}$
0	33.35	111	0.438		17.17	18.28	33.90
	37.8	200					
	54.80	220					
	64.05	311					
0.4	33.35	111	0.417		18.03	17.40	30.73
	37.8	200					
	54.80	220					
	64.05	311					
1.04	33.35	111	0.415		18.14	17.33	30.37
	37.8	200					
	54.80	220					
	64.05	311					
1.20	33.35	111	0.39		19.30	16.29	26.82
	37.8	200					
	54.80	220					
	64.05	311					

4-4 Scanning Electron Microscope (SEM)

Microstructures characterization of synthesized samples was studied by scanning electron microscopy SEM and transmittance electron microscopy TEM. Figure (4) shows the SEM and TEM images of the CdO and Ag NPs films, deposited on a smooth and homogeneous distributed, and the crystallites were very fine. Particle size increases with the addition of Ag NPs at different concentrations (1, 2 and 3) chips to the main target surface Cd metal. Figure (4-9-e),(4-10-f),(4-11-g) and (4-

12-h),which represents Transmission Electron Microscopy TEM shows that spherical shaped nanoparticles has been achieved with different diameters varies from (25-40) nm when the addition of Ag nanoparticles was 1.20 at.%.

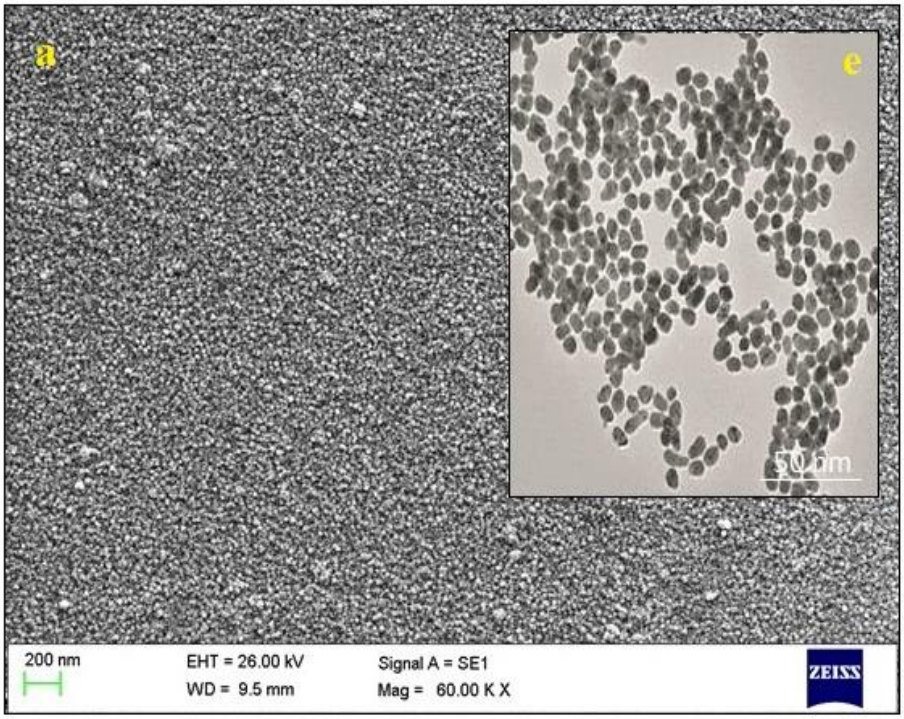


Fig.(4-9): SEM of undoped CdO films deposited by DC reactive magnetron sputtering, (a) 200 nm and (e) 50 nm

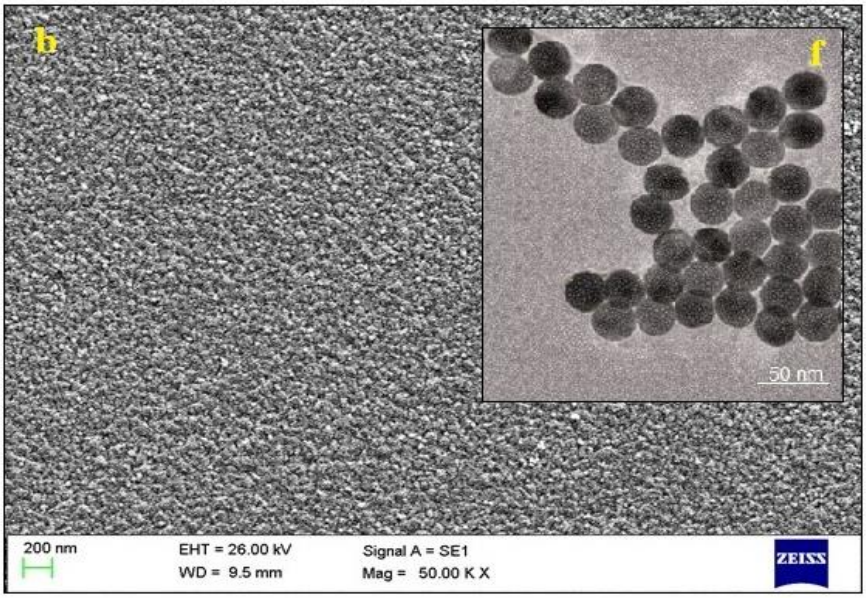


Fig.(4-10): SEM of one chip of silver doped cadmium films deposited by DC reactive magnetron sputtering (a) 200 nm and (e) 50 nm

