Sudan University of Science and Technology

College of Graduate Studies
College of Science and Technology

Change of Electric permittivity of Nacl due to the Change of Its Nano Size

تغير السماحية الكهربية لكلوريد الصوديوم Nacl تبعا لتغير حجمة النانوي

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الآية

قَالَ تَعَالَىٰ: ﴿ ۞ ٱللَّهُ نُورُ ٱلسَّمَٰوَٰتِ وَٱلۡأَرۡضِۚ مَثَلُ نُورِهِۦ كَمِشۡكَوٰةٖ فِيهَا مِصۡبَاحٌۖ ٱلۡمِصۡبَاحُ
فِي زُجَاجَةٍۖ ٱلزُّجَاجَةُ كَأَنَّهَا كَوۡكَبٞ دُرِّيّٞ يُوقَدُ مِن شَجَرَةٖ مُّبَٰرَكَةٖ زَيۡتُونَةٖ لَّا شَرۡقِيَّةٖ وَلَا
غَرۡبِيَّةٖ يَكَادُ زَيۡتُهَا يُضِيٓءُ وَلَوۡ لَمۡ تَمۡسَسۡهُ نَارٞۚ نُّورٌ عَلَىٰ نُورٖۚ يَهۡدِي ٱللَّهُ لِنُورِهِۦ مَن يَشَآءُۚ
وَيَضۡرِبُ ٱللَّهُ ٱلۡأَمۡثَٰلَ لِلنَّاسِۗ وَٱللَّهُ بِكُلِّ شَيۡءٍ عَلِيمٞ ٣٥ ﴾ النور: ٣٥

صدق الله العظيم

Dedication

To my father

It is greatest love that he holds

To my mother

It is lifelong supportthat she gives

To science and knowledge

To my sister and brothers

To my teachers

To all my friends

Acknowledgement

Before of all the praise and thanks be to Allah whom to be ascribed all perfection and majesty.

The thanks after Allah must be to my supervisor Prof. Mubarak Dirar Abd Allah who supervised this researchand guide me in patience until the result of this are researchobtained.

I wish to express my thanks to the Sudan university of science and technology, graduate college, of science, and department of physics.

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Abstract

Nano science plays an important role in modern technology. This motivates trying to study the change of some electrical properties due to the change of Nano size structure. The aim of this work is to see how change of nano size of matter leads to a change in its electric permitivity. To do this, the research methodology is based on experimental work, in which nine samples of nacl were grinded for nine different grinding times, which are 10,20,30,40,50,60,70,80,90 minutes. The electric permitivity of these samples were measured by using a capacitor. The result shows that the electric permittivity decrease as the nano size decrease. This may be attributed to the fact that decreasing nano size increases density which decreases electric permitivity.

ملخص البحث

يلعب علم النانو دورا مهما فى التقنية الحديثة, وهذا حفز لمحاوله دراسة تغير بعض الخواص الكهربية نتيجة لتغير البنية النانوية. يهدف هذا البحث لرؤية كيف يؤدى تغير الأبعاد النانوية للمادة لتغير قابليتها الكهربية. لعمل هذا إعتمدت طريقة البحث على المنهج التجريبى, وقد تم عمل تجارب تم فيها تحضير 9 عينات بأذمان سحن (10,20,30,40,50,60,70,80و 90) دقيقة. تم حساب السماحية الكهربية لهذه العينات بإستخدام مكثف, وقد بينت النتيجة المتحصل عليها أن السماحية الكهربية للعينات تقل مع صغر الحجم النانوى. ينسب ذلك إلى أن نقصان الحجم النانوي يزيد الكثافه التى بدورها تزيد السماحية الكهربية.

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Chapter one

Electricity

Introduction

(1-1) Electricity:

Electricity is the set of physical phenomena associated with the presence of electrons. The presence of an electric charge, which can be either positive or negative, produces an electric field [6].

When a charge is placed in a location with non-zero electric field, a force will act on it. The magnitude of this force is given by Coulomb's law. Thus, if that charge were to move, the electric field would be doing work on the electric charge. Thus we can speak of electric potential, which is equal to the work done by an external field on a positive charge from an arbitrarily chosen reference point to that point measured in volts. The materials that conduct electricity are divided into three types. They are conductors, semiconductors and insulators. In capacitor device the conductors make it possible to apply voltage across the insulators [1].

Electricity can pass through conductors, inductors and Capacitors. Capacitor is an instrument to store electrical energy to a particular time and discharge it when needed. It's manufactured for specific value of **C** [1].

The capacitance of the capacitor depend on the plates area, distance between plates, as well as permittivity [7].

The electric permittivity measures how electric field penetrates certain material. Thus the change of electric permittivity is strongly dependent on the material structure as well as chemical composition. Recently their so called nano-science shows another way that can be used to change the electric permittivity [7].

Nano-science is that part of science which deals with materials that consists of small tiny isolated particles have dimensions in the range of

(1-300nm). Such small particles obeys quantum laws [5].

(1-2) Research Problem:

The research problem is concerned with the need to find nano factors that affect electric permittivity.

(1-3) literature review:

Abdelnabi Ali Elamin, Abdelhlaim Ahmed ZainElabdeen, Mubarak Dirar abd Allah, Ali Sulaiman Mohamed and Bashir Elhaj Ahmed studied Self Magnetization Dependence of Iron fillings on Nano particle size: The main objective of their work was investigation of the self magnetization of Iron filling samples. The experiment shows that the self magnetization increasing is dependent on the size nano particls for the samples (hard, mid-size and small).

G.yu.yurkov, A.S.Fionov, yu. A. koksharov, v.v. kolesovand s.p. Gulbin study the Electrical and Magnetic properties of Nano-materials Containing Iron or Cobalt Nanoparticles: they are prepared nano-composites consisting of narrowly sized metal-containing nano-particles embedded in a polyethylene matrix and have established conditions for the fabrication of thick films and bulk materials from the synthesized polymer powders. Dielectric permittivity and resistivity measurements demonstrate that the electrical properties of the nano-composites depend significantly on the nanoparticle size and content. The microwave absorption and permittivity of the materials are shown to vary little in a broad frequency range. The magnetization (including the remanent one) of the cobalt-containing nano-materials is higher than that of the iron-containing samples.

(1-4) Aim of the Work:

The aim of the work is to study the effect of changing nano size of matter on its electric permittivity.

(1-5) Thesis layout:

The thesis consists of chapters chapter **1** and **2** are devoted for introduction.

Chapter two

Electric field and permittivity

Electric Field and Permitivity

(2-1)Introduction:

The electric field is very important for human life. This is since it is responsible for electric energy generation. The electric energy is used widely by humans [6]. Thus this chapter is devoted to study the nature of electric field.

(2-2) Electrical terms:

The continuous flow of free electrons constitues an electric current. The unit of current is Ampere. It is denoted by the later 'I'. If one coulomb charge cross over of the cross section of the conductor per one second, the value of current flows through the conductor is called ' one Ampere ' [6].

The current can be generated by electric pressure which is used to moves electrons. This pressure is called voltage. It is denoted by the letter "V" .The unit of is "volt" and is measured by voltmeter. One volt means the force to move one coulomb of electrons is one second [6].

The motion of current is through conductors. The property of conductor which opposes the flow of current through it is called resistance, denoted by "R" The unit of resistance is ohms (Ω) and is measured by ohm by ohm meter.

When a conductor have 1V potential between the two end points, one ampere current flow through the conductor and the resistance value of the conductor is 1 ohm[6].

(2-3) Coulomb's law:

Charles Augustin de Coulomb (1736 ─ 1806) studied theinteraction force of charge particles in detail in (1784). He used a torsion balance fig2.2a.Similar to the one used 13 year later by Cavendish to study the much weaker gravitational interaction [1].

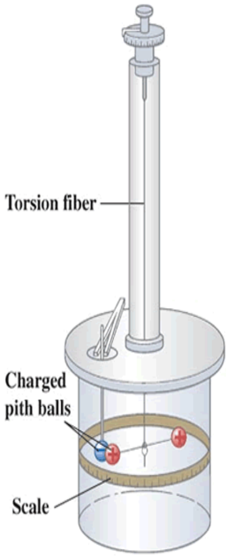

Figure 2.1a: A torsion balance of the type used by coulomb to measured the electric force.

