Chapter One

1.1 History of Electricity

Later on Benjamin proved that lightning is a form of electricity. Surprising at 1800 A.D the discovery of electricity generated by natural sources in courage's Alessandro Volt to invent the first battery, this generated electric current was used by Thomas Edison. This is done on 1879 A.D the electrical current generated by battery can operate only small devices. This means that a new electric source is Michael Faraday was the first to generate current electricity on practical scale. His discovery leads to generation of electricity is a large amount [1].

The nature of electricity is well known after the discovery of atomic structure. Electricity is the flow of electron which have negative [2].

The conductivity of mater includes beside ordinary matter, living tissues as well. The important of the electrical properties of living tissues comes from the new application of these properties in diagnosis and therapy [3].

1.2 Research problem:

The research problem is related to the fact that electrical properties of tissues is rare in Sudan.

1.3 literatures Review

A lot of work was done to study electrical properties of tissues. A work was done to measure and comparing the electric proparatis of tumor and healthy surrounding tissues. It was found the tumer tissue is more conductive at low frequencies because of its smaller volume and at high frequencies because of its higher waters content [4].

A more commercially oriented application in measurement of the dielectric properties of meat products the result show that the anisotropy of skeletal muscle is lower in the commercially purchased samples the conductivity is high for commercial samples particularly at low frequencies[5].

1.4 Aim of the word

The aim of this work is to determine .the conductivity of caw and rabbit and to classify there type.

1.5 presentations of these:

is consists of three chapters. Chapter one is the introduction while chapter two is concerned with the conductivity of tissues the contribution is in chapter three.

Chapter two

Electrical properties of living tissues

2.1 Introduction

This chapter is concerned with the conductivity of matter in general, baside conductivity of living tissues.

2.2 Electric current conductivity

The electrical current is a flow of free electron inside matter. Conventionally the electrical current is defined as the amount of charge that passes through a certain cross section per unit time. Consider an amount of charge dQ passes through a certain cross section during a time dt. The current in this case is given by

$$i=\frac{dQ}{dt}(2.2.1)$$

i

Fig (2.2.1) electrical current

The passage of current through aconductor is done under the action of an electric field of intensity E. the electrons of charge e suffers from a frictional force Fr which a posses the motion of the electron. Therefore the equation of motion of the electron is given by

$$m\frac{dv}{dt}=eE-F_r(2.2.2)$$

When m and *v* stands for electron mass and velocity respectively for uniform motion

v = constant

$$\frac{dv}{dt}=0$$

Thus

$$F_r=eE(2.2.3)$$

The resistive force is related to the relaxation time τ via the relation

$U = U_o - a\tau$

$U = o$ = final velocity

$U_o = v$ = initial velocity

$0 = v - a\tau$

$$a = \frac{v}{\tau} \quad (2.2.4)$$

eE

Fig (2.2.2) electron under the action of electric field

$t=0 \quad t=\tau$

$U_o = v$ $\qquad$ $U = o$

Fig (2.2.3) relaxation time

inserting (2.2.40 in (2.2.3) and using the relation

$$F_r = ma = \frac{mv}{\tau} (2.2.5)$$

Yields

$$\frac{mv}{\tau} = eE$$

$$v = \frac{e\tau E}{m} (2.2.6)$$

Since the current density J is related to the electrons density n and its speed v it follows that

$$J = nev = \frac{ne^2 \tau E}{m} (2.2.7)$$

But the conductivity σ is defined by

$$J = \sigma E$$

Comparing equation (2.2.6) and (2.2.7) the conductivity is given by

$$\sigma = \frac{ne^2 \tau}{m} (2.2.8)$$

The conductivity is the reciprocal of resistivity

$$\rho = \frac{1}{\sigma} \quad (2.2.9)$$

The resistance R of any conductor is given by

$$R = \frac{\rho L}{A} \quad (2.2.10)$$

Where

L = length

A = cross sectional area

+

Fig (2.2.4) current Passing through conductor

The current follow is associated with the work done by the electric field on electron the work done on a unit positive charge is called potential difference V. thus the potential difference is equal to the force on unit charge E multiplied by the distance L, 1.C

V = EL
(2.2.11)

But from equation (2.2.11)

$$I = JA = \sigma AE = \frac{AE}{\rho} (2.2.12)$$

Hence

$$E = \frac{\rho}{A} I$$

$$V = \frac{\rho LI}{A} = RI (2.2.13)$$

The electrical field intensity which causes charge motion is related to the electric flux density D, 1.c

$$D = \varepsilon E (2.2.14)$$

Where ε stands for electrical permittivity

2.3 Semiconductor

The magic word semiconductor is composed of two words-Semi and Conductor. Semi means not completely while conductor mean something, which can conduct electricity.. A semiconductor is a material that has intermediate conductivity between a conductor and an insulator. It means that it has unique physical properties somewhere in between a conductor like aluminum and an insulator like glass. In a process called doping, small amounts of impurities are added to pure semiconductors causing large changes in the conductivity of the material. Examples include silicon, the basic material used in the integrated circuit, and germanium, the semiconductor used for the first transistors.

Semiconductors are mainly classified into two categories: Intrinsic and Extrinsic. An intrinsic semiconductor material is chemically very pure and possesses poor conductivity. It has equal numbers of negative carriers (electrons) and positive carriers (holes). Where as an extrinsic semiconductor is an improved intrinsic semiconductor with a small amount of impurities added by a process, known as doping, which alters the electrical properties of the semiconductor and improves its conductivity. Introducing impurities into the semiconductor materials (doping process) can control their conductivity. Doping process produces two groups of semiconductors: the negative charge conductor (n-type) and the positive charge conductor (p-type). Semiconductors are available as either elements or compounds. Silicon and Germanium are the most common elemental semiconductors. Compound Semiconductors include InSb, InAs, GaP, GaSb, GaAs, SiC, GaN. Si and Ge both have a crystalline structure called the diamond lattice. That is, each atom has its four nearest neighbors at the corners of a regular tetrahedron with the atom itself being at the center. In addition to the pure element semiconductors, many alloys and compounds are semiconductors. The advantage of compound semiconductor is that they provide the device engineer with a wide range of energy gaps and mobilities, so that materials are available with properties that meet specific requirements. Some of these semiconductors are therefore called wide band gap semiconductors.

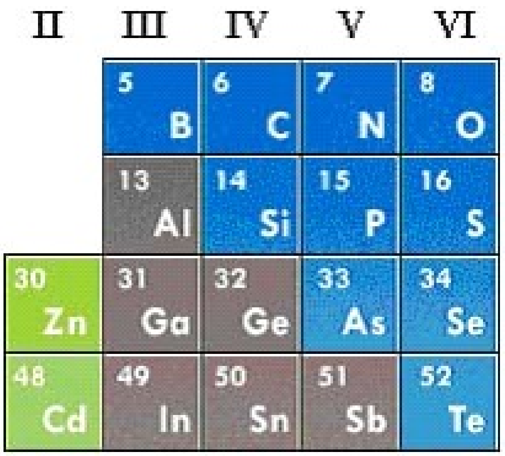
Most of the semiconductor devices and chips are created with silicon. The commonly heard expressions like "Silicon Valley" and the "Silicon Economy" come from this fact. In the periodic table, you will find that silicon sits next to aluminum, below carbon and above germanium. Carbon, silicon and germanium have a unique property in their electron structure -- each has four electrons in its outer orbital. This allows them to form nice crystals. The four electrons form perfect covalent bonds with four neighboring atoms, creating a lattice. In carbon, we know the crystalline form as diamond. In silicon, the crystalline form is a silvery, metallic-looking substance. Metals tend to be good conductors of electricity because they usually have "free electrons" that can move easily between atoms, and electricity involves the flow of electrons. While silicon crystals look metallic, they are not, in fact, metals. All of the outer electrons in a silicon crystal are involved in perfect covalent bonds, so they can't move around. A pure silicon crystal is nearly an insulator -- very little electricity will flow through it. You can change the behavior of silicon and turn it into a conductor by doping it. In doping, you mix a small amount of an impurity into the silicon crystal. A minute amount of either N-type or P-type doping turns a silicon crystal from a good insulator into a viable (but not great) conductor -- hence the name "semiconductor."