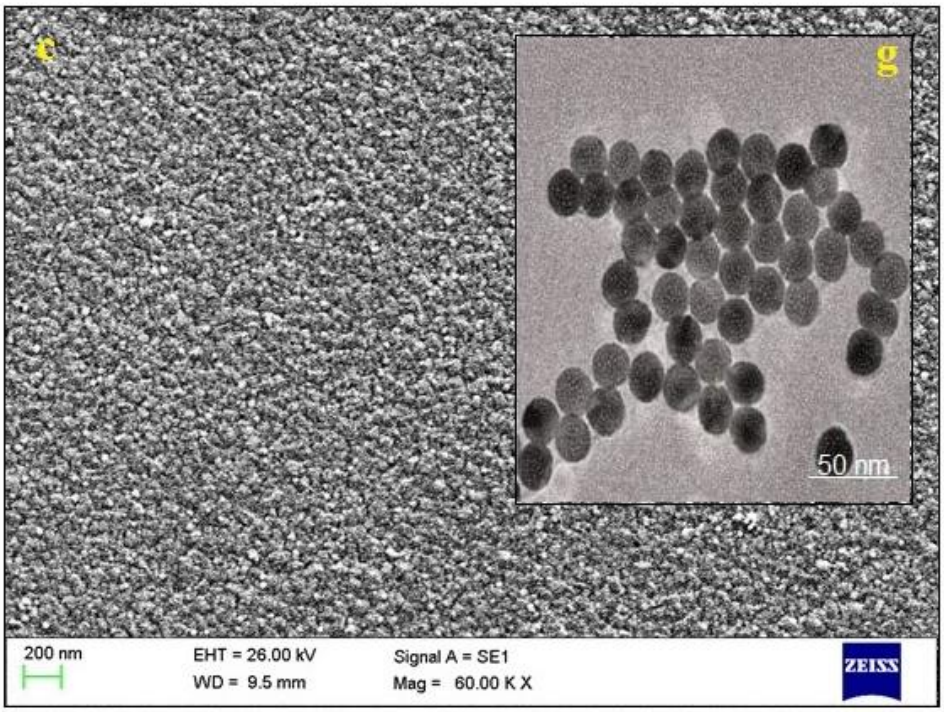


Fig.(4-11): SEM of two chips of silver doped cadmium films deposited by DC reactive magnetron sputtering (a) 200 nm and (e) 50 nm

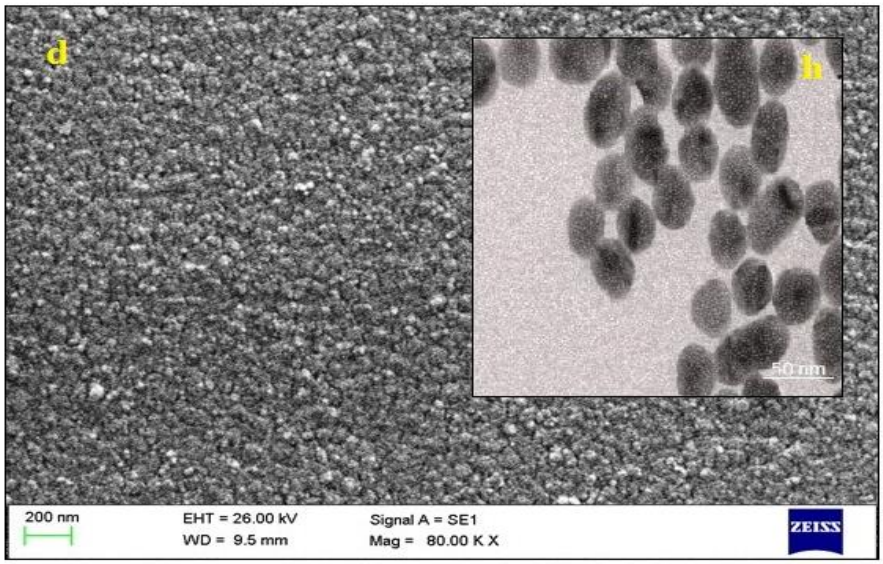


Fig.(4-12): SEM of three chips of silver doped cadmium films deposited by DC reactive magnetron sputtering (a) 200 nm and (e) 50 nm

4-5 Atomic Force Microscope (AFM)

The Atomic Force microscope (AFM) gives us significant information about the topography of the surface of the film. It is known that the optical and electrical properties of the film are affected by the properties of the surface, which are considered important information in electronic optical applications. The Atomic Force microscope (AFM) has been used to study the surface morphology and the roughest of all the CdO and CdO doped Ag thin films at different concentrations of Ag (0.4, 1.04 and 1.2) at. % deposited on glass substrates by DC reactive magnetron sputtering. Figure (4-13-a) representing two dimensional image(2D), Figure (4-13-b) represents three dimensional(3D), Figure (4-13-c) represents the

distribution of particle diameters as a function of percentages within the scanning area 2µm × 2µm. And the Figures (4-13-d) represent an image of the cross-section of the scanning area chosen from the figure (4-13-a). All these figures topography of AFM images for undoped CdO NPs. The Figures below show a uniform distribution with the formation of small single nanorods as illustrated in Figures (4-13-a and b). From the figure (4-13-c) we notice that the distribution of the nanostructures diameters is greatest at 70 nm, while the figure (4-13-d) shows the height of these nanostructures about 20 nm, the diameter within the range of 5-10 nm and that these nanostructures rods are not precisely clear.