For point charge charged bodies that are very small in comparison with the distance (r) between them. Coulomb that the electric force is proportional to$1/_{r^2}$that is, when the distance (r) double, the force decrease to ($\frac{1}{4}$) of its initial value. The electric force between two point charges depends on the quantity of charge on each body, which we will denote by q or Q .To explore this dependence, Coulomb divided a charge into two equal parts by placing a small charged spherical conductor into contact with an identical, but uncharged sphere: by symmetry, the charge is shared equally between the two sphere. Thus he could obtain one half. One quarter and so on, of any initial charge. He found that the forces that two point charge q_1 and q_2 exert on each other are proportional to each charge and there are proportional to the product q_1q_2 of the two charges [1].

Thus Coulomb established what we now call Coulomb's law. The magnitude of the electric force between two point charges is directly proportional to the product of the charge and inversely proportional to the product of the change and inversely proportional to the square of the distance between them [1].

In mathematical terms, the magnitude F of force that each of two point charge q_1 and q_2 a distance r a part exerts on other can be expressed as:

$$F = \frac{k|q_1 q_2|}{r^2} \qquad (2.3.1)$$

Where K is a proportionality constant whose numerical value depend on the system of units used. The absolute bars are used in equation (2.3.1) because the charge $q_1$andq_2 can be either positive or negative, while the force magnitude F is always positive [1].

The directions of the forces the two charges exerts on each other are always along the line joining them. When the charges q_1 and $q_1$have the same sign, either bath positive or both negative, the first forces are repulsive figure 2.2b, when the second charges have opposite sign. The forces are attractive figure 2.2b, the two forces obey Newton's law; they are always equal in magnitude and opposite interaction even when the charge are not equal. So that the electric interaction depend on electric charge and can be attractive or repulsive [1].

The value of the proportionality constant K in Coulomb's law depends on the system of units used. In SI the constant K in equation (2.3.1):

$$K = 8.987551787 \times 10^9 \, N.m^2/c^2 \qquad (2.3.2)$$

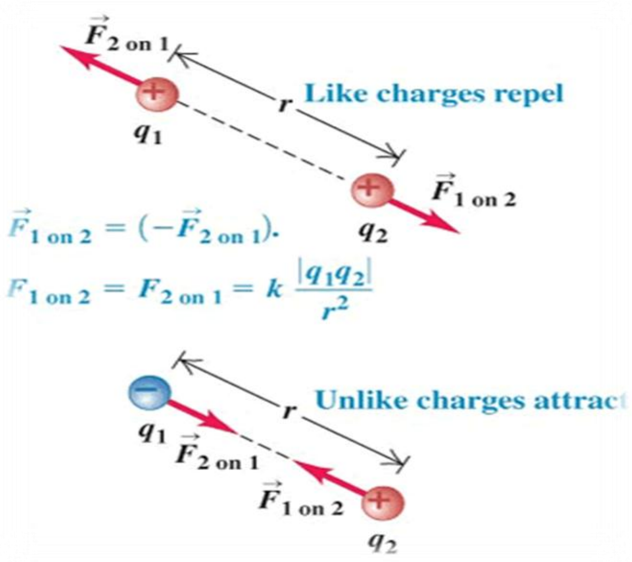

Figure 2.2b: Electric charges of the same sign repel each other
And electric of charge of opposite sign attract each other

The value of K is known to such a long number of significant digits because this value is closely related to the speed of light in vacuum. When we want to measure the electric force F between two equal charge q at a measured distance r and used Coulomb's law to determine the charge. Thus we could regard the value of K as an operational definition of the Coulomb [1].

In SI unit we usually write constant K in equation (2.3.1) as $(\frac{1}{4\pi\varepsilon_\circ})$. Where $\varepsilon_\circ$ is another constant, this appears to complicate matter, we will usually write Coulomb's law as:

$$F = \frac{1}{4\pi\varepsilon_\circ}\frac{|q_1q_2|}{r^2} \tag{2.3.3}$$

(2-4) Electric Field:

When the restraining forces are removed from any mechanical system in gravitational field, it readjusts itself to the condition for which its potential energy is minimum. In the some way, when any positive charge is free to move in an electric field, it travels from positive in which potential energy due to the field relatively high to one at which it is lower, and energy is released. In potential energy per unit charge placed at any point in an electric field is known as the electric potential at that point. And the potential difference (p.d) between two point in the work done in conveying a unite charge from one point to other the unit of potential can be defined as follows:

The volt is the potential difference between two points which are such that (1joule) of work is expended in conveying a charge of (1 coulomb) from one point to other [7].

It is often convenient to refer not only to a difference in potential but also to the actual potential at points. To do this we must agree upon some arbitrary zero of potential, and it is customary to make the potential at on infinite distance from all charge as the zero, although for practical purposes the potential of the earth forms a convenient reference value [7].

Hence potential at point is measured by the work done in bringing a unit positive charge from infinity to the point [7].

Any positive charge in an electric field experiences a force tending to make it move in direction in which the potential decrease most rapidly. Hence, the electric field strength, or intensity of the field in any direction is defined as the potential gradient in that direction. Thus, in a uniform field, the intensity E between two point distance X meters apart and differing in potential by V volt is given by:

$$\mathrm{E} = \frac{\text{dicrease in potential}}{\text{distance}} \tag{2.4.1}$$

$$= \frac{-V}{\mathrm{x}} \ \mathrm{v/m} \tag{2.4.2}$$

The negative sign is required since the positive direction of the field is that in which the potential decrease [7].

For a non-uniform field, suppose that the potential at a point is V volt and that at a point distance dx metre from that point, in the direction of field, it is approaches zero or in calculus notation,

$$E = \frac{-dV}{dx} V/m \tag{2.4.3}$$

If the force F Newtons experienced by a charged Q coulombs in an electric field moves the charge a distance dx metre, in the direction of the field, from a point at which the potential is V volts to one at which it is (v-dv) volts, then:

$$work\ done\ by\ field = F \times \delta x joules \qquad (2.4.4)$$

And, from our definition of a volt,

$$workdonebyfield = Q \times -\delta V joules \qquad (2.4.5)$$

Hence $-Q.\delta V = F.\delta x$

$$-\frac{\delta V}{\delta x} = \frac{F}{Q}$$

(2.4.6)

From equations (2.4.3) and (2.4.9) that:

$$E = \frac{F}{Q} Newtons/Coulom$$

(2.4.7)

Thus, the electric intensity at any point is equal to the force experienced per unit charge placed at that point [7].

When a mechanical force is applied to an object which is not free to move as whole, it produces within the object which is proportional the applied force and dependent upon the nature of material of which the object is composed. In the same way , when an electric field is applied to an insulator in which there we no electrons free to move through the medium it produces an electric strain, or displacement, which depend upon the nature of the medium [7].

In material medium this electric strain may be regarded as displacement of the electrons within the atoms, but it can be shown that a corresponding strain also exists in a vacuum in which there are no electrons [7].

The meaning of electric displacement may be made clear by showing experimentally something of the conditions in a uniform electric field maintained between two parallel plates distant d metre a part and at a constant potential difference of V volts. Two thin, similar metal plates on insulating handles are placed in contact with their planes perpendicular to direction of the electric.

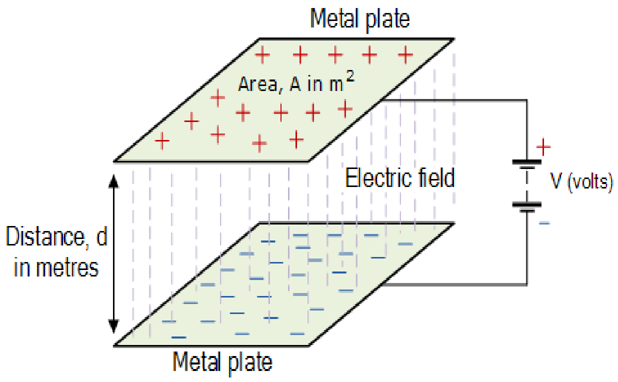

Figure 2.3: Electric Displacement.