However electrons are not the only players in the "conduction game"! Another particle plays a major role in conduction in semiconductors. What is this particle? That is also what happens when an electron in a semiconductor jumps from the valence band to the conduction band. It is called a hole. Some electrons and holes play an important role in electrical conduction in semiconductors:

these electrons are the ones that jumped in the conduction band these holes are the ones that are created in the valence band
Electrons have a negative charge. Holes have a positive charge. Electrons and holes are not static: they can move. Holes move more slowly than electrons. When electrons move in one direction, holes move in the opposite direction. This is like cars parked along a street. If one car moves to an empty slot, the empty slot moves the other way.

The cars move to the right, the empty slot to the left. A solitary electron in the presence of a solitary hole will recombine. Only electrons and holes which are free, and hence have not recombined, play a role in electrical conduction.

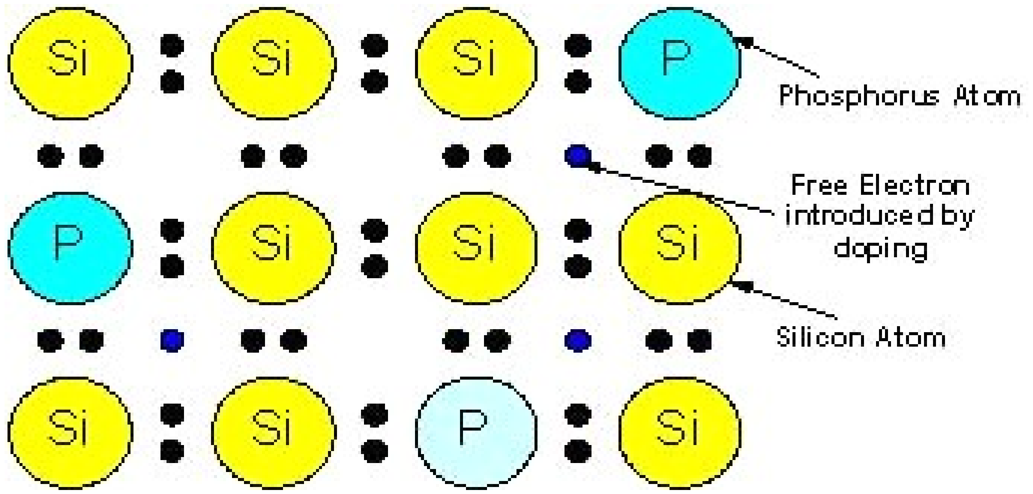
All the elements used to make semiconductors appear in Column IV of the Periodic Table or are a combination of elements in columns at equal distance of Column IV on each side.



II	III	IV	V	VI
	5 B	6 C	7 N	8 O
	13 Al	14 Si	15 P	16 S
30 Zn	31 Ga	32 Ge	33 As	34 Se
48 Cd	49 In	50 Sn	51 Sb	52 Te

For example, two elemental semiconductor materials are silicon and germanium from Column IV. Another common compound is gallium arsenide (GaAs), Ga from Column III and As from Column V. The elements for zinc oxide (ZnO) are each two columns away from Column IV, Zn in Column II and O in Column VI. All of these chemical bonds yield an average of four valence electrons per atom. These valence electrons are shared between all the atoms in the silicon crystal. Semiconductors are important because of their electrical properties. Some semiconductors are probably the purest materials on earth. Any trace of unintended impurity atoms can have a drastic effect on those properties. When being manufactured, purity must be very carefully controlled. Intentionally added impurities are called dopants.

Dopants are added in a controlled environment and it is known beforehand how many impurity atoms will be added and what the effect will be.



Semiconductors have many useful properties that insulators and conductors do not possess. These properties are based on the fact that an electron can jump from the valence band to the conduction band and vice versa. Temperature can give this little extra energy to an electron and make it jump to the conduction band thus creating a hole in the valence band.

Light can also give this energy boost and create what we call an electron-hole pair: a free electron and a free hole: this phenomenon is called absorption.

Photoconductivity is the increase of current in a semiconductor due to the absorption of photons.

The photons with the right energy are absorbed by the material the electrons from the valence band have enough energy to jump to the conduction band. The conductivity increases due to the higher number of electrons in the conduction band.

Electroluminescence is the conversion of electrical energy into light. Let's consider electrons in the conduction band. These electrons are in an excited state: they have gained some energy to jump to the conduction band.

Such electrons eventually fall back into the valence band in a lower energy state:

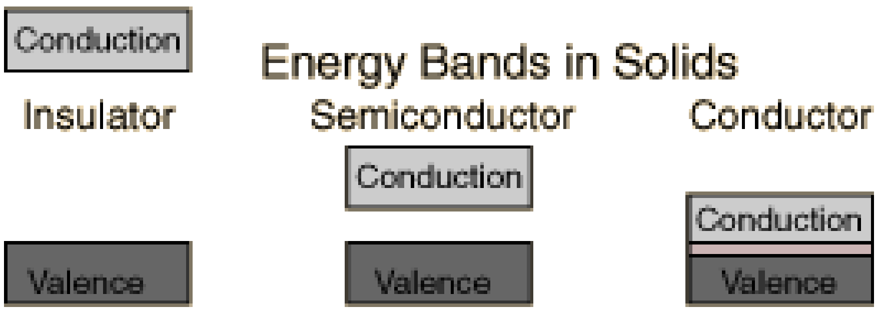
they release the extra energy that they have · this energy is emitted as a photon Photons emitted by electroluminescence come out in random directions: this type of light is called incoherent light. For instance light from a light bulb is incoherent. Stimulated emission is a little bit like electroluminescence except that it is not a spontaneous process: the excited electron is forced into jumping back to the valence band and emitting a photon

.

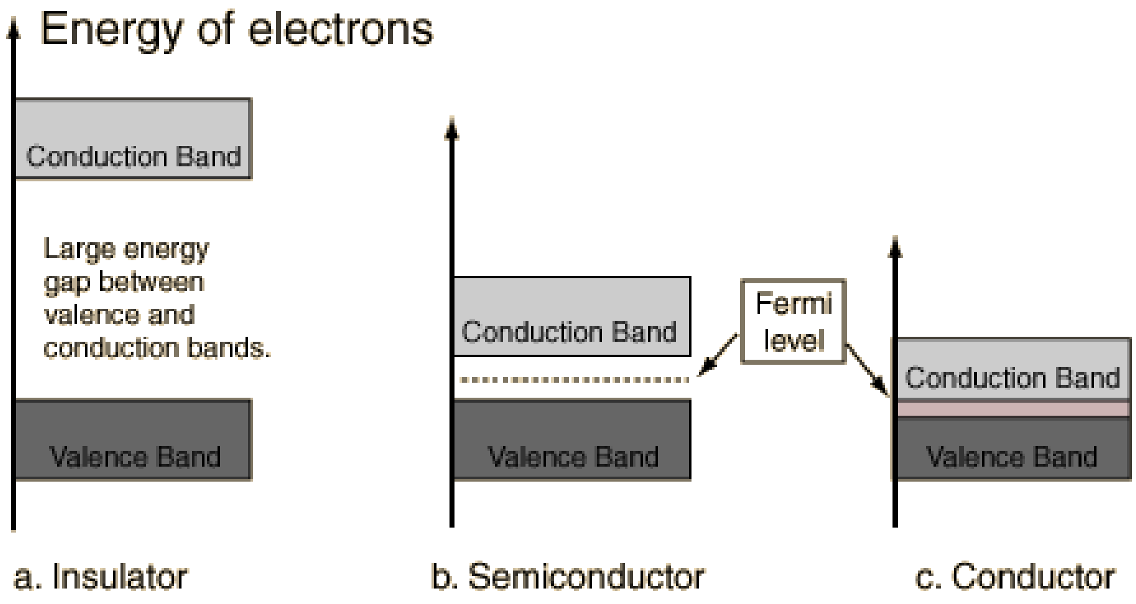
2.4 Band Theory of Solids

A useful way to visualize the difference between conductors, insulators and semiconductors is to plot the available energies for electrons in the materials. Instead of having discrete energies as in the case of free atoms, the available energy states form bands. Crucial to the conduction process is whether or not there are electrons in the conduction band. In insulators the electrons in the valence band are separated by a large gap from the conduction band, in conductors like metals the valence band overlaps the conduction band, and in semiconductors there is a small enough gap between the valence and conduction bands that thermal or other excitations can bridge the gap. With such a small gap, the presence of a small percentage of a doping material can increase conductivity dramatically.