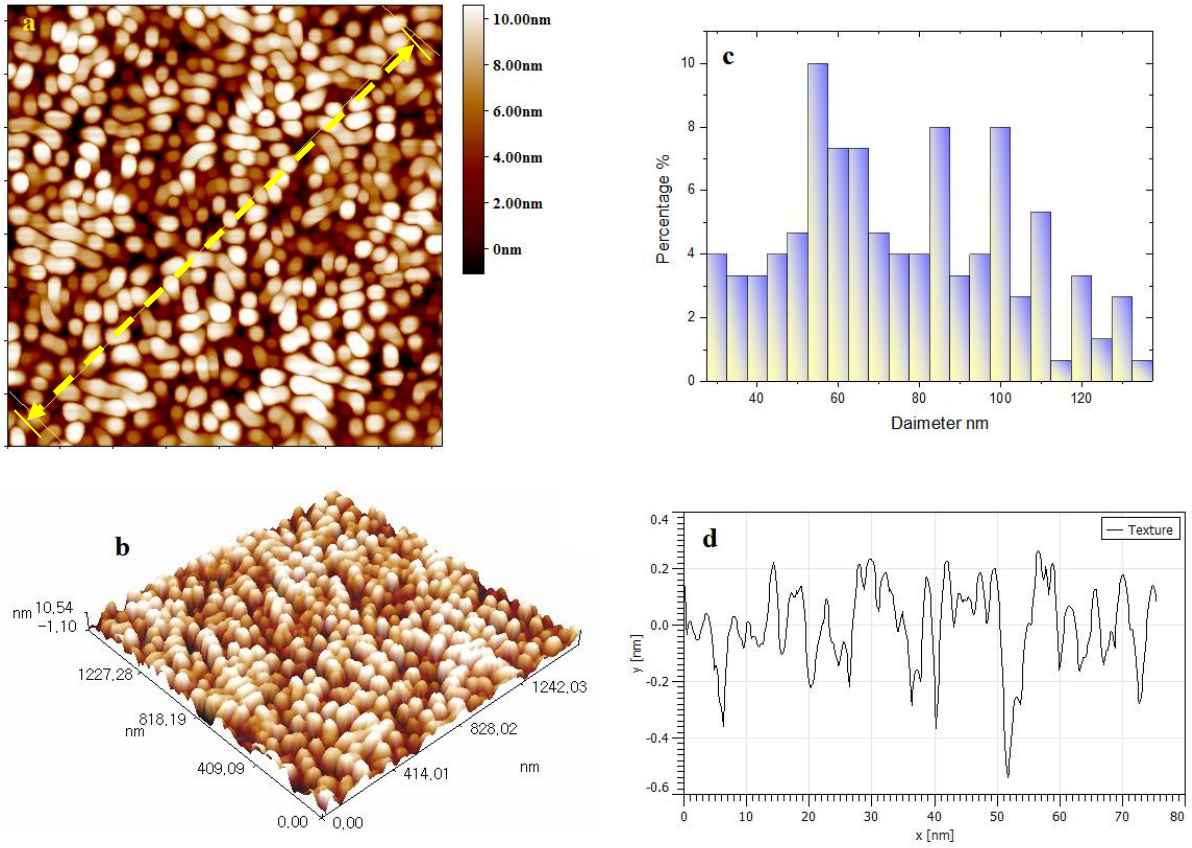


Fig. (4-13): CdO:Ag 0at% (a) representing two dimensional, (b) represents a three dimensional (c) represents the distribution of particle diameters as a function of percentages within the scanning area 2µm × 2µm and (d) line texture roughness

Figure (4-14-a) representing two dimensional (2D), Figure (4-14-b) represents three dimensional(3D) and figure (4-14-c) represents the distribution of particle diameters as a function of percentages within the scanning area 2µm × 2µm.

The Figure (4-14-d) represents an image of the cross-section of the scanning area chosen from the Figure (4-14-a).

All these figures topography of AFM images for CdO NPs doped with Ag NPs 0.4 at. %. These figures show that the distribution still uniform comparing with the undoped CdO and the Nanostructures peaks become wider.

From the Figure (4-14-c) we notice that the distribution of the nanostructures diameters will be greatest possible at (45- 55) nm, while the Figure (4-14-d) shows that the height of these nanostructures is around 22 nm and the diameter is around 8 nm and that these nanostructure rod shapes have become more evident.

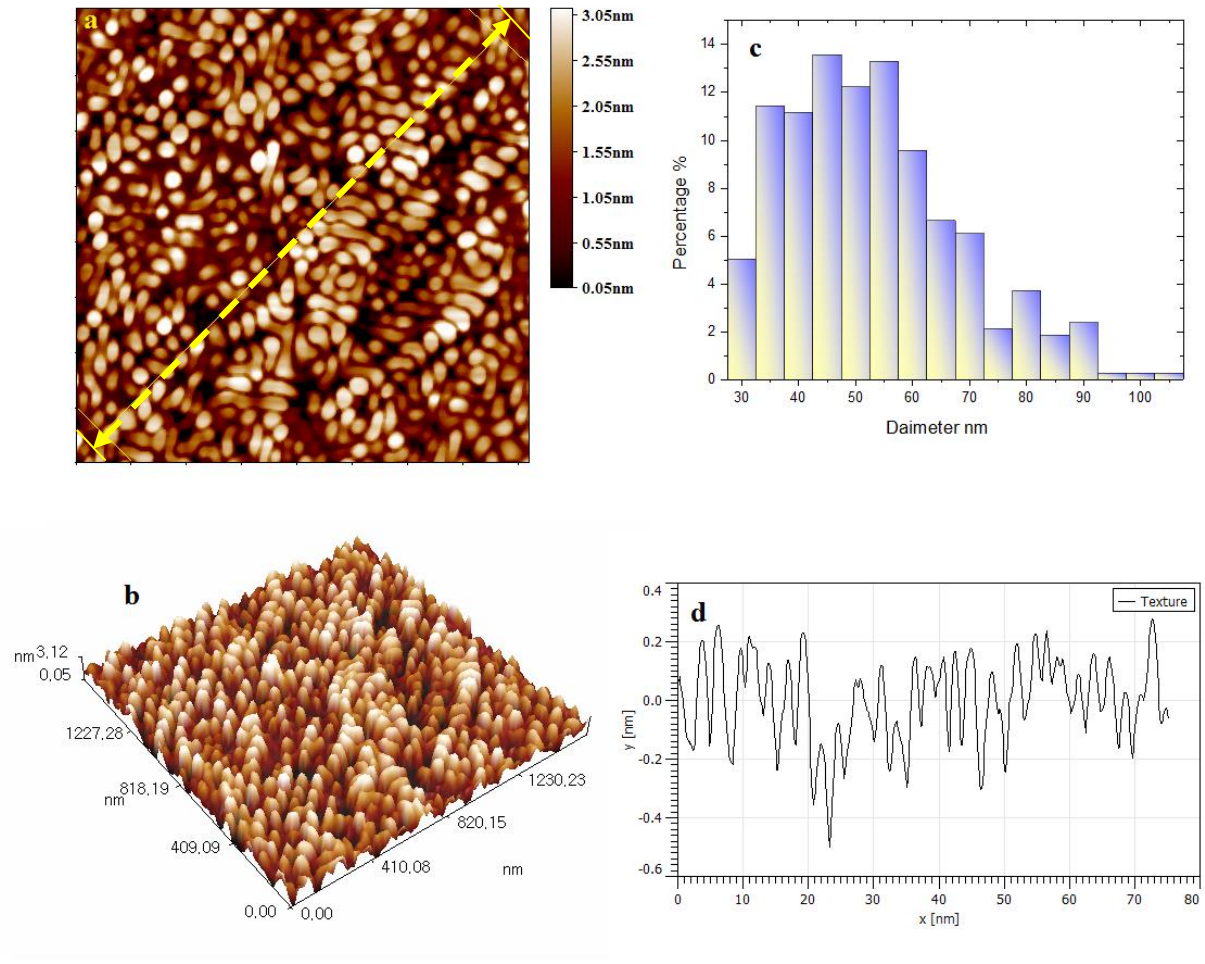


Fig. (4- 14): CdO:Ag 0.4at% (a) representing two dimensional, (b) represents a three dimensional (c) represents the distribution of particle diameters as a function of percentages within the scanning area 2μm × 2μm and (d) line texture roughness

Figure (4-15-a) representing two dimensional (2D), Figure (4-15-b) represents three dimensional(3D) and Figure (4-15-c) represents the distribution of particle diameters as a function of percentages within the scanning area 2μm × 2μm.