Field figure 2.3, if the plates are separated while they are still in field, they are found, on removal, to have acquired equal and opposite charges. The field produced a displacement of electrons from one test plate to the other. The charge displaced per unit area perpendicular to the field is defined as the magnitude of the displacement, or displacement density, produced in the medium by the field.

Displacement is expressed in Coulombs per$metre^2$, and for a uniform field is equal to the surface density of change, or charge per unit area, on the boundary plates producing the field [7].

(2-5) Capacitors and Capacitance:

Capacitance is the ability of a dielectric or store an electric charge the more charge stored for a given voltage, the higher the capacitance. The symbol for capacitance is C, and the unit is the farad (F), named after Michael faraday.

A capacitor consists of an insulator (also called a dielectric) between two conductors. The conductors make it possible to apply voltage across the insulators. Different types of capacitors are manufactured for specific values of C. They are named according to the dielectric common types are air, ceramic, mica, paper film, and electrolytic capacitors. Capacitors used in electronic circuits are small and economical. The most important property of a capacitor is its ability to block a steady dc voltage while passing ac signals. The higher the frequency, the less the opposition to Ac voltage. Capacitors are a common source of troubles because they can have either an open at the conductors or a short circuit through the dielectric [1].

(2-5-1) Electric Field in the Dielectric:

Any voltage has a field of electric lines lf force between the opposite electric charges. The electric field corresponds to the magnetic lines of force of the magnetic field associated with electric current. What a capacitor does is concentrate the electric field in the dielectric between the plates. This concentration corresponds to a magnetic field concentrated in the turns of a coil. The only function of the capacitor plates and wire conductors is to connect the voltage source V across the dielectric. Then the electric field is concentrated in the capacitor, instead of being spread out in all direction [7, 2].

(2-5-2) Electrostatic Induction:

The capacitor has opposite charge because of electrostatic induction by the electric field Electrons that accumulate on the negative side of the capacitor provide electric lines of force that repel electrons from the opposite side. When this side lose electrons, it becomes positively charged. The opposite charges induced by an electric field correspond to the opposite poles induced in magnetic materials by a magnetic field [3].

(2-5-3)Charging and discharging a capacitor:

Charging and discharging are two main effects of capacitors. Applied voltage puts charge in the capacitor. The accumulation of charge results in a buildup of potential difference across the capacitor plates. When the capacitor voltage equals the applied voltage, there is no more charging. The charge remains in the capacitor, with or without the applied voltage connected.

The capacitor discharges when conducting path is provided across the plates without any applied voltage. Actually, it is necessary only that the capacitor voltage be more than the applied voltage then the capacitor can serve as a voltage source temporarily, to produce discharge current in the discharge path the capacitor discharge continues until the capacitor voltage drops to Zero or is equal to the applied voltage.

(2-5-4) Appling the charge:

In figure 2.4, the capacitor is neutral with no charge because it has not been connected to any source of applied voltage and there is no electrostatic field in the dielectric. Closing the switch in figure 2.4, however, allows the negative battery terminal to repel free electrons in the conductor to the one plate. At the same time the positive terminal attract s free electrons from plate another plate. The side of the dielectric at first plate accumulates electrons because they cannot flow through the insulator, and the second plate has an equal surplus of protons. The charging process continues until the capacitor voltage equals the battery voltage.

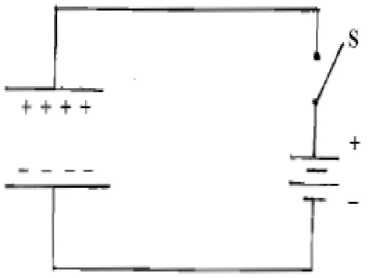

Figure 2.4: Storing electric charge in capacitance.

(2-5-5)Storing the charge:

The negative and positive charges on opposite plates have an associated electric field though the dielectric. The direction of these electric lines of force is shown repelling electrons from one plate, making this side positive. The effect of electric lines of force thought the dielectric result in strong of the charge. The electric field distorts the molecular structure so that the dielectric is no longer natural. The dielectric is actually stressed so that the dielectric field. As evidence the dielectric can be ruptured by a very intense field with high voltage across the capacitor.

The result of the electric field, then, is that the dielectric has charge supplied by the voltage source. Since the dielectric is an insulator that cannot conduct, the charge remains in the capacitor even after the voltage source is removed.

(2-5-6) Discharging:

The action of neutralizing the charge by connecting a conducting path a cross the dielectric is called discharging the capacitor. The wire between plates is allow resistance path for disgorge current with the stored charge in dielectric providing the potential difference. The negative plate repels electrons. Which are attracted to the positive plate thought the wire, until the positive and negative charges are neutralized. Then there is none charge. The capacitor is completely discharged, the voltage across it equals zero, and here is no discharge current now the capacitor is in the same uncharged condition it can be charged again however, by a source of applied voltage.

(2-6) Capacitance:

The field at any point in the region between the conductors is proportional to the magnitude Q of charge on each conductor. It follows that the potential barrier V_{ab}between the conductors is also proportional to Q. we double the magnitude of charge on each conductor, the charge density at each point doubles, the electric field at each point double, and the potential difference between conductors doubles; however, the ratio of charge to potential difference does not change. This ratio is called the capacitance C of the capacitor:

$$C = \frac{Q}{V_{ab}} \tag{2.6.1}$$

To found capacitance between two parallel plate:

Suppose there is a potential different V between two parallel conducting plates, each of area A, which carry charge of $+Q$and $-Q$respectively, and that the space between the plate is filled with a medium of permittivity Ɛ. Then the field between the plates is uniform and at any point in this field the electric displacement $D = \frac{Q}{A}$and the electric intensity$E = \frac{V}{d}$, where d is the distance between the plates.

$$D = ƐE \tag{2.6.2}$$

But Hence

$$\frac{Q}{A} = \frac{\varepsilon V}{d} \tag{2.6.3}$$

And

$$C = \frac{Q}{V} \tag{2.6.4}$$

$$= \frac{\varepsilon V}{d} = \frac{\varepsilon_{\circ} \varepsilon_r A}{d} \tag{2.6.5}$$

Where $\boldsymbol{\varepsilon_{\circ}}$is permittivity of a vacuum, is less than that of any

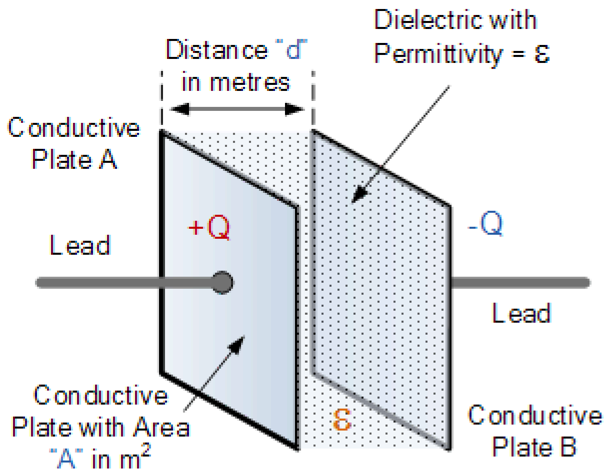

Figure 2.5: illustrate the permittivity

Material medium, $\boldsymbol{\varepsilon_r}$ is relative permittivity of the medium and it's equal to the ratio of the permittivity of any medium to that of free space.

If is expressed in farads / metre, An in square metres and d in metres C will be in farads.

The farad unit of capacitance:

With more charging voltage, the electric field is strong and more charge is stored in the dielectric. The amount of charge Q stores in the capacitance is therefore proportional to the applied voltage. Also, a larger capacitance can store more charge. These relations are summarized by the formula:

$$Q = CV\ Coulombs \qquad (2.6.6)$$

Were Q is the charge store in the dielectric in coulombs (C). V is the voltage across the plates of the capacitor, and C is the capacitance in farads.

The C is a physical constant, indicating the capacitance in terms of the amount of charge that can be stored for a given amount of charging voltage when one coulomb is stored in the dielectric with a potential different of one volt the capacitance is one farad.

Larger Plate Area Increases Capacitance:

When the area of earth plate is doubled the capacitance in stores twice the charge of the potential difference in both case is still in it is value, this voltage produces a given strength of electric field. A large plate area, however mean that more of the dielectric surface can contact each plate allowing more lines offorce through the dielectric between the plate and less flux leakage outside the dielectric. Then the field can store more charge in the dielectric. The result of large plate area is more charge stored for the same applied voltage which means that the capacitance is larger.