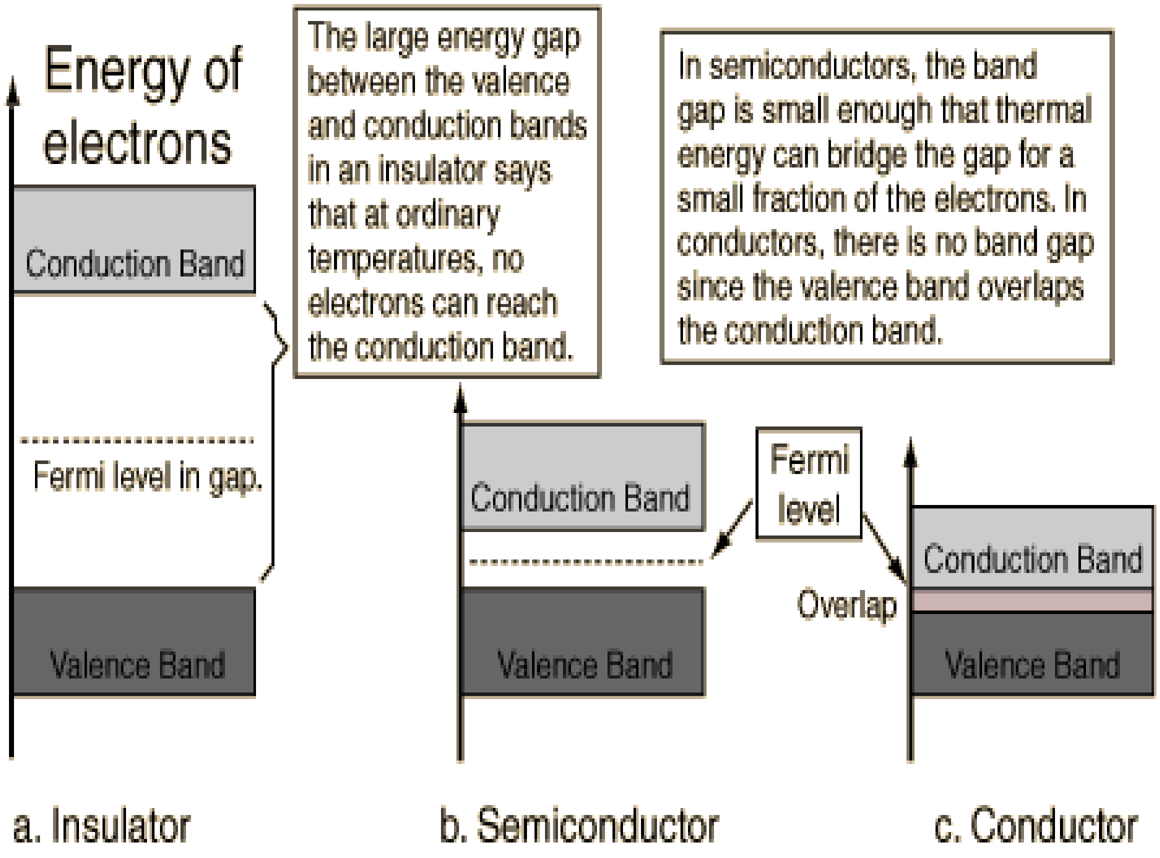
An important parameter in the band theory is the Fermi level, the top of the available electron energy levels at low temperatures. The position of the Fermi level with the relation to the conduction band is a crucial factor in determining electrical properties.


Energy Bands in Solids
Insulator
Semiconductor
Conductor
Conduction
Conduction
Conduction
Valence
Valence
Valence

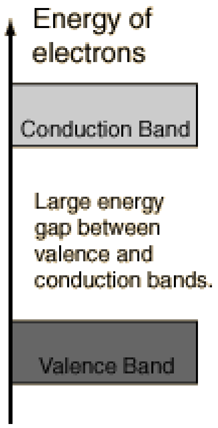
2.5 Energy Bands for Solids



2.6 Energy Bands Comments



2.7 Insulator Energy Bands



a. Insulator

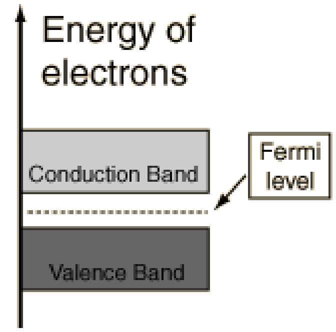
Most solid substances are insulators, and in terms of the band theory of solids this implies that there is a large forbidden gap between the energies of the valence electrons and the energy at which the electrons can move freely through the material (the conduction band).

Glass is an insulating material which may be transparent to visible light for reasons closely correlated with its nature as an electrical insulator. The visible light photons do not have enough quantum energy to bridge the band gap and get the electrons up to an available energy level in the conduction band. The visible properties of glass can also give some insight into the effects of "doping" on the properties of solids. A very small percentage of impurity atoms in the glass can give it color by providing specific available energy levels which absorb certain colors of visible light. The ruby mineral (corundum) is aluminum oxide with a small amount (about 0.05%) of chromium which gives it its characteristic pink or red color by absorbing green and blue light.

While the doping of insulators can dramatically change their optical properties, it is not enough to overcome the large band gap to make them good conductors of electricity. However, the doping of semiconductors has a much more dramatic effect on their electrical conductivity and is the basis for solid state electronics

2.8 Semiconductor Energy Bands

For intrinsic semiconductors like silicon and germanium, the Fermi level is essentially halfway between the valence and conduction bands. Although no conduction occurs at 0 K, at higher temperatures a finite number of electrons can reach the conduction band and provide some current. In doped semiconductors, extra energy levels are added.

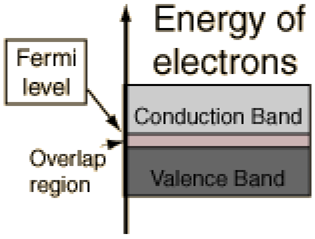


b. Semiconductor

The increase in conductivity with temperature can be modeled in terms of the Fermi function, which allows one to calculate the population of the conduction band.

2.9 Conductor Energy Bands

In terms of the band theory of solids, metals are unique as good conductors of electricity. This can be seen to be a result of their valence electrons being essentially free. In the band theory, this is depicted as an overlap of the valence band and the conduction band so that at least a fraction of the valence electrons can move through the material.



c. Conductor

2.10 Properties of Bones

Bones are an integral part of the human body that exhibit piezoelectric properties, meaning that when stress is applied to the bone, the bone produces a current within itself. This is known as the piezoelectric effect. Material that are piezoelectric can similarly exhibit the reverse piezoelectric effect, meaning that when a current is applied, the material compresses on itself. This property has many applications such as applying a current to a fractured bone to promote compression of the bone to allow it to heal faster. However, too much of a current will destroy the tissue of the bone, thus killing the cells.

2.11 ELECTRIC PROPERTIES OF TISSUES

The electrical properties of tissues and cell have been of interest for many reasons. They determine the of current flow through the body and, thus, are very important in the analysis of a wide range of biomedical applications such as functional electrical stimulation and the diagnosis and treatment of various physiological conditions with weak electric currents, radio-frequency hyperthermia, electrocardiography, and body composition. Indeed, biological impedance studies have long been important in electrophysiology and biophysics; one of the first demonstrations of the existence of the cell membrane was based on dielectric studies on cell suspensions.

To analyze the response of a tissue to electric stimulation, one needs data on the specific conductivities and relative permittivities of the tissues or organs. A microscopic description of the response is complicated by the variety of cell shapes and their distribution inside the tissue as well as the different properties of the extracellular media. Therefore, a macroscopic approach is most often used to characterize field distributions in biological systems. Moreover, even on a macroscopic level, the electrical properties are complicated. They can depend on the tissue orientation relative to the applied field, the frequency of the applied field (the tissue is neither a perfect dielectric nor a perfect conductor), or they can be time- and space-dependent (e.g., changes in tissue conductivity during electropermeabilization).

If a conductor is placed in an electric field, charges will move within the conductor until the interior field is zero. In the case of an insulator, no free charges exist, so net migration of charge does not occur. In polar materials however, the positive and negative charge centers in the molecules do not coincide. An electric dipole moment, p, is said to exist. An applied field, E0, tends to orient the dipoles and produces a field inside the dielectric, Ep, which opposes the applied field. This process is called polarization.

Most materials contain a combination of orientable dipoles and relatively free charges so that the electric field is reduced in any material relative to its free-space value.