The Figure (4-15-d) represents an image of the cross-section of the scanning area chosen from the Figure (4-15-a). All these figures topography of AFM images for CdO NPs doped with Ag NPs 1.04 at%. These figures show that the distribution

become not uniform on the surface of the scanning area and these nanostructures unified with each other and formed structures with size ranges between (85- 100) nm as in Figure (4-15-c), while the Figure (4-15-d) show that nanostructure rods became in a uniform distribution and their height around 40 nm from the baseline and the diameter became wider and around 10 nm.

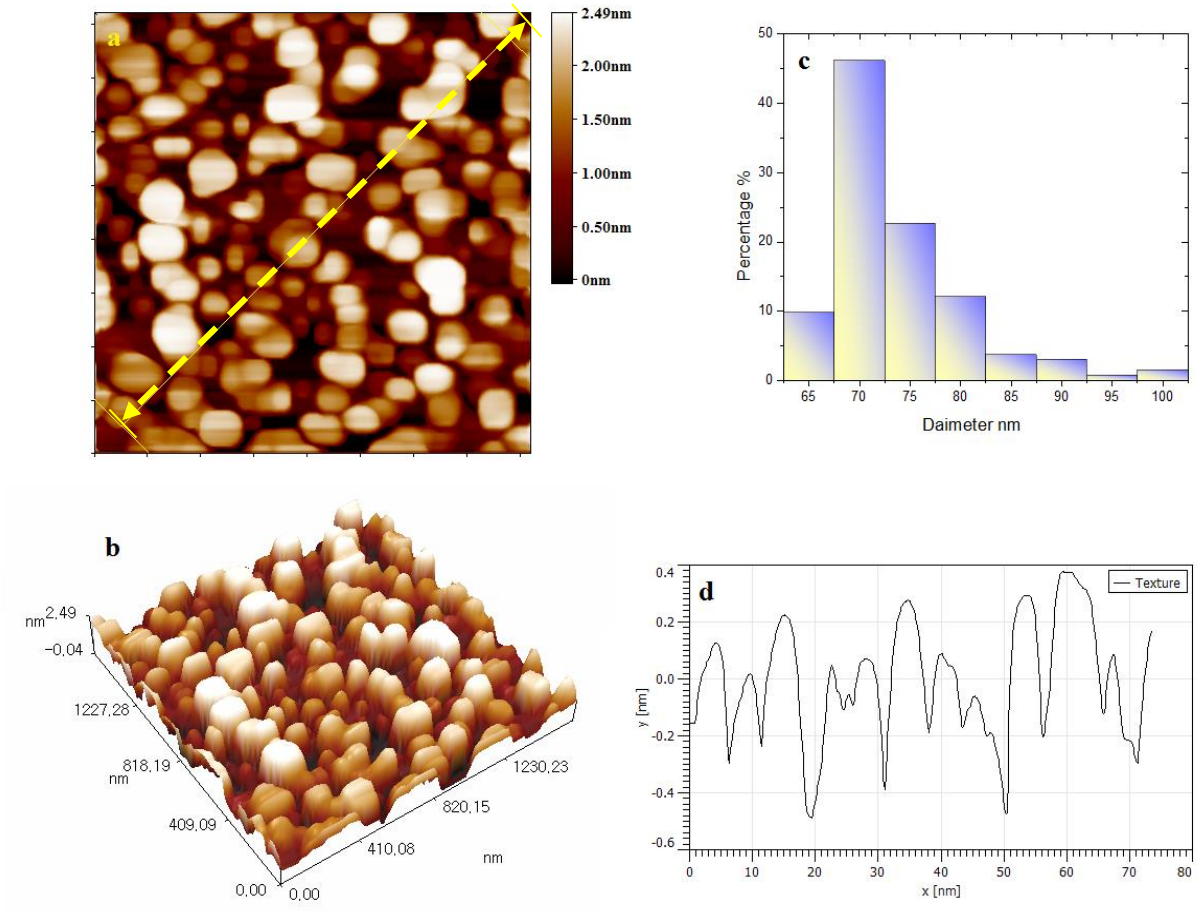


Fig. (4- 15): CdO:Ag 1.04 at% (a) representing two dimensional, (b) represents a three dimensional (c) represents the distribution of particle diameters as a function of percentages within the scanning area 2µm × 2µm and (d) line texture roughness

Figure (4-16-a) representing two dimensional (2D), Figure (4-16-b) represents three dimensional(3D) and figure (4-16-c) represents the distribution of particle diameters as a function of percentages within the scanning area 2µm × 2µm.

The Figure (4-16-d) represents an image of the cross-section of the scanning area chosen from the Figure (4-16-a). All these figures topography of AFM images for CdO NPs doped with Ag NPs 1.2 at. %. From Figure (4-16-a) we notice that the distributions of these nanostructures have become higher than the intensity of brightness (color bar), and these nanostructures have become larger in diameter. That is, the largest diameter is around 100 nm as in Figure (4-15-c).

Figure (4-16-d) represents a plot or a graph of the X-axis and the Y-axis represents a cross-section of the surface and It is noted from the figure that the shape of the nanostructures has become conical structures and that their height is within 40 nm and their diameter within 15 nm.

