Summary and Conclusion

Nanotechnology is the most important technology in recent years that deals with the synthesis of materials, structures and/or devices havening dimensions up to ~ 100 nm with new properties. This is attributed to its unusual properties and so its wide applications.

The objective of this work aims to study the effect of particle size in the range of nanometer on some physical and biological properties of Ag as well as some metals and non-metals oxides.

This thesis consists of four chapters:

Chapter 1 deals with a general introduction of the subject and literatures survey.

Chapter 2 concerns theoretical review and calculation methods used for analyzing the results of dc-, ac-conductivity, dielectric constant (ε`), dielectric loss (ε``) and complex impedance (Z*). The characterization and calculation methods of surface area, pore volume and particle size was also discussed.

Chapter 3 includes the used materials, the preparation of the samples by conventional and micelle-template methods, in which different types of surfactants were utilized such as:

1- Cationic surfactants: Tetrabutylammonium bromide (TBAB) and cetylpyridinium bromide monohydrate CPB.

2- Anionic surfactants: Dodecylbenzene sulphonic acid (sulph), cyproheptadine HCl (CYP), detergent (Deter)

3- Non-ionic surfactants: Triton X-100 (TX), diethanol amine (D.A) and troysol UGA (U.G.A)

This chapter includes also experimental procedures and techniques that are used for samples characterization (X-ray diffraction (XRD), differential thermal analysis, (DTA, TG), FT-IR, scanning electron microscope (SEM), transmission electron microscope (TEM)).

Chapter 4 deals with the results and discussions of the investigated materials; consists of five parts that are reported as follows:

Part (A): Titanium dioxide (TiO_2).

Part (B): Zinc oxide (ZnO).

Part (C): Nickel oxide (NiO).

Part (D): Silica (SiO_2. xH_2O).

Part (E): Silver (Ag).

The main general conclusions are the following:

(1) The particle size of all the investigated materials lies in nanorange from 5 nm to 85 nm and depends mainly on the preparation method.

(2) The surfactant used have an effective role on the phase structure (TiO_2), particle size and the morphology of the prepared TiO_2.

(3) All the prepared samples have higher biological activities toward the most microorganisms used specially that with lower particle size.

(4) The values of dc-conductivity of the prepared nano-materials (TiO_2, ZnO, NiO) are higher than that of the bulk of large particle size.

(5) All the investigated samples have higher surface area. The surface area of samples increases as the particle size decreases.

(6) Each of the structure and the surface morphology has an effect on the type and the intensity of the acidic sites on the surface of the investigated samples.

(7) The nano-TiO_2 and ZnO samples have a high photocatalytic degradation on MB dye and used to make solar cell with high efficiency.

(8) The silica samples showed a high adsorption capacity toward the aqueous solution of MB dye.

Moreover, the most important conclusions found for each investigated sample are:

I - Conclusions of TiO_2:

1- The particle size of the samples ranging from 5 nm to 14 nm and have different phase structure (rutile and anatase) depending on the surfactant used.

2- Rutile structure is formed at lower temperature range whereas the anatase structure formed and becomes stable at higher temperatures.

3- The surface morphology of the samples depend on the preparation method.

4- TiO_2 sample ($T_{(C)}$) with anatase structure shows the higher activity toward E. coli (59 mm). While the T_{TX} sample that has rutile structure, shows a higher activity toward Ser. m and Agr. S. (55 mm)

5- All the prepared samples have high surface areas and pore volumes due to the lower particle sizes of the samples.

6- From The electrical conductivity results it was found that:

a) The dc-conductivity of nanomaterials have higher values than that of the bulk samples.

b) The investigated samples behave as semiconductor materials.

c) The values of ac-conductivity are higher than the dc-conductivity, which is attributed to that the frequency acts as a pushing force for the mobile charge carries and indicates the presence of polarization.

d) The electrical conduction process occurred by a correlated barrier-hopping mechanism (CBH).

e) Both ε` and ε`` values are high and increase with the temperature and the frequency, which is attributed to orientation polarization of the dipoles in the sample.

f) The values of ε` and ε`` are high at low frequency, which may be attributed to the possible dielectric amplification due to the presence of conducting grain boundaries covering insulating grains.

g) The impedance measurements and plots ($Z^{``}$ - $Z^{`}$) for the samples showed a single semicircle that acts as a parallel combination of capacitor and resistance. The bulk conductivity decreases as temperature increases.