The net field inside the material, E, is then .

$$E=E_0-E_P(2.5.1)$$

The net field is lowered by a significant amount relative to the applied field if the material is an insulator and is essentially zero for a good conductor. This reduction is characterized by a factored , which is called the relative permittivity or dielectric constant, according to

$$E=\frac{E_0}{\varepsilon_r}(2.5.2)$$

In practice, most materials, including biological tissue, actually display some characteristics of both insulators and conductors because they contain dipoles as well as charges that can move, but in a restricted manner.

For materials that are heterogeneous in structure, charges may become trapped at interfaces. As positive and negative ions move in opposite directions under the applied field, internal charge separations can then result within

the material, producing an effective internal polarization that acts like a very large dipole.

On a macroscopic level, we describe the material as having a permittivity, e, and a conductivity, s. The permittivity

characterizes the material’s ability to trap or store charge or to rotate molecular dipoles, whereas the conductivity describes its ability to transport charge .

The permittivity also helps to determine the speed of light

in a material so that free space has a permittivity

E_0 =8:85X10^{-12} F\m. For other media.

$$\varepsilon = \varepsilon_r \times \varepsilon_0 (2.5 .3)$$

The energy stored per unit volume in a material, u, is

$$u = \frac{\varepsilon E^2}{2}, \qquad (2.5.4)$$

and the power dissipated per unit volume, p, is

$$p = \frac{\sigma E^2}{2}. \qquad (2.5.5)$$

We can represent these tendencies by using a circuit model to describe the tissue (1,4). Consider a sample of material that has a thickness, d, and cross-sectional area, A. If the material is an insulator, then we treat the sample as a capacitor with capacitance.

C= $\varepsilon . \frac{A}{d} (2.5.6)$

2.12 CONDUCTONCE OF TISSUES

If it is a conductor, then we treat it as a conductor with conductance

G = $\sigma.$ A\ d $(2.6.1)$

A simple model for a real material, such as tissue, would be a parallel combination of the capacitor and conductor.

Such a model is referred to as ‘‘Debye-type.’’ Other, more complicated models are sometimes used, as will be described later. If a constant (DC) voltage V is applied across this parallel combination, then a conduction current

Ic = GV $(2.6.2)$

will flow and an amount of charge

Q = CV $(2.6.3)$

will be stored. Suppose, instead, that an alternating (AC) voltage was applied to the combination:

$$V(t) = V_0 \cos(wt)$$

Here, V0 is the amplitude of the voltage and o¼2pf , where f is the frequency of the applied signal. The charge on the capacitor plates now is changing with frequency f.

This change is associated with a flow of charge or current in the circuit. We characterize this flow as a displacement current:

$$I_d = \mathrm{d}Q/\mathrm{d}t = -\omega C V_0 \sin(\omega t).$$

The total current flowing through the material is the sum of the conduction and displacement currents, which are 90 degrees apart in phase because of the difference in the trigonometric functions. This phase difference can be expressed conveniently by writing

$$V(t) = V_0 \mathrm{e}^{\mathrm{i}\omega t}, \quad \text{where} \quad \mathrm{i} = \sqrt{(-1)}$$

and taking its real part for physical significance. The total current is I= I_c + I_d, hence

$$I = GV + C \cdot \mathrm{d}V/\mathrm{d}t = (\sigma + \mathrm{i}\omega\varepsilon)A \cdot V/d.$$

The actual material, then, can be characterized as having an admittance, Y_, given by

$$Y^* = G + \mathrm{i}\omega C = (A/d)(\sigma + \mathrm{i}\omega\varepsilon),$$

where _ indicates a complex-valued quantity. In terms of material properties, we define a corresponding, complexvalued conductivity

$$\sigma^* = (\sigma + \mathrm{i}\omega\varepsilon).$$

Describing a material in terms of its admittance emphasizes its ability to transport current. Alternatively, we could emphasize its ability to restrict the flow of current by considering its impedance, Z =1\Y, or, for a pure conductance, its resistance, R=1\G. Factoring ioe0 in Equation 11 yields

$$I = (\varepsilon_r - \mathrm{i}\sigma/\omega\varepsilon_0)\mathrm{i}\omega\varepsilon_0 A/d = C\frac{\mathrm{d}V}{\mathrm{d}t}.$$

We can define a complex-valued, relative permittivity

$$\varepsilon^* = \varepsilon_r - \frac{\mathrm{i}\sigma}{\omega\varepsilon_0} = \varepsilon_r' - \mathrm{i}\varepsilon_r'',$$

with $\varepsilon'_r = \varepsilon''_r$ and $\varepsilon_r = \sigma/(w\varepsilon_0)$. The complex conductivity and complex permittivity are related by

$$\sigma^* = i\omega\varepsilon^* = i\omega\varepsilon_0\varepsilon_r^*.$$

In physical terms, we can regard the conductivity of a material as a measure of the ability of its charge to be transported throughout its volume by an applied electric field. Similarly, its permittivity is a measure of the ability of its dipoles to rotate or its charge to be stored by an applied external field. Note that if the permittivity and conductivity of the material are constant, the displacement current will increase with frequency whereas the conduction current does not change. At low frequencies, the material will behave like a conductor, but capacitive effects will become more important at higher frequencies. For most materials, however, these material properties are not constant, but vary with the frequency of the applied signal. s_ and e_ are frequency-dependent. Such a variation is called dispersion. Biological tissues exhibit several different dispersions over a wide range of frequencies.

Dispersions can be understood in terms of the orientation of the dipoles and the motion of the charge carriers. At relatively low frequencies, it is relatively easy for the dipoles to orient in response to the change in the applied field, whereas the charge carriers travel larger distances over which a greater opportunity exists for trapping at a defect or interface. The permittivity is relatively high and the conductivity is relatively low. As the frequency increases, the dipoles are less able to follow the changes in the applied field, and the corresponding polarization disappears.

In contrast, the charge carriers sample shorter distances during each half-cycle and are less likely to be trapped. As frequency increases, the permittivity decreases and, because trapping becomes less important, the conductivity increases (4,5). The dispersion can be characterized by an angular relaxation frequency $W_r = 2 \pi f_r$ or, equivalently, by a relaxation time $T_r = 1\backslash f_r$.

2.13 COMPLICATIONS IN DIELECTRIC MEASUREMENTS OF TISSUES

1. The measurement of tissue dielectric properties can be complicated because of several factors, such as tissue in:

1. homogeneity .
2. anisotropy
3. the physiological state of the tis-sue, and electrode polarization. Therefore, caution must be used in the design of the measurement procedure.

2.14 Anisotropy of Tissues:

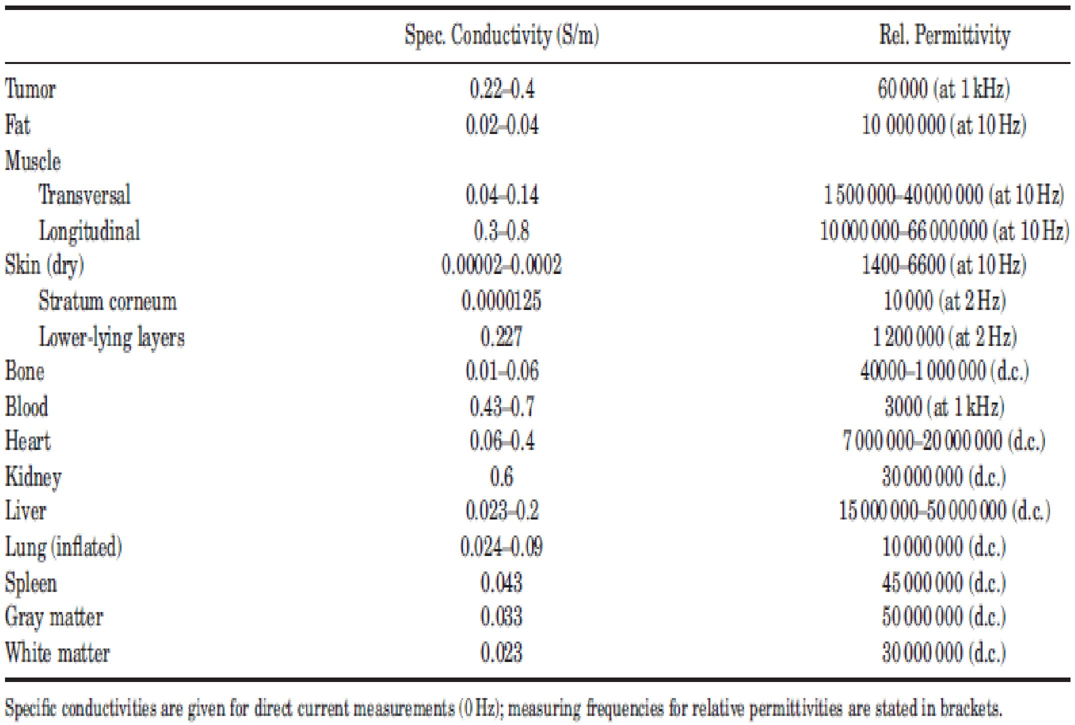
Some biological materials, such as bone and skeletal muscle, are distinctly anisotropic. Therefore, when referring to published conductivity and permittivity values, we need to check the orientation of the electrodes relative to the major axis of the tissue (e.g., longitudinal, transversal, or a combination of both).