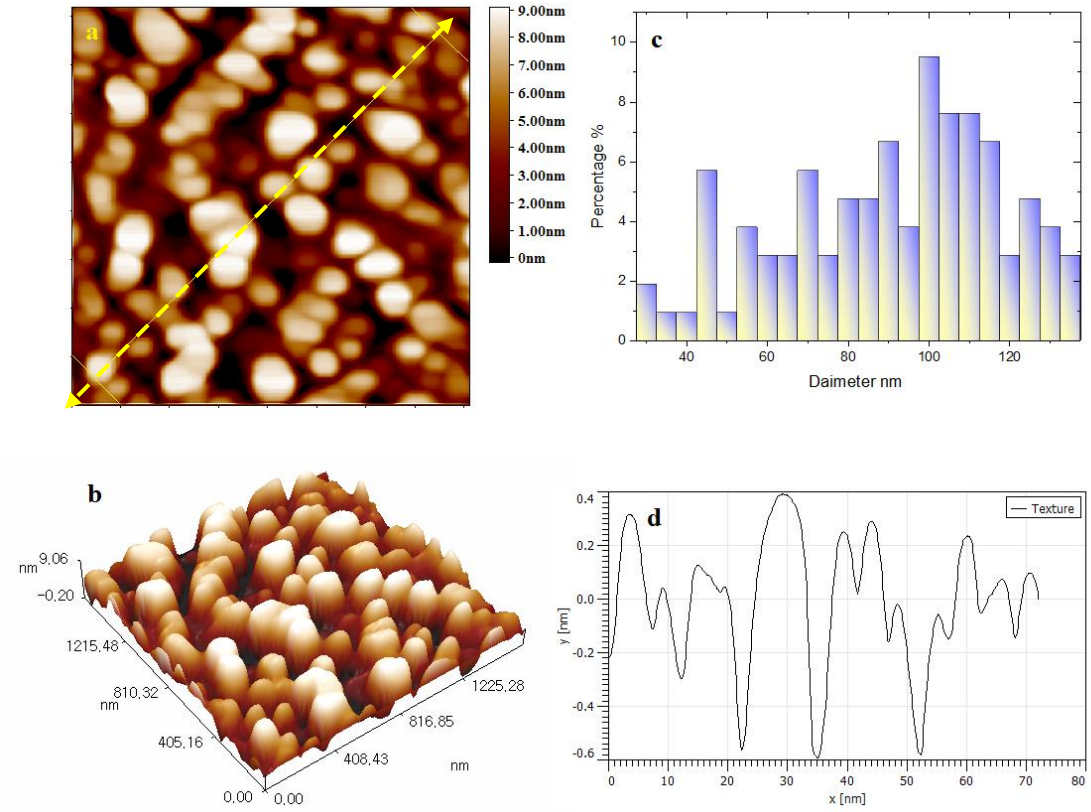


Fig. (4- 16): CdO:Ag 1.20 at% (a) representing two dimensional, (b) represents a three dimensional (c) represents the distribution of particle diameters as a function of percentages within the scanning area 2µm × 2µm and (d) line texture roughness

4-6 Optical Properties

4-6-1 Transmission

The Figure (4-17) shows the Transmittance spectrums as Function to the Wavelength for undoped CdO NPs and CdO NPs doped with Ag NPs, at different concentration (1, 2 and 3) chips at%, prepared by DC reactive Magnetron Sputtering and deposited on a glass substrate. They were measured by UV-VIS spectrophotometer at a wavelength range from 200nm to 900nm. Figure (4-17) shows the Transmittance value decrease as the silver concentration increases, from 91% for CdO: Ag 0 at% to 77% for CdO:Ag 1.20 at %. The reason is due to increased crystallization and a decrease in crystal defects, but the effect of

impurities has led to the formation of sites for scattering fallen rays. The Transmittance spectrums which doped with (0 and 1) chip shows Swanepoel phenomenon, which indicates the high homogeneity of the thin film surface and disappeared in the two concentrations of doping silver (2 and 3) chips. It is also illustrated from the two models that the transmittance at the wavelength of 350 nm is not equal to zero, but T≈50% due to the effect of impurities in these shades.