7) The samples showed higher photocatalytic degradation for methylene blue (MB) in 70 min.

8) The $T_{(C)}$ sample used to make solar cell with high efficiency (6%).

II- Conclusions of ZnO:

1) The prepared samples of ZnO lie in nanorange from 35 nm to 85 nm.

2)The preparation method affect on the particle size and the morphology of ZnO samples.

3) The prepared samples have high surface area and increase with the decrease in the particle size.

4) The samples show different acidic sites on its surface.

5) The samples have higher biological activity toward most of microorganisms tested.

6) The samples show higher photocatalytic degradation towards MB dye and the activity increases as the particle size decreases, which is attributed to their high surface area and active sites.

7) From the electrical conductivity results, it was concluded that:

a) The dc-conductivity of more materials prepared is higher than that of the bulk ZnO.

b) The conductivity increases with decreasing the particle size

c) The values of ac-conductivity higher than that of dc-conductivity that attributed to the frequency act as a pushing force for the mobile charge carries and indicates the presence of polarization.

d) The conductivity mechanism in the samples agrees with the correlated barrier-hopping model (CBH).

e) Both the ε` and ε`` - values are high and increase with the temperature and the frequency, which is attributed to orientation polarization

f) The deviation in electrical properties of nanostructured materials from those of their bulk counterparts is attributed mainly to the spatial confinement of free and bound chargers, and disorder grain boundary.

8) The $Z_{(C)}$ sample used to make solar cell with high efficiency (4.2%).

III- Conclusions of NiO:

1) The prepared samples have particle size (6 nm -14 nm).

2) The surfactants used showed a great effect on the particle size and the surface morphology of the samples.

3) The prepared samples have a high surface area, which increases as the particle size decreases.

4) The samples prepared by surfactant has high biological activity, especially toward Can. a, Asp. n and Bac. m (66 mm, 65 mm and 63 mm, respectively). The higher activity of N_{TX} sample may be attributed to its smaller size 6 nm, which causes an increase in the surface area and hence increasing the activity.

5) From the electrical conductivity results, it is concluded that:

a) The values of dc conductivity of the prepared nanomaterials are higher than that of the bulk NiO

b) The materials behave as semiconductor materials.

c) The predominant conductivity mechanism in NiO nanoparticles over the temperature range investigated is the band like conduction due to large polarons in the 2p band of O^{2-}.

d) The ac-conductivity is higher than dc conductivity due to the presence of polarization

e) Both the ε` and ε`` have high values and increase as temperature increase, which is attributed to orientation polarization.

f) From impedance measurements, the $Z^{`}$ - $Z^{``}$ plots showed semicircles that act as a parallel combination of capacitor and resistance. The obtained bulk conductivity increases as the temperature increases.

IV- Conclusions of Silica:

1) All the prepared samples have amorphous structure.

2) The particle size of the prepared samples from TEM lies in the range from 11 nm to 52 nm.

3) The surfactants used have a great effect on each of the particle size and the surface morphology of the samples.

4) The samples showed different acidic sites on their surface (Bpy & Lpy) depending on the morphology and the particle size.

5) All the prepared samples have a very high surface area and varying from 373 to 603 m^2 /gm.

6)The samples have high biological activity especially toward Can. a, Asp. n and Bac. m. microorganisms and depend on the particle size.

7) The silica samples have high adsorption capacity toward the MB from aqueous solution. So it can be used as remover to the dyes from water.

V- Conclusions of Silver:

1) All the prepared samples have a silver metallic crystal structure (FCC).

2) The particle size of the prepared samples lies in the range from 15 nm to 22 nm. **3)** The dispersing agent and stabilizing agent (surfactants) have a high effect on the particle size and the morphology.

4) The prepared samples have spherical structure with different particle size.

5) All the prepared samples have high surface area and it increases as particle size decreases.

6) The silver samples prepared have high biological activity toward most of microorganisms. This higher activity of the prepared Ag samples is due to high surface area of nanocrystalline Ag. Silver is toxic to microorganisms by poisoning respiratory enzymes and components of the microbial electron transport system as well as impairing some DNA function.