Electrical anisotropy is often related to the physiological demands made on the tissue. Major bones and muscles of limbs are designed to produce and support significant longitudinal forces. For example, muscles are composed of fibers that are very large individual cells and are aligned in the direction of muscle contraction. Electrical conduction along the length of the fiber is thus significantly easier than conduction between the fibers in the extracellular matrix because the extracellular matrix is less conductive than the cell. Therefore, muscle tissue manifests typical anisotropic electric properties (4). The longitudinal conductivity is significantly higher than the transverse conductivity even when path differences in the charge

transport are taken into account, especially in the low frequency range (11). A similar anisotropy exists in the long bones of the body where charge transport is easier along the longitudinal axis than transverse to it.

Moreover, tissue anisotropy is frequency-dependent. Namely, if the frequency of the current is high enough, the anisotropic properties disappear (specifically for muscle tissue, that happens in the MHz frequency range). At higher frequencies, charge movement takes place over shorter distances so large-scale structures become less important and capacitive coupling across membranes becomes more important.

Table 1. Data Ranges of Specific Conductivities and Relative Permittivities of Some Other Tissues in the Low-Frequency Range (10 , 12 , 13 , 27 , 28 , 30 , 32 – 36,39 – 44)



	Spec. Conductivity (S/m)	Rel. Permittivity
Tumor	0.22–0.4	60 000 (at 1 kHz)
Fat	0.02–0.04	10 000 000 (at 10 Hz)
Muscle		
Transversal	0.04–0.14	1 500 000–40 000 000 (at 10 Hz)
Longitudinal	0.3–0.8	10 000 000–66 000 000 (at 10 Hz)
Skin (dry)	0.00002–0.0002	1400–6600 (at 10 Hz)
Stratum corneum	0.0000125	10 000 (at 2 Hz)
Lower-lying layers	0.227	1 200 000 (at 2 Hz)
Bone	0.01–0.06	40000–1 000 000 (d.c.)
Blood	0.43–0.7	3000 (at 1 kHz)
Heart	0.06–0.4	7 000 000–20 000 000 (d.c.)
Kidney	0.6	30 000 000 (d.c.)
Liver	0.023–0.2	15 000 000–50 000 000 (d.c.)
Lung (inflated)	0.024–0.09	10 000 000 (d.c.)
Spleen	0.043	45 000 000 (d.c.)
Gray matter	0.033	50 000 000 (d.c.)
White matter	0.023	30 000 000 (d.c.)

Specific conductivities are given for direct current measurements (0 Hz); measuring frequencies for relative permittivities are stated in brackets.

Chapter 3

Experimental work

(3.1) Introduction

The conductivity of bones for some animals was determine in this work.

The energy gap is also found.

The experiments were conducted at Elneelain University and at Non destructive test center in Khartoum.

(3.2) Materials and Methods

The materials consist of samples and equipments.

(3.2.1) Materials

No of samples cow and rabbit.

In this work the bones of cow and rabbit which are grinded to a powder. The conductivity of the two powders was measured by simple electrical methods.

(3.2.2) Equipments

The following equipments were used:

1. **2 capacitors tow plats of Copper that dimension 5X10cm**
2. **Voltmeter**

Model	177microvolt DMM
Company	KEITHLEY
Country	American
Range	from nV – 1000 V

3. **Ammeter**

Model	642 electro meter
Company	KEITHLEY
Country	American
Range	10^{-15}A – 1A

4. **UV**

UV –VIS 1240 Spectrophotometer:

This device was used to measure the absorption and the transmission of the solutions and solvents before use in cavity. It is covering a wavelength from 190-1100 nm with auto lamp switch from visible to ultraviolet range. UV-VIS spectrophotometer from SHIMADZU contains a cell of thickness 0.1 mm as a sample holder.

5. **XRF**

Model	X-MET5000
Company	OXFORD Instrument
Country	America
Range	all element expect light element

The X-MET5000 series analyzers are based on energy dispersive X-ray fluorescence technology and uses an X-ray tube as the source of excitation.

(3.2.3) Methods

The following methods were used to determine elemental concentration, energy gap and conductivity

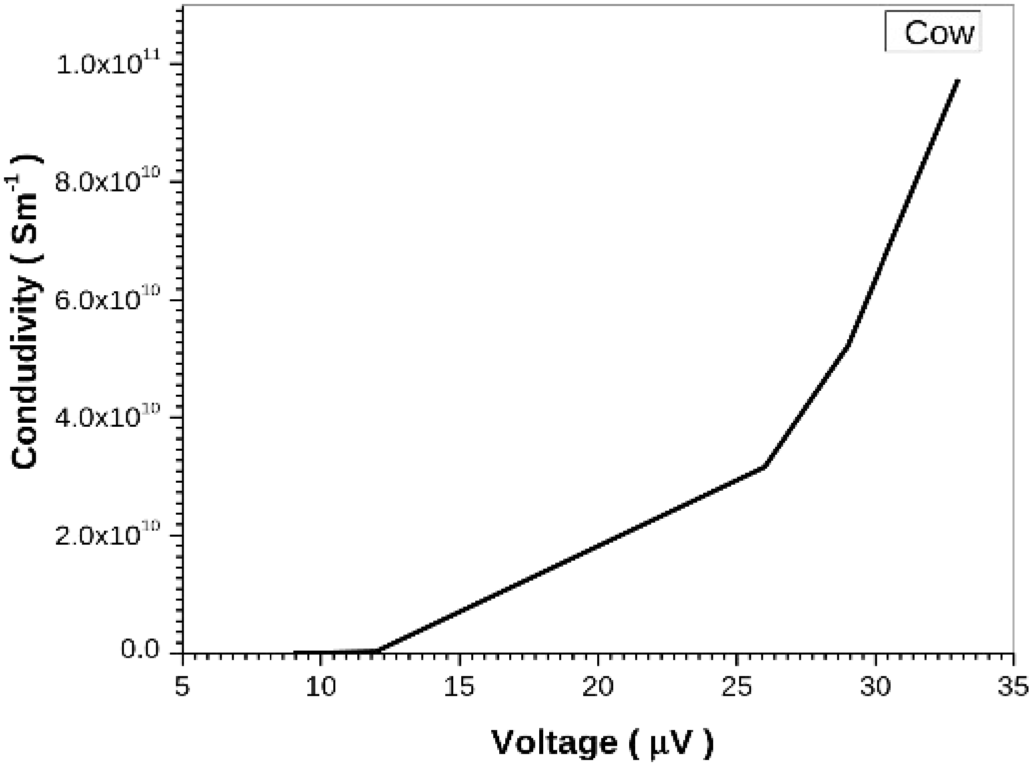
a. To determine concentration of elements in boues.
b. To determine Energy gap