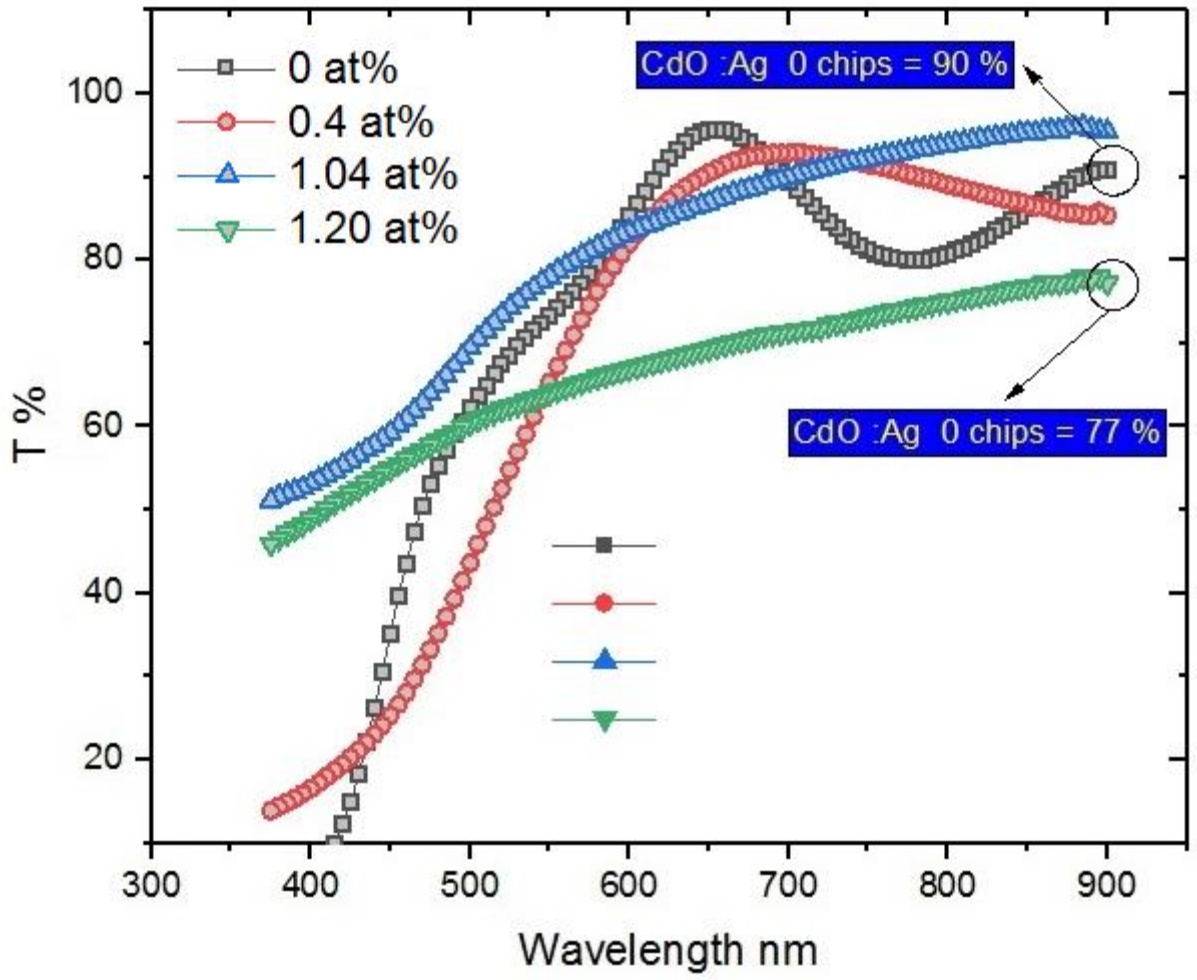


Fig. (4-17): Transmittance spectrum of undoped CdO and CdO:Ag

4-6-2 Absorption

Figure (4-18) shows the UV-VIS optical absorption spectra, as Function to the Wavelength for undoped CdO NPs and CdO NPs doped with Ag NPs, at different concentration (1, 2 and 3) chips at%, prepared by DC reactive Magnetron Sputtering and deposited on a glass substrate. The UV- Vis optical properties in the range from 300nm to 900nm at fixed temperature 150°C, shows that the high absorbance in about 10^5 and decrease to 10^4 CdO:Ag at%. This indicates the occurrence of allowed electronic transfers directly of the permissible or impermissible and not allowed direct transition. Optical absorption spectra decreases with increasing of the doping process, due to the decrease in the value of the energy gap (E_g), where it requires less energy to transfer an electron from the valence band (V.B) to the conduction band (C.B).

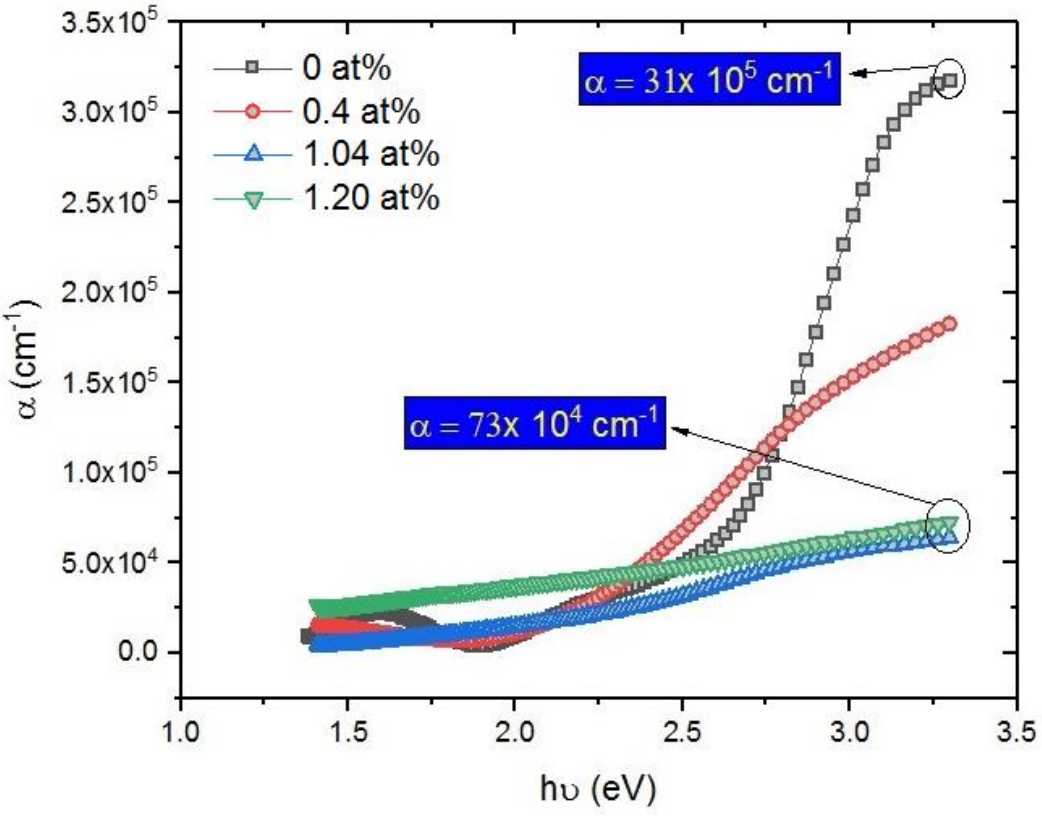


Fig. (4-18): Absorption coefficient for doped CdO-Ag at different concentration

4-6-3 Optical Energy Gap $E_g^{op.}$

The Figure (4-19) represents the value of $(\alpha h\nu)^2$ as a Function of energy for an incident photon for all samples for undoped CdO NPs and CdO NPs doped with Ag NPs, at different concentration (1,2 and 3) chips at%, prepared by DC reactive Magnetron Sputtering and deposited on a glass substrate.

From the Figure (4-19), the value of energy gap (E_g) can be determined by extrapolating the linear portion of this plot to $(\alpha h\nu)^2=0$ vs. $h\nu$. We can determine optical band gap of Cd0-Ag NPs, from the Tau equation.The extrapolation of the linear part of the above plot to $(\alpha h\nu)^2= 0$ gives the energy gap values of the CdO. The band gap value decreases as the doping concentration increase with Ag NPs (1, 2 and 3) chips, as shown in figure (4-19) from 2.766 undoped CdO at % to 1.896 CdO: Ag 3 chips. This may be attributed to First: the crystallinity of the CdO-Ag thin films being improved by increasing the doping concentration, which reduces crystalline defects. Second: The emergence of secondary energy levels within the energy gap, which reduces the values of the energy gap.