Thinner Dielectric increases capacitance:

When the distance between plates is reduced by one – half, the capacitance store twice the charge. The potential difference is still on it is value, but its electric field has greater flux density in the thinner di-electric. Then the field between opposite plates can store more charge in the dielectric. With less distance between the plates, the stored charge is greater for the same applied voltage, which means that the capacitance is greater.

(2-7) Capacitive Reactance:

When a capacitor charges and discharges with a varying voltage applied, alternative current can flow. Although there cannot be any current through the dielectric of the capacitor, its charge and discharge produce alternating current in the circuit connected to the capacitor plates. The amount of I that results from the applied sine-wave voltage V depends on the capacitor's capacitive reactance.

The capacitor, in an AC circuit, is acting something like a resistor in a DC circuit with the additional dimension of frequency to take into consideration. The two effects of frequency and capacitance are combined in an expression known as capacitive reactance and is expressed as X_C and its unit is the ohm, reactance acts something like resistance, and uses the same unit in order to combine the two later. The frequency is expressed as the number of alternations which occur in one second, abbreviated cps for "cycles per second" or Hz for "Hertz". Capacitive reactance is inversely proportional to both frequency and capacitance, that means its decrease for higher frequencies and with more C because more charge and discharge current results either with more capacitance or faster charges in applied voltage. The capacitive is given by:

$$\mathrm{C} = \frac{Q}{\mathrm{V}} \tag{2.7.1}$$

Thus the current defined as:

$$i = \frac{dQ}{dt}, dQ = idt,\, i = \sqrt{-1} \tag{2.7.2}$$

And the voltage is given by:

$$V = \frac{1}{C}\int Q = \frac{1}{C}\int idt \tag{2.7.3}$$

Let

$$i = i_{\circ}e^{\mathrm{jwt}}$$

Hence

$$V = \frac{i_{\circ}}{C}\int e^{jwt}\,dt \;=\; \frac{i_{\circ}}{jwt}e^{jwt} \;=\; \frac{-ij}{wC} \tag{2.7.4}$$

Therefore

$$\mathrm{V} = \frac{-ij}{\mathrm{wC}} \tag{2.7.5}$$

Thus

$$V_{\circ}e^{iwt} = \frac{-ije^{iwt}}{wc} \tag{2.7.6}$$

$$\mathrm{V}_{\circ} = \frac{-\mathrm{ji}_{\circ}}{\mathrm{wC}} \tag{2.7.7}$$

The capacitive reactance is given by:

$$X_C = \text{Capacitive Reactance} = \frac{V_e}{i_e} = \frac{V_\circ/\sqrt{2}}{i_\circ/\sqrt{2}} = \frac{V_\circ}{i_\circ} \tag{2.7.8}$$

$$= \frac{-j}{\mathrm{wC}}$$

Numerically

$$X_C = \frac{1}{\mathrm{wC}} = \frac{1}{2\pi \mathrm{fC}} \tag{2.7.9}$$

(2-8) Typical capacitors:

Commercial capacitor are generally classified according to the dielectric most common are air , mica, paper , plastic film and ceramic capacitors , plus the electrolytic type Electrolytic capacitor use a molecular thin oxide film as the dielectric , resulting in large capacitance value in little space.

Mica Capacitors:

Thin mica sheets as the dielectric are stacked between tinfoil sections for the conducting plates to provide the required capacitance. Alternate strips of tinfoil are connected and brought out as one terminal for one set of plates, and the opposite terminal connects to the other set of interlaced plates. Mica capacitors are often used for small capacitance in about 10 to 500μF.The structure is shown in figure 2.6.

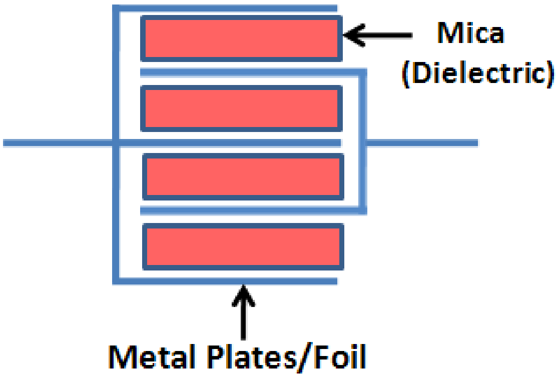

Figure 2.6: Mica capacitor.Physical construction.

Paper Capacitors:

In this type two rolls of tinfoil conductor separated by a paper dielectric are rolled into a compact cylinder. Each outside lead connects to its roll of tinfoil as plate. The entire cylinder is generally placed in a cardboard container coated with wax or encased in plastic. Paper capacitors are often used for medium capacitance values of 0.001 to $1.0\mu F$. A paper capacitor shown in figure 2.7.

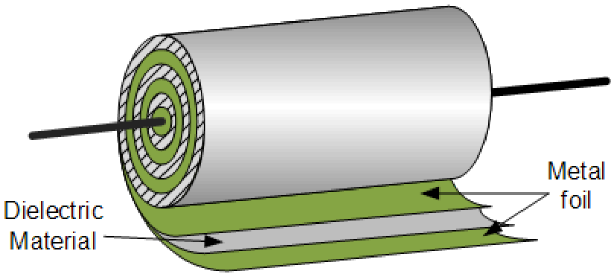

Figure 2.7: paper capacitor.Physical construction.

Film Capacitors:

Film capacitors are constructed much like paper capacitors except that the paper dielectric is replaced with elastic film such as polypropylene, polystyrene, polycarbonate or polyethelene terepthalate (Mylar).There are two main types of film capacitors: the foil type and metalized type. The foil type uses sheets of metal foil, such as aluminum or tin for its conductive plates. The metalized type is constructed by depositing a thin layer of metal such as aluminum or zinc, on the plastic film the spared – on metal serves as the plate of the capacitor. The advantage of the metalized type over the foil type is that the metalized type is much smaller for a given capacitance value and breakdown voltage rating. The reason is that metalized type has much thinner plate because they are sprayed on. Another advantage of the metalized types that it is self-healing. This means that if the dielectric is punctured because its breakdown voltage rating exceeded. The capacitor is not damage permanently instead the capacitor heals itself this not true of the foil type. Film capacitors are available with values ranging from about $100pF$to $100\mu F$ figure 2.8 shows film capacitor.

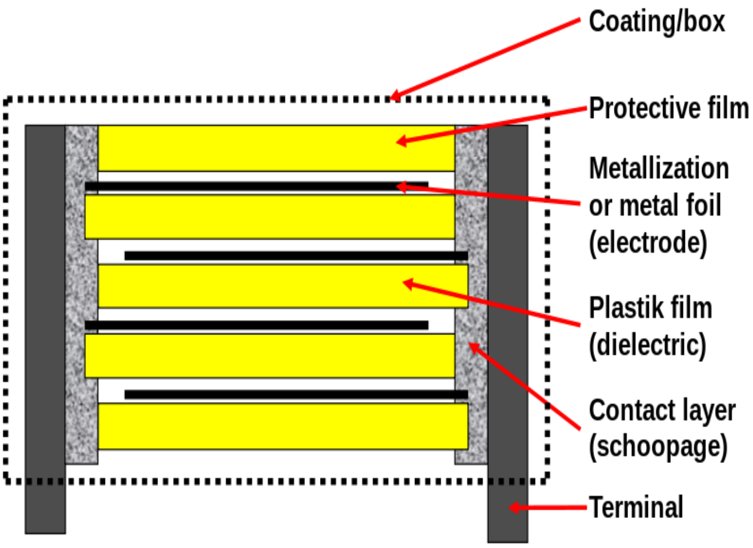

Figure 2.8: Cross-section of a plastic film capacitor.

Ceramic Capacitors

The ceramic materials used in ceramic capacitors are made from earth fired under extreme heat. With titanium dioxide or one of several types of silicates, very high values of dielectric constant k can be obtained.