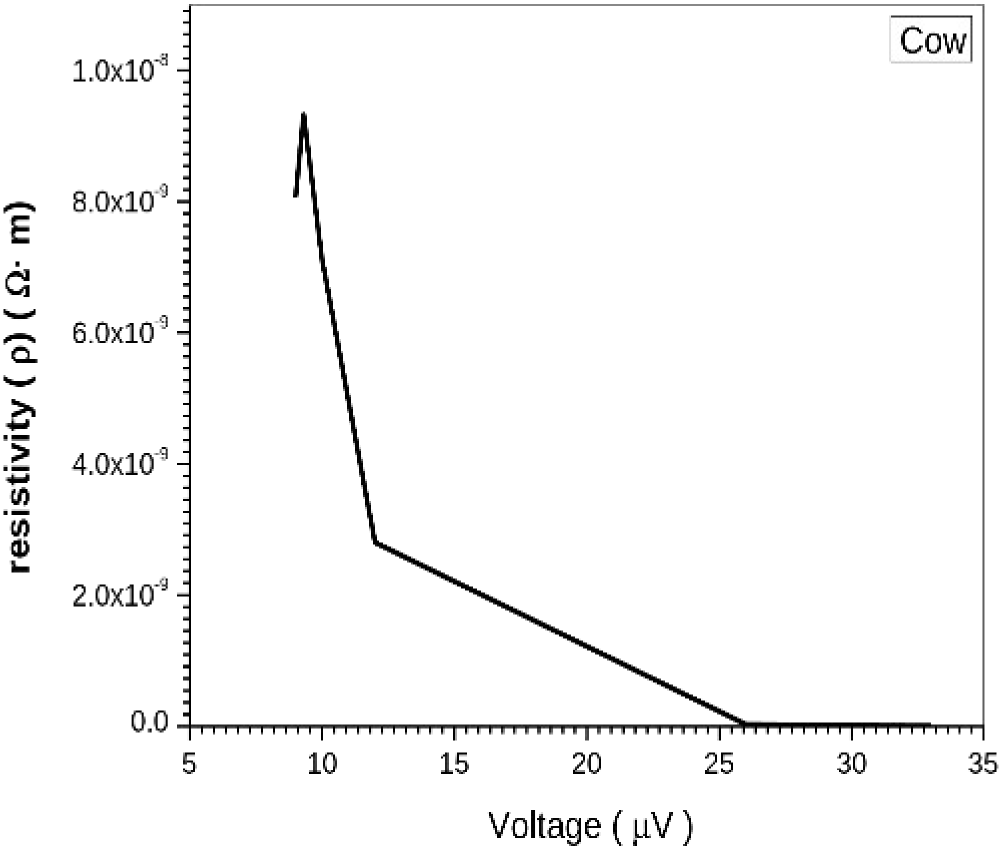
The optical energy gap (Eg) has been calculated by the relation

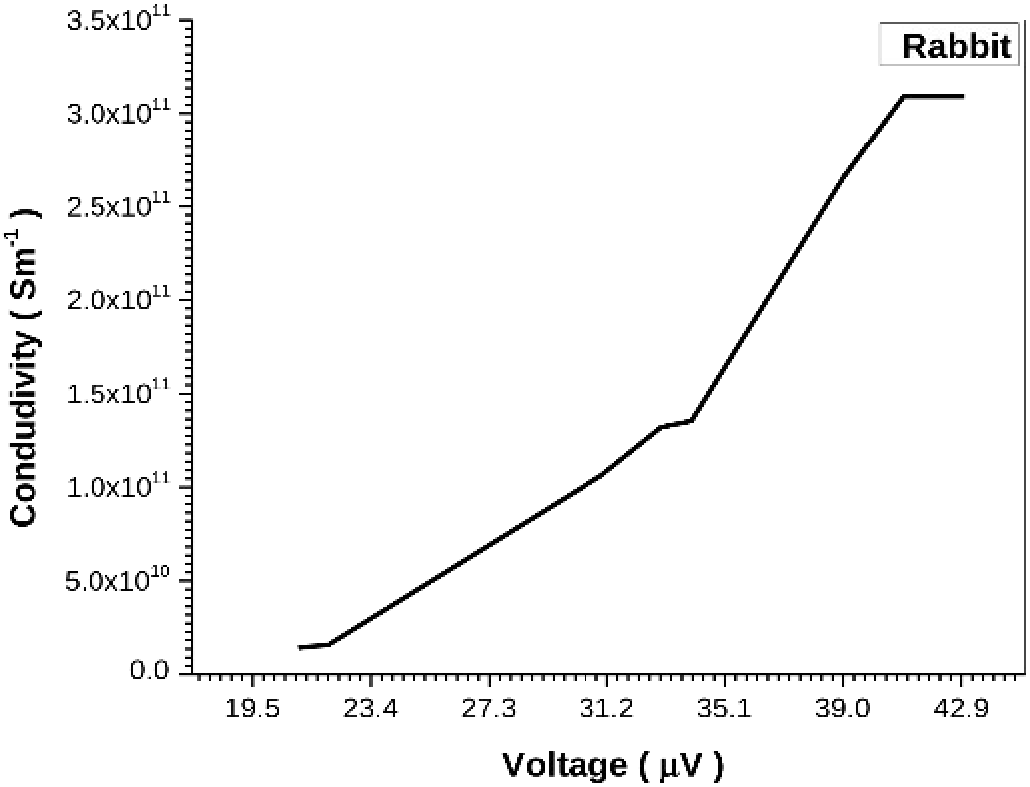
$$(\alpha h\upsilon)2 = C(h\upsilon - Eg) \ldots\ldots..(2)$$

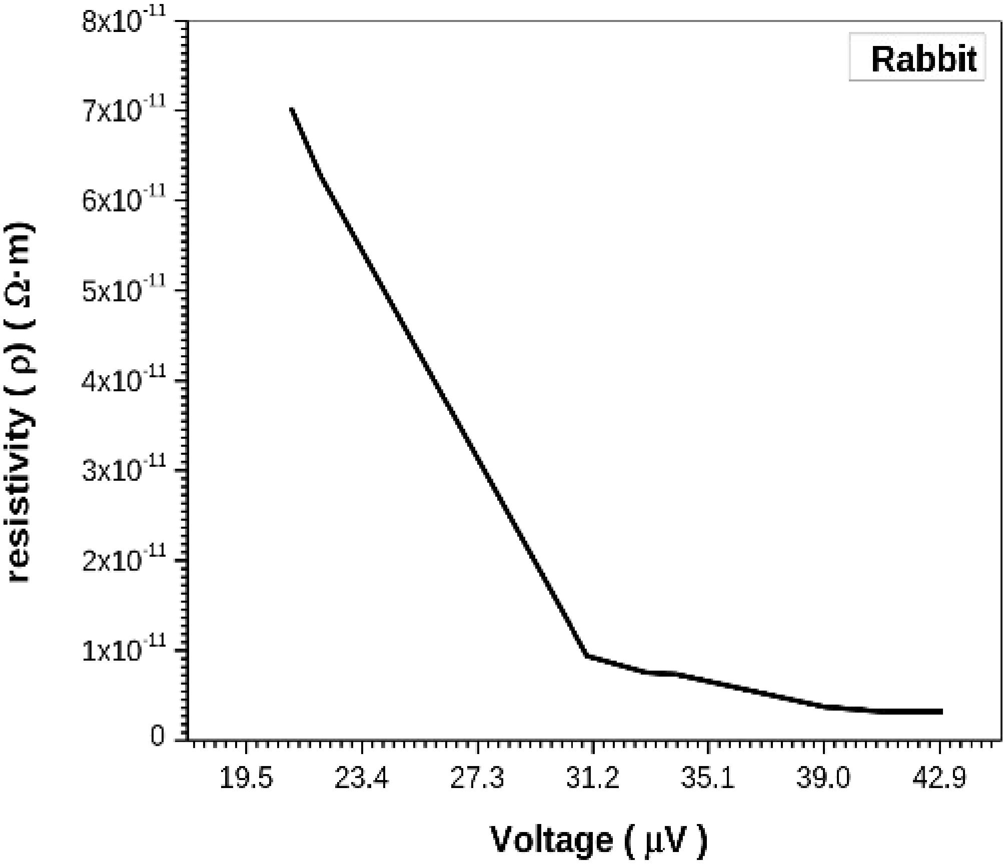
where (C) is constant. By plotting (αhυ)2 vs photon energy (hυ) as shown in fig. (1 and fig 2). Value of samples And by extrapolating the straight thin portion of the curve to intercept the energy axis , the value of the energy gap has been calculated. the value of (Eg) obtained was (rabbit E_g 1= 4.22 eV) eV . and (cow E_g = 5.3eV)

c. To determine conductivity of Cow




Cow
resistivity (ρ) (Ω· m)
1.0x10⁻⁸
8.0x10⁻⁹
6.0x10⁻⁹
4.0x10⁻⁹
2.0x10⁻⁹
0.0
5
10
15
20
25
30
35
Voltage (μV)


Rabbit
Condudivity (Sm^{-1})
Voltage (µV)
3.5x10^11
3.0x10^11
2.5x10^11
2.0x10^11
1.5x10^11
1.0x10^11
5.0x10^10
0.0
19.5
23.4
27.3
31.2
35.1
39.0
42.9



(3.3) Tables and result

The following results were obtained for element concentration, energy gap and conductivity.