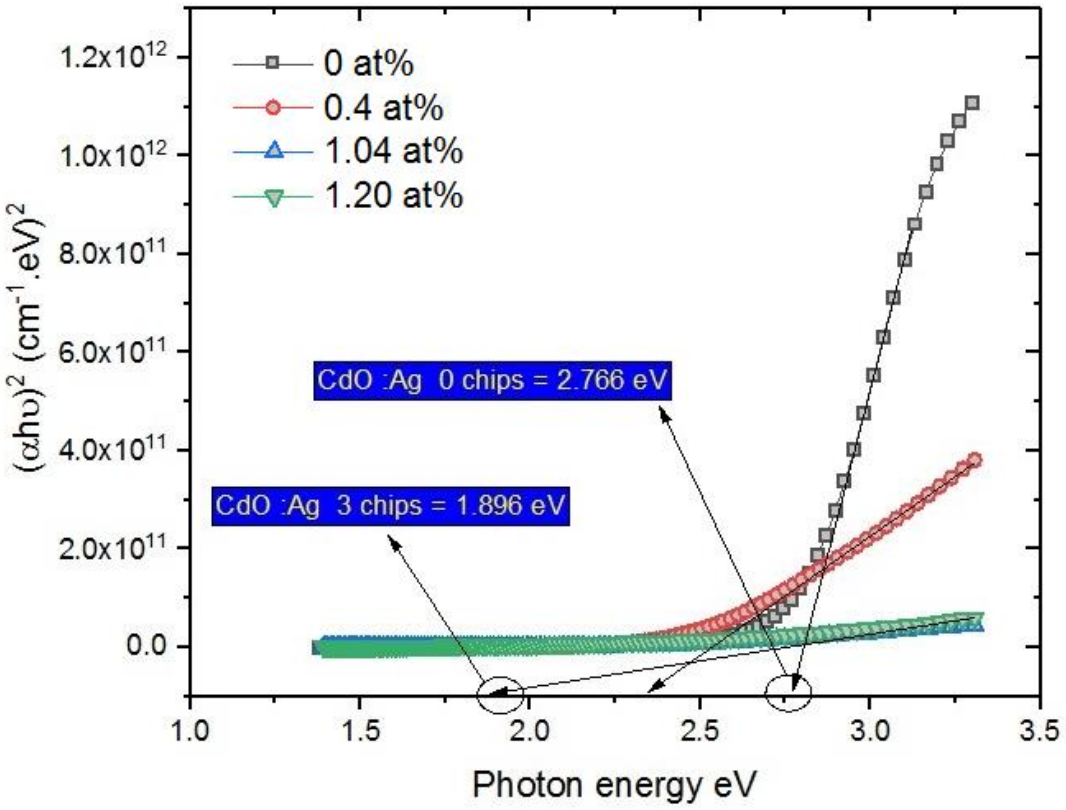


Fig. (4-19): A plots of (αhν) ^{2} ***verses (hυ) of CdO and CdO-Ag thin films at different doping concentrations***

4-6-4 Photo Luminescence (PL)

Figure (4-20) shows Photoluminescence measurements as a function of the wavelength for undoped CdO NPs and Ag doped CdO NPs at different concentration (0.4, 1.04 and 1.20) at.%, were detailed at room temperature. Figure (4-20) shows the emission of wavelengths at 539.51 nm and 541.25 nm, these beams represent the recombination processes between the electrons and the gaps generated by the photon emission. According to the mechanism of green wavelengths 529 nm attributed to the increase in the concentration of electrons

which increased due to the doping of silver at different constructions, as well as the emergence of crystal defects due to oxidation processes during the deposition process by DC reactive magnetron sputtering method.

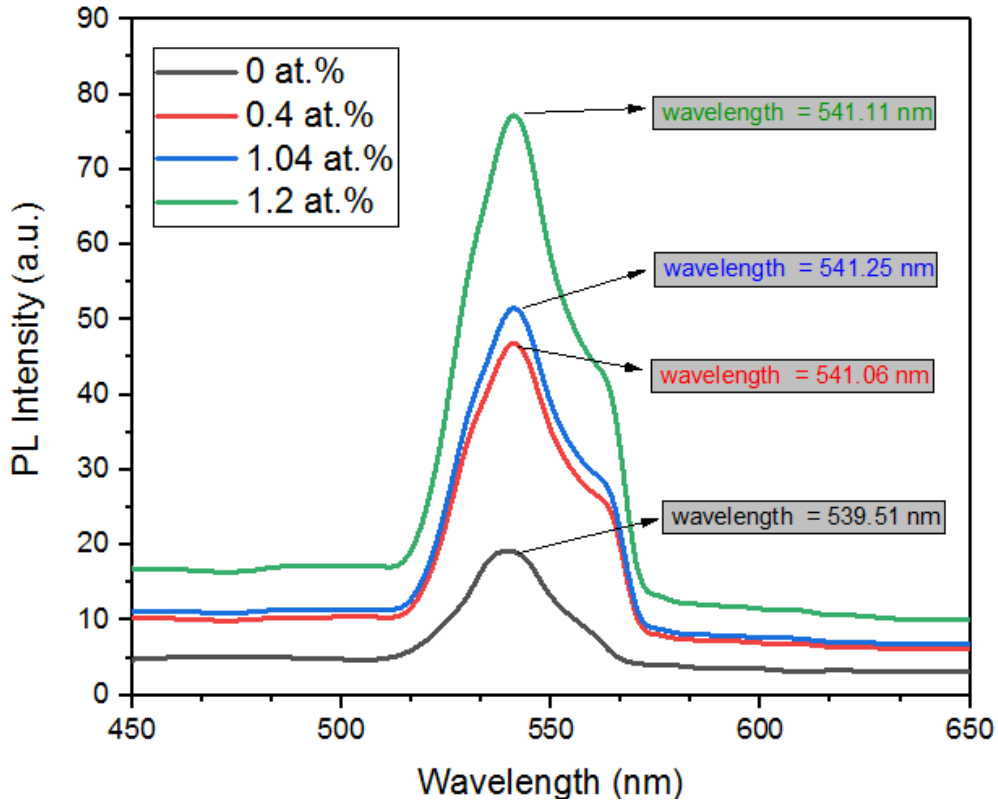
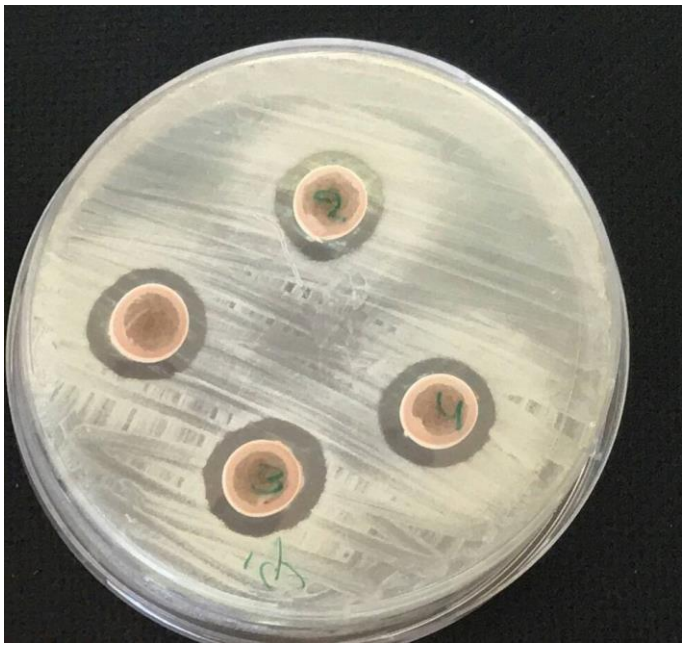