Most ceramic capacitors come in disk form, as shown in fig 2.9. In the disk form, silver is deposited on both side of the ceramic dielectric to form the capacitor plates. Ceramic capacitor are available with values of $1PF$ (or less) up to about $1\mu F$.Ceramic capacitors are also available in for other than disk some ceramic capacitor s are available with axial lead and use a color code similar to that of a resistor.

Figure 2.9: Ceramic capacitors

(2-9) Nano Science:

This term is sometimes defined as "the science underlying nanotechnology" but is this not biology, chemistry and physics or the “molecular sciences”. It is the technology of designing and making functional objects at the nanoscale that is new; science has long been working at this scale and below. No one is arguing that fundamentally new physics, in the sense of new elementary forces, for example, appears at the nanoscale; rather it is new combinations of phenomena manifesting themselves at that scale that constitute the new technology. The term “nanoscience” therefore appears to be superfluous if it is used in the sense of “the science underlying nanotechnology”, although as a synonym of conceptual nanotechnology it might have a valid meaning as the science of mesoscale approximation [4].

The molecular sciences, it will have been noted, include the phenomena of life (biology), which do indeed emerge at the nanoscale (although without requiring new elementary laws) [4].

(2-10) Nanotechnology:

The bald definition of nanotechnology: “the design, characterization, production and application of materials, devices and systems by controlling shape and size of the nanoscale”. The nanoscale itself is at present consensually considered to cover the range from (1 to 100)nm^2. A slightly different nuance is given by “the deliberate and controlled manipulation, precision placement, measurement, modeling and production of matter at the nanoscale in order to create materials, devices, and systems with fundamentally new properties and functions”. Another formulation flouting around is the design, synthesis, characterization and application of material, devices and system that have a functional organization in at least one dimension on the nanoscale, the other foresight gives: nanotechnology is group of emerging technologies in which the structure of matter is controlled at nanometer scale to produce novel materials and devices that have useful and unique properties [5].

A very succinct definitions of nanotechnology is simply" engineering with atomic precision" [5].

Elaborating somewhat on the definitions, one can expand nanotechnology along at least three imaginary axes:

1. The axis of tangible objects, in order of increasing complexity: materials, devices andsystems. Note that the boundaries between these three can be crossed by such things as“smart” materials.
2. The axis starts with passive, static objects (such as nanoparticles) whose new properties arise from their small size. It continues with active devices (e.g., able to transduce energy,or store information, or change their state)—that is, their dynamical properties are explicitly considered. Further along the axis are devices of ever more sophistication and complexity, able to carry out advanced information processing.
3. The axis starts with direct nanotechnology: materials structured at the nanoscale (including nano particles), devices with nanoscale components, etc.; continues with indirect nanotechnology, which encompasses things like hugely powerful information processors based on very large scale integrated chips with individual circuit components within the nanoscale; and ends with conceptual nanotechnology, which means the scrutiny of engineering processes at the nano scale in order to understand them better [5].

(2-11) The Nanoscale:

Any definition of nanotechnology must also incorporate, or refer to, a definition of the nano scale. As yet, there is no formal definition with a rational basis, merely a working proposal. If nanotechnology and nano science regard the atom (with size of the order of 1 angstrom, i.e., 0.1nm) as the smallest indivisible entity, this forms a natural lower boundary to the nano scale. The upper boundary is fixed more arbitrarily. By analogy with microtechnology, now a well-established field dealing with devices up to about 100 micrometers in size, one could provisionally fix the upper boundary of nanotechnology as 100nanometers. However, there is no guarantee that unique properties appear below that boundary. The advent of nanotechnology raises an interesting question about the definition of the prefix “micro”. An optical microscope can resolve features of the order of 1 micrometer in size. It is really a misnomer to also refer to instruments such as the electron microscope and the scanning probe microscope a “microscopes”, because they can resolve features at the nanometer scale. It would be more logical to rename these instruments electron nanoscopes and scanning probe nanoscopes although the word “microscope” is probably too deeply entrenched by now for a change to be possible [4].

Chapter three

Experimental setups

Experimental setups

(3-1) Introduction:

In this experiment a samples was prepared to find their electric permittivity the experiment was done at Sudan university of science laboratories (physics lab for 4th year). The experiment was done at 9/2017. The experimental preparations and methods are presented here.

(3-2) Equipments and Materials:

In this work sodium chloride sault was grinded for 10,20,30,40,50,60,70,80 and 90 minutes. Thus comprising **9** samples, each sample was inserted between two copper plate capacitor.

Equipment:

Were used in this experiment:

Voltmeter:

Styler: DT9205A

Range: 200mV-750V.

Ammeter:

Styler: DE722-1P.

Range: 200mA-20A.

Electric Source (AC):

Frequency: 50 HZ .

Parallel Plate Capacitor:

Distance between plates = 1.2 cm.

Dimensions: 4.3×4.7 cm.

(3-3) Experimental procedures:

1-Each sample of Nacl power was inserted between capacitor plates

2- The capacitor was connected to the **AC** source, Voltmeter and ammeter as shown in fig 3.3.1.

3- The reading of **V**and **I** was taken by changing the current of source. The correspond voltage was readed. **11** readings were taken.

4- The procedures in (1,2,3) were repeated for each sample.

5- The capacitance was founding for each case using an equation (2.6.5).

6- The electric permittivity for each sample was found using equation (2.7.9).

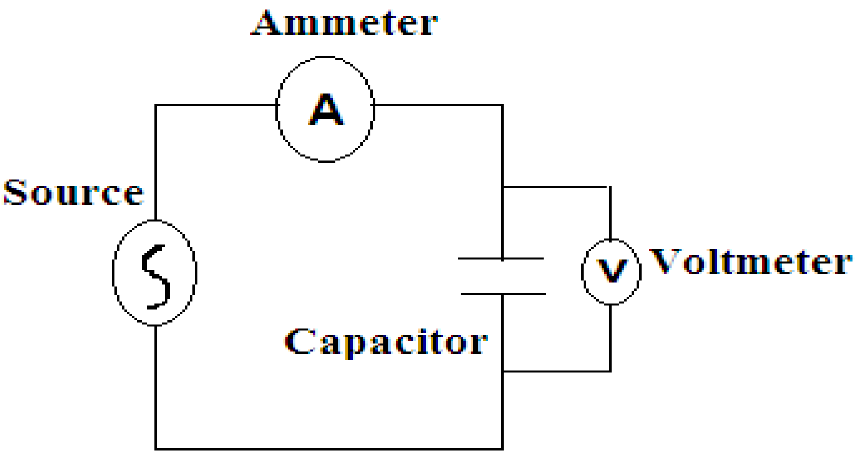

Figure 3.3.1: Capacitor circuit.

Chapter four

RESULTS &DISCUSSION AND CONCLUSION

RESULTS &DISCUSSION AND CONCLUSION

(4-1) Introduction:

The results obtained which are concerned with electric permittivity change due to the change of grinding time are exhibited here. The discussion and conclusion are also presented here.

(4-2) RESULTS:

Table (4.2.1): Capacitor I and v values when sample (1) is inserted (grinding time 10 min).

Current I (Micro A)	**Voltage V (volt)**
0	0
2	0
4	0.1
6	0.2
8	0.3
10	0.35
12	0.4
14	0.5
16	0.55
18	0.6
20	0.65

Table (4.2.2): Capacitor I and v values when sample (2) is inserted (grinding time 20 min).

Current I (Micro A)	Voltage V (volt)
0	0
2	0.1
4	0.2
6	0.3
8	0.4
10	0.5
12	0.6
14	0.7
16	0.8
18	0.9
20	1

Table (4.2.3): Capacitor I and v values when sample (3) is inserted (grinding time 30 min).

Current I (Micro A)	Voltage V (volt)
0	0
2	0.3
4	0.5
6	0.6
8	0.8
10	1
12	1.1
14	1.3
16	1.5
18	1.6
20	1.8

Table (4.2.4): Capacitor I and v values when sample (4) is inserted (grinding time 40 min).

Current I (m A)	Voltage V (volt)
0	0
2	0.5
4	0.7
6	0.9
8	1.2
10	1.4
12	1.7
14	1.9
16	2.1
18	2.4
20	2.6

Table (4.2.5): Capacitor I and v values when sample (5) is inserted (grinding time 50 min).