(3.3.1) Tables for consent of element:

Table (3.3.1.1) concentration for sample rabbit

Element	**%**	**STD**
Cr	0.02	0.007
Mn	0.01	0.012
Fe	0.13	0.022
Ni	0.01	0.001
Cu	0.00	0.002
Zn	0.03	0.005
Pb	0.00	0.003
P	28.22	0.211
Ca	72.13	0.131

Element	**%**	**STD**
Cr	0.07	0.023
Mn	0.00	0.009
Fe	0.23	0.029
Ni	0.01	0.002
Cu	0.00	0.003
Zn	0.02	0.005
Pb	0.00	0.003
Ca	68.09	0.132
P	32.13	0.153

Evarage

Element	**%**	**STD**
Fe	0.21	0.080
Zn	0.03	0.005
Pb	0.00	0.003
Cr	0.03	0.028
Ni	0.01	0.001
Mn	0.00	0.004
Ca	69.31	0.195
P	30.02	0.142

Table (3.3.1.2) concentration for sample Caw:

Element	%	STD
Cr	0.02	0.000
Mn	0.00	0.008
Fe	0.13	0.018
Ni	0.01	0.001
Cu	0.00	0.002
Zn	0.01	0.002
Pb	0.00	0.002
Ca	24.43	0.135
P	22.19	0.122

Element	%	STD
Cr	0.02	0.007
Mn	0.00	0.009
Fe	0.07	0.014
Ni	0.01	0.001
Cu	0.00	0.002
Zn	0.01	0.003
Pb	0.00	0.003
Ca	36.13	0.135
P	18.07	0.002