Fig. (4-20): shows Photoluminescence measurements as a function of the wavelength for undoped CdO and Ag doped CdO

4-7 Antibacterial Studies

The antibacterial study of CdO NPs and Ag doped CdO NPs at different concentration (0.4, 1.04 and 1.20) at.%, were detailed at room temperature and prepared by DC reactive magnetron sputtering technique, was tested against bacteria: Gram-positive bacteria, and Gram-negative bacteria. Figure (4-21) shows the inhibition zone of CdO NPs and CdO NPs-Ag NPs against Gram-positive bacteria, and Gram-negative bacteria.



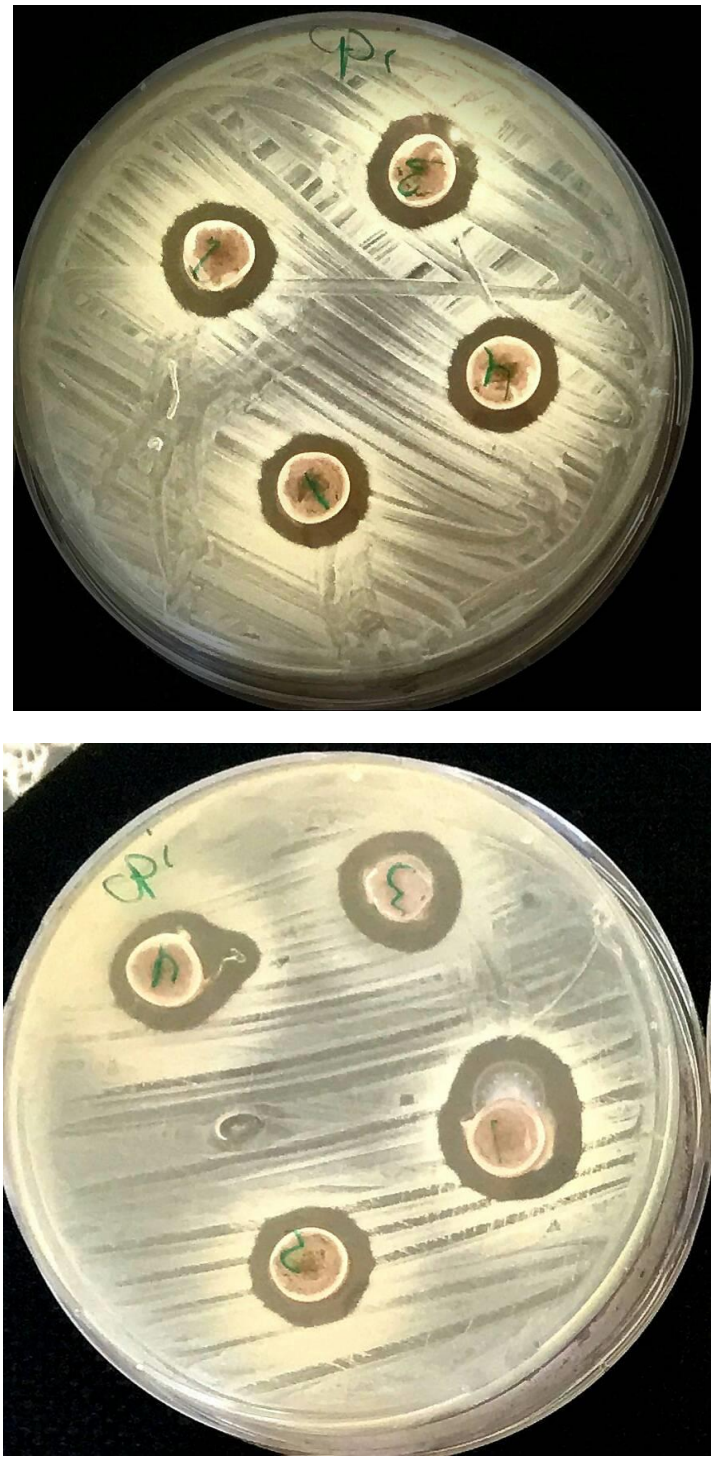


Figure (4-21) the antibacterial activity of: (1) CdO NPs, (2) CdO- Ag nanostructure by DC magnetron sputtering method, against: (A), (B), (C).

Figure (4-2), and (4-3) shows the inhibition diameter zones of CdO NPs and CdO NPs - Ag NPs, prepared by DC reactive magnetron sputtering technique .using different concentrations of Ag NPs (0.4, 1.04 and 1.20) at.%, at 150 ºC for 2 h, against Gram-positive, and Gram-negative bacteria . The inhibition diameter wire (15, 18, 16 and 19) with Ag concentrations (1chip, 2chips and 3 chips), respectively