Current I (m A)	Voltage V (volt)
0	0
2	0.6
4	0.8
6	1.2
8	1.6
10	1.7
12	2
14	2.4
16	2.7
18	2.9
20	3.2

Table (4.2.6): Capacitor I and v values when sample (6) is inserted (grinding time 60 min).

Current I (m A)	Voltage V (volt)
0	0
2	0.7
4	1
6	1.4
8	1.8
10	2
12	2.3
14	2.7
16	3
18	3.4
20	3.7

Table (4.2.7): Capacitor I and v values when sample (7) is inserted (grinding time 70 min).

Current I (m A)	Voltage V (volt)
0	0
2	1.4
4	2.8
6	3.8
8	4.9
10	5.9
12	7
14	8.1
16	9.2
18	10.3
20	11.1

Table (4.2.8): Capacitor I and v values when sample (8) is inserted (grinding time 80 min).

Current I (m A)	**Voltage V (volt)**
0	0
2	1.8
4	3.1
6	4.4
8	5.3
10	6.7
12	7.9
14	9.1
16	10.6
18	11.8
20	12.8

Table (4.2.9): Capacitor I and v values when sample (9) is inserted (grinding time 90 min).

Current I (m A)	**Voltage V (volt)**
0	0
2	3.8
4	7.1
6	10.3
8	13.8
10	16.7
12	19.3
14	22.1
16	25.1
18	
20	

Table (4.2.10): Capacitor I and V value when samples (1), (2) and (3) current in (micro A).

Current I (Micro A)	V_{S1} (volt)	V_{S2} (volt)	V_{S3} (volt)
0	0	0	0
2	0	0.1	0.3
4	0.1	0.2	0.5
6	0.2	0.3	0.6
8	0.3	0.4	0.8
10	0.35	0.5	1
12	0.4	0.6	1.1
14	0.5	0.7	1.3
16	0.55	0.8	1.5
18	0.6	0.9	1.6
20	0.65	1	1.8

Table (4.2.11): capacitor I and V value when Samples (4), (5), (6), (7), (8), and (9) current in (m A).

Current I (m A)	V_{S4} (volt)	V_{S5} (volt)	V_{S6} (volt)	V_{S7} (volt)	V_{S8} (volt)	V_{S9} (volt)
0	0	0	0	0	0	0
2	0.5	0.6	0.7	1.4	1.8	3.8
4	0.7	0.8	1	2.8	3.1	7.1
6	0.9	1.2	1.4	3.8	4.4	10.3
8	1.2	1.6	1.8	4.9	5.3	13.8
10	1.4	1.7	2	5.9	6.7	16.7
12	1.7	2	2.3	7	7.9	19.3
14	1.9	2.4	2.7	8.1	9.1	22.1
16	2.1	2.7	3	9.2	10.6	25.1
18	2.4	2.9	3.4	10.3	11.8	
20	2.6	3.2	3.7	11.1	12.8	

Table (4.2.12): Capacitor I and V value when it is dielectric is vacuum.

Current I (Micro A)	Voltage V (volt)
0	0
2	0.1
4	0.2
6	0.3
8	0.5
10	0.6
12	0.7
14	0.8
16	0.9
18	1.0
20	1.1

Table (4.2.13): The values of capacitance and permittivity to all samples on its different grinding time.

Sample No	Grinding time (±min)	Capacitance C (farads)	Permitivity □(farad/metre)
1	10	0.0885	0.00515
2	20	0.0637	0.00370
3	30	0.0371	0.00216
4	40	0.0257	0.00149
5	50	0.0209	0.00122
6	60	0.0182	0.00106
7	70	0.0058	0.00034
8	80	0.0051	0.00029
9	90	0.0013	0.0001

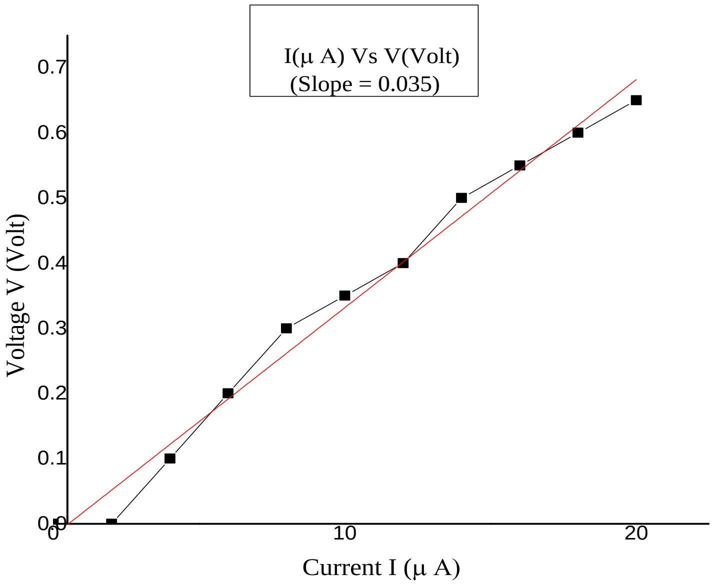

Figure (4.2.1): V versus I for sample 1.

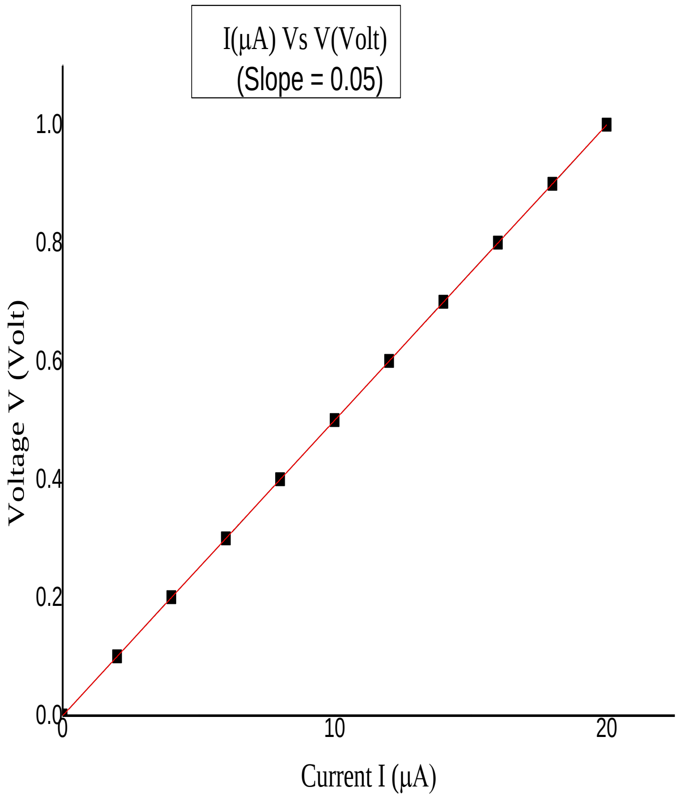

Figure (4.2.2): V versus I for sample 2.

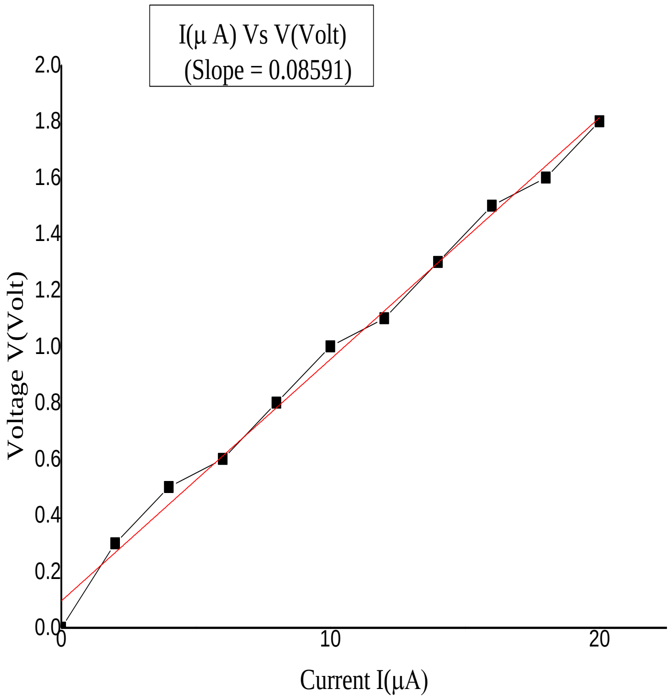

Figure (4.2.3): V versus I for sample 3.

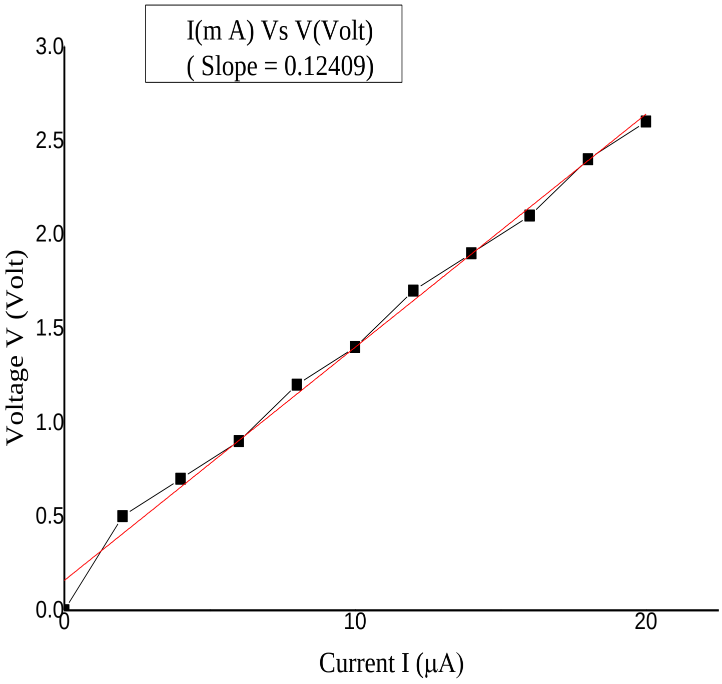

Figure (4.2.4): V versus I for sample 4.

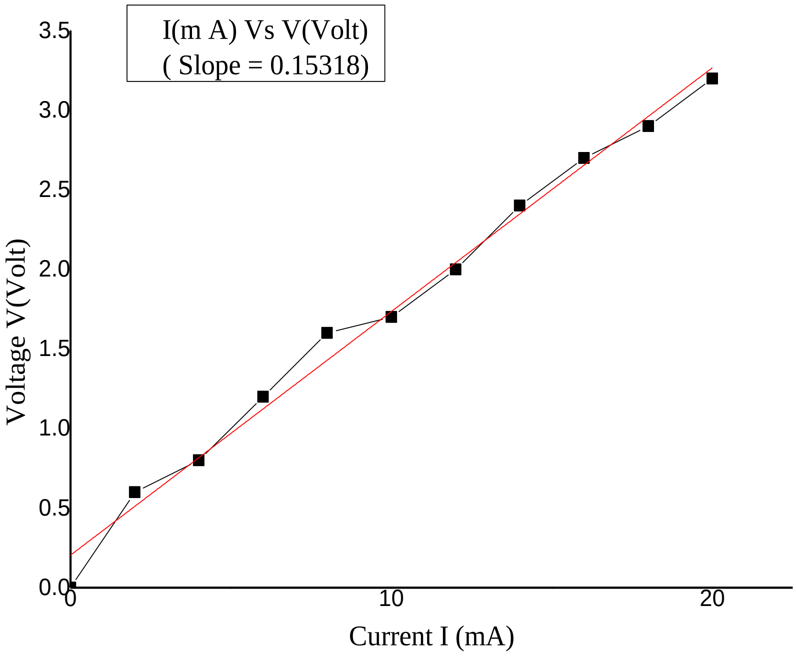

Figure (4.2.5): V versus I for sample 5

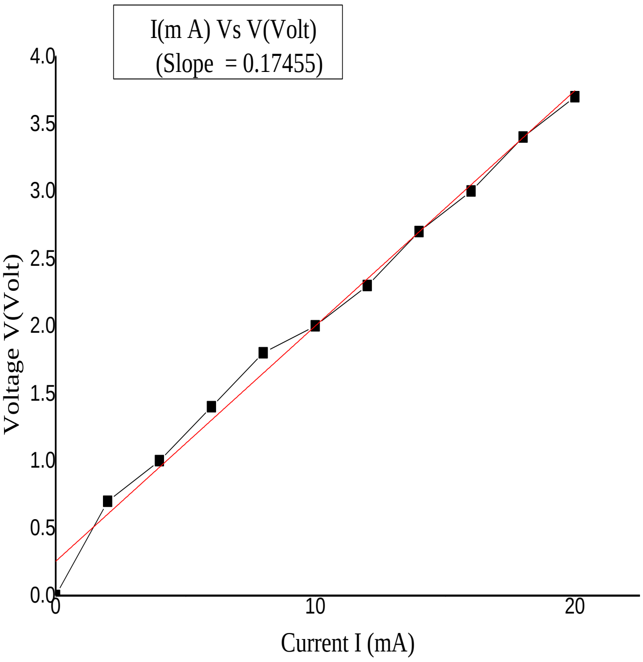

Figure (4.2.6): V versus I for sample 6

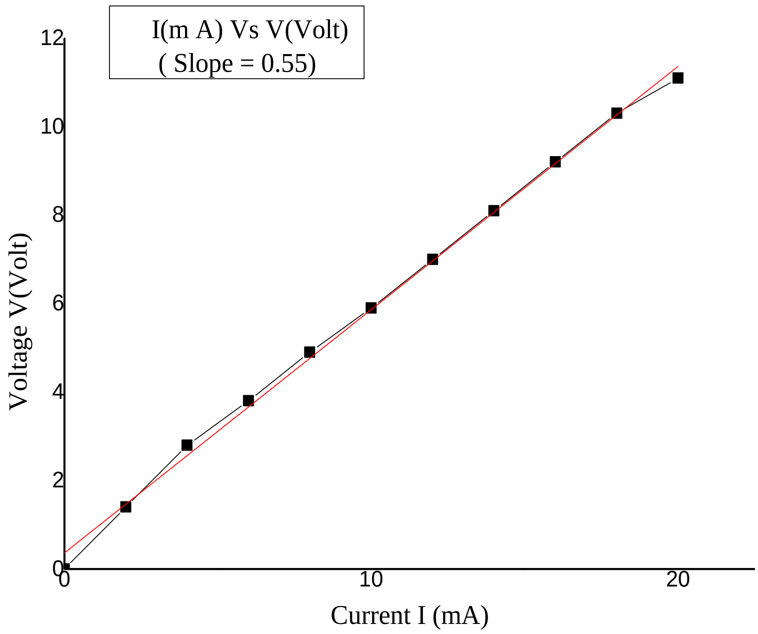

Figure (4.2.7): V versus I for sample7.

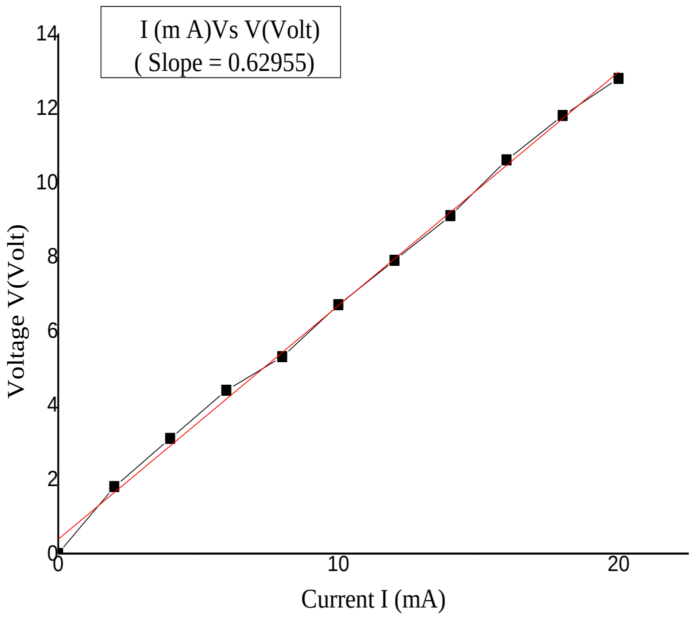

Figure (4.2.8): V versus I for sample 8.

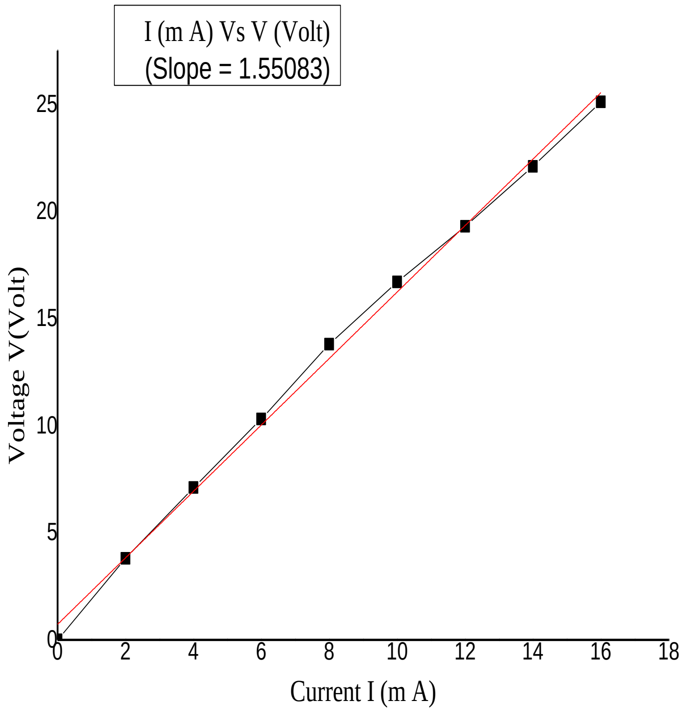

Figure (4.2.9): V versus I for sample 9

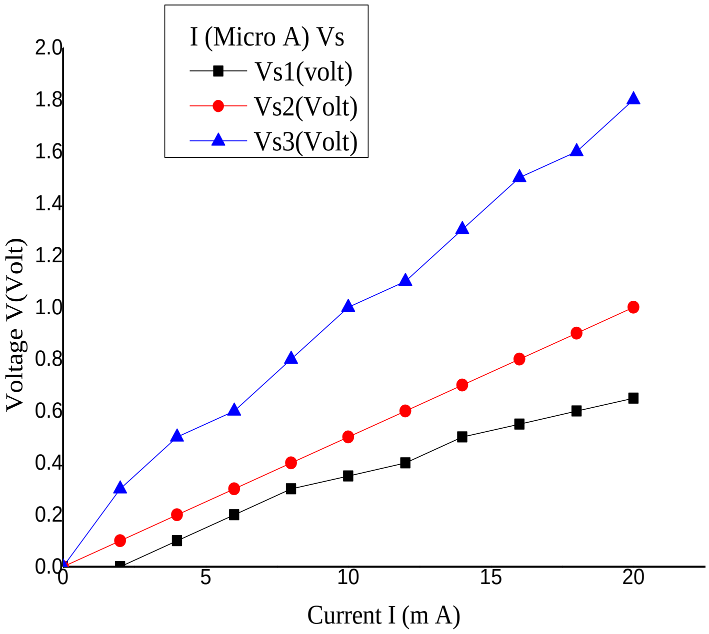

Figure (4.2.10): V versus I for samples (1-3)

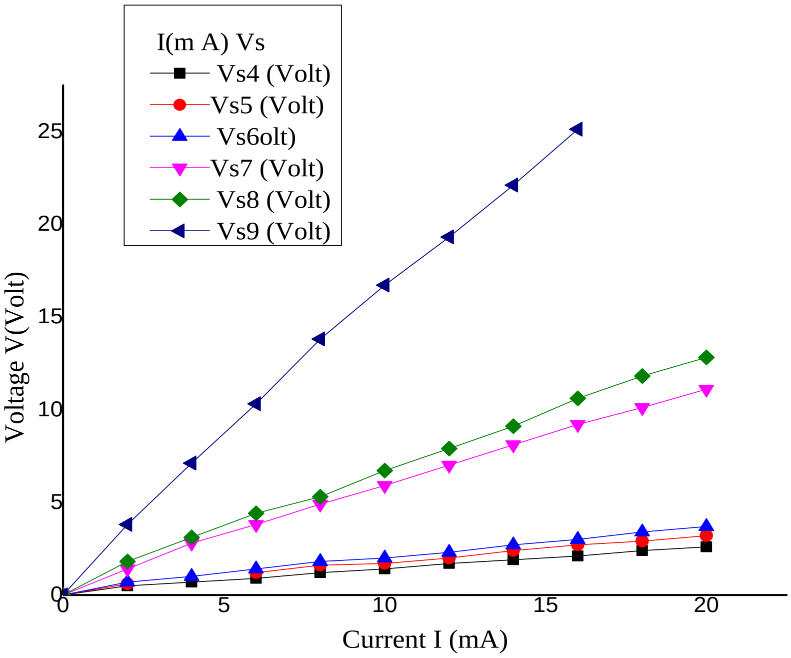

Figure (4.2.11): V versus I for samples (4-9)

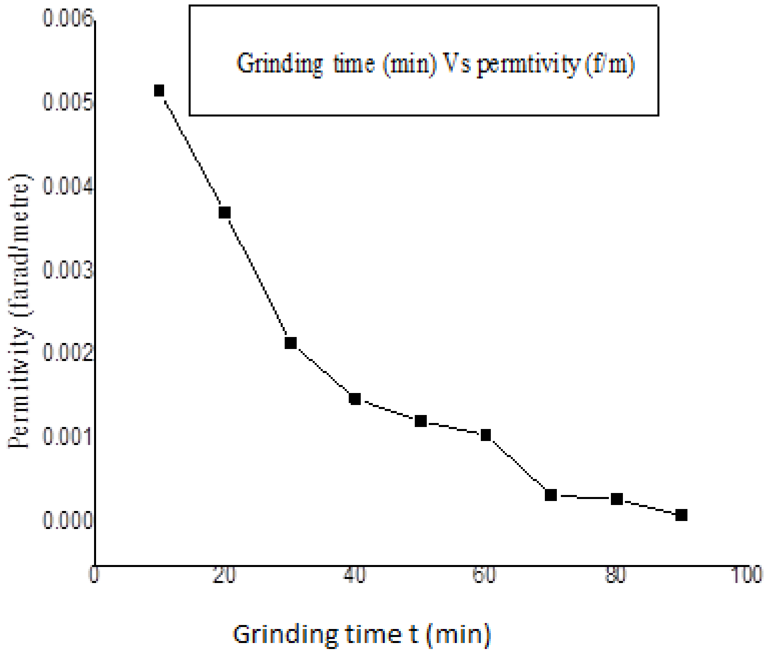

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Figure (4.2.12): versus t for all samples.

(4-3) Discussion:

The capacitance in air and for materials which are inserted between the capacitor plates. The capacitance was obtained by finding the capacitive reactance X_C from the figures (4.2.1,4.2.2,4.2.3,4.2.4,4.2.5, 4.2.6, 4.2.7, 4.2.8, 4.2.9,4.2.10,4.2.11 and 4.2.12) which relates capacitor voltage V to the current I which passes through capacitor. Where:

$$X_C = \frac{1}{WC} = \frac{V}{I} \tag{4.3.1}$$

Where:

$$C = \frac{\varepsilon A}{d} \tag{4.3.2}$$

$$\frac{C}{C_\circ} = \frac{\varepsilon}{\varepsilon_\circ} \tag{4.3.3}$$

$$\varepsilon = \frac{\varepsilon_\circ C}{C_\circ} \tag{4.3.4}$$

By using this relation the electric permitivity for each nano size was found. It is assumed that the nano size decreases as the grinding time increase. According to this hypothesis a relation between ε and grinding time was displayed in fig 4.2.12. This relation shows that increase grinding time decreases ε. This may be attributed to the fact that increasing grinding time decreases nano size and increases density. The increase in density decrease penetration of field thus decrease ε.

(4-4) Conclusion:

The experiments done for the change of the electric permittivity of sodium chloride (Nacl) shows that the change of nano size for different grinding time change the electric permittivity of sodium chloride. The decrease of nano size, decreases the electric permittivity.Thus one cancontrol the electric permitivity by controlling the nano material size.

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