Evarage

Element	%	STD
Fe	0.09	0.029
Zn	0.01	0..004
Mn	0.00	0.000
Cr	0.02	0.004

Ni	0.01	0.001
Ca	31.42	0.123
P	19.18	0.126

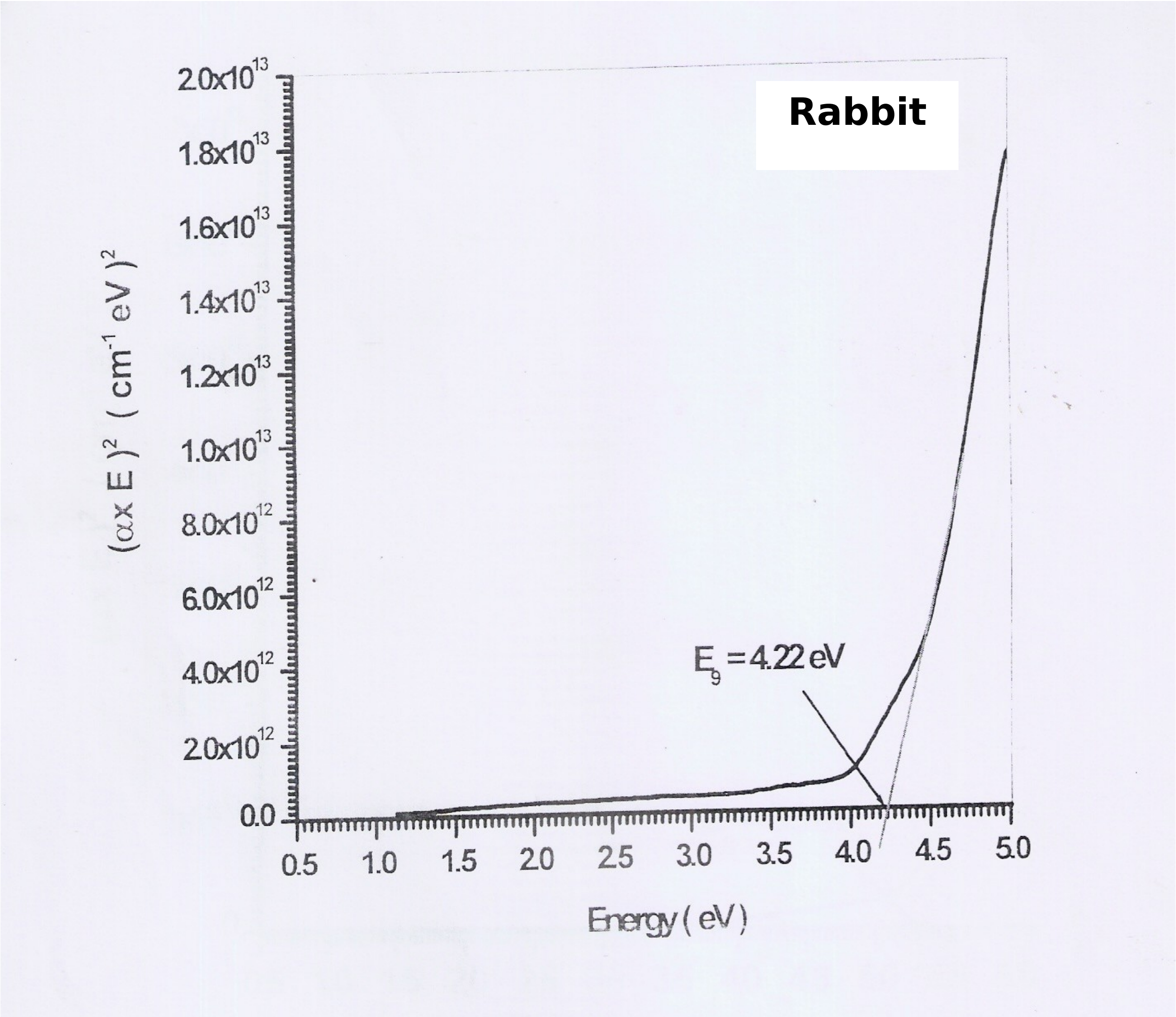


Fig (3.3.2.1): Energy gap for rabbit

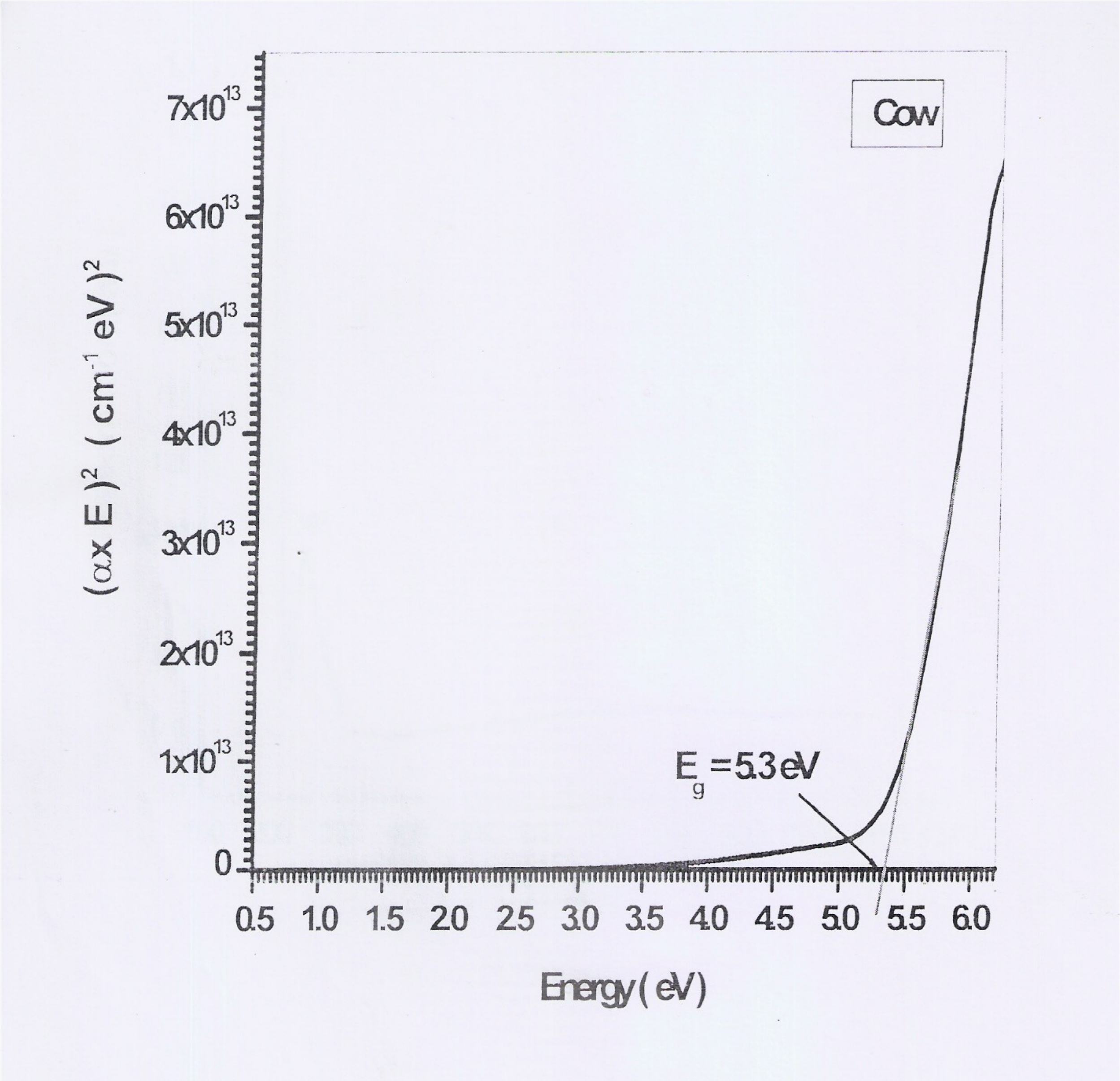


Fig (3.3.2.2) absorption against wavelength

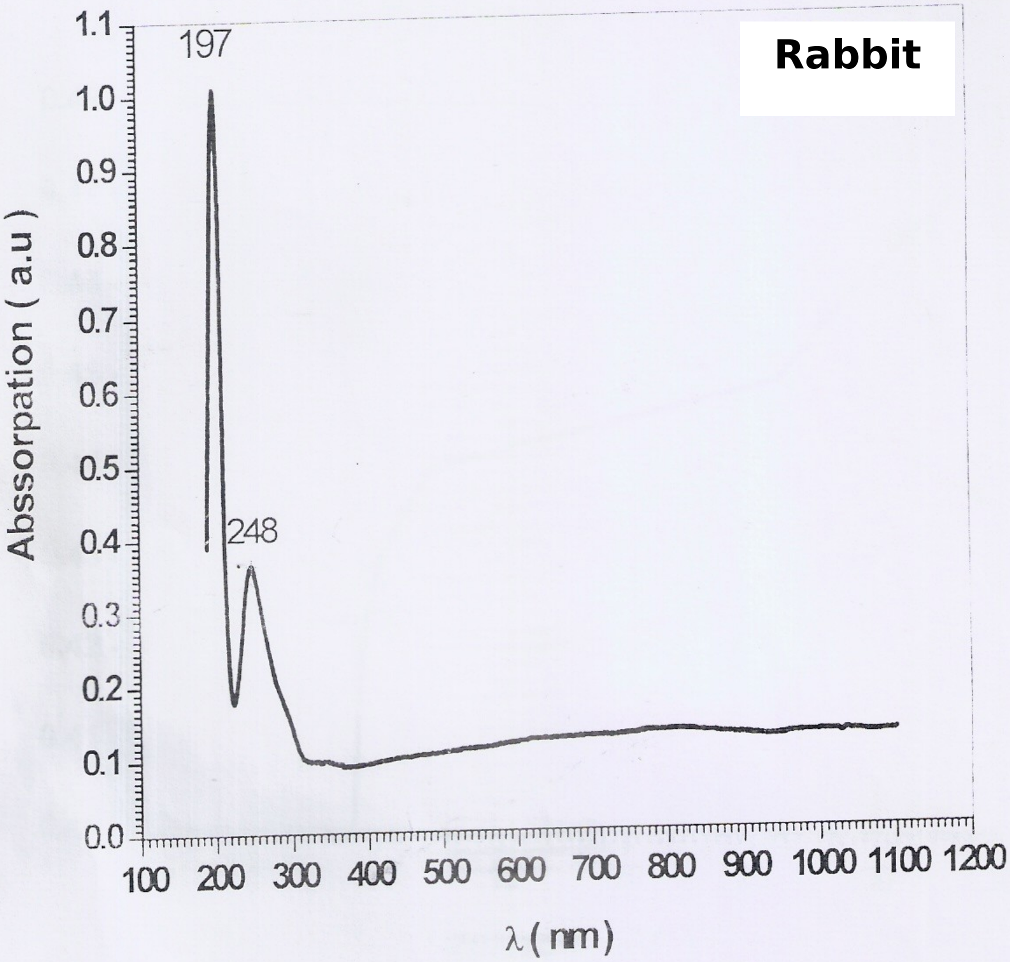


Fig (3.3.2.3) Absorption against wavelength for rabbit bone

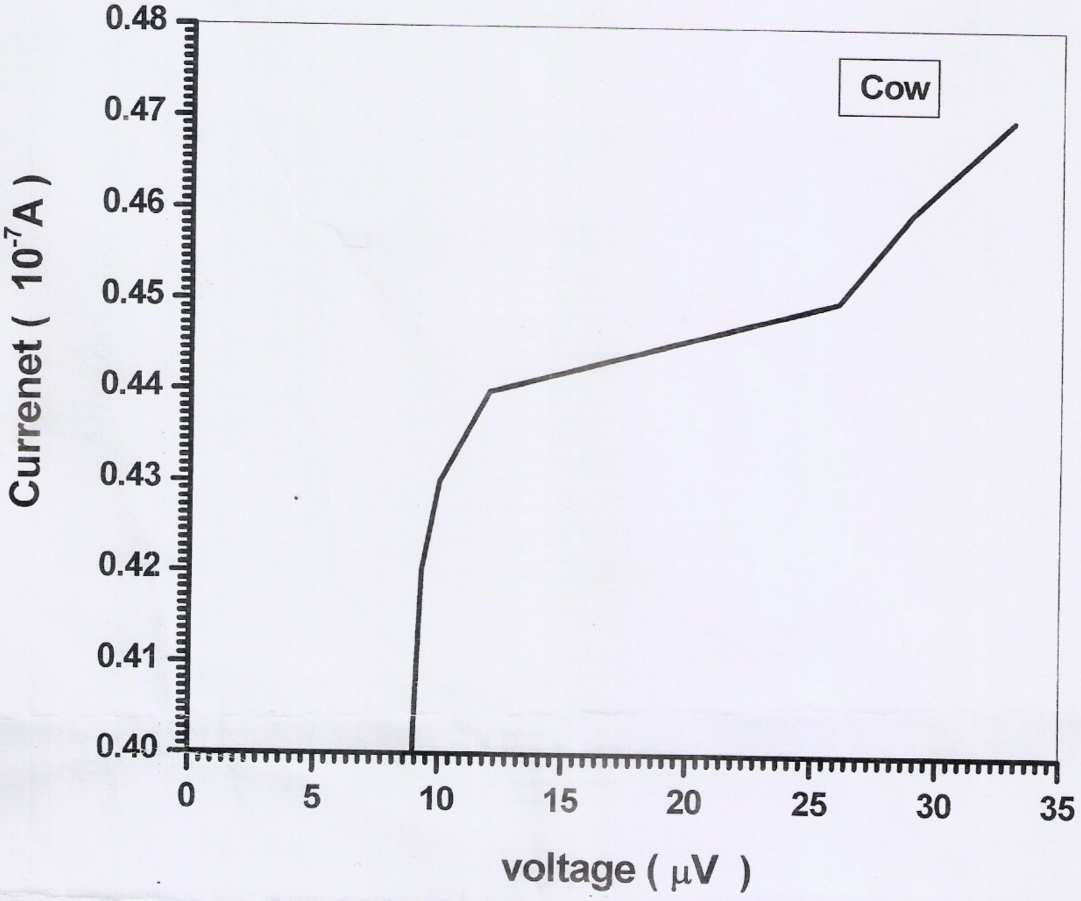


Fig (3.3.2.4): I against V for Cow

(3.3.3) Table for conductivity

(3.3.3.1) Relation of *I* against *V* for rabbit bones

Current	**Voltage**
0.42	21
0.43	22
0.44	31
0.45	33
0.46	34
0.47	39
0.48	41
0.48	42
0.5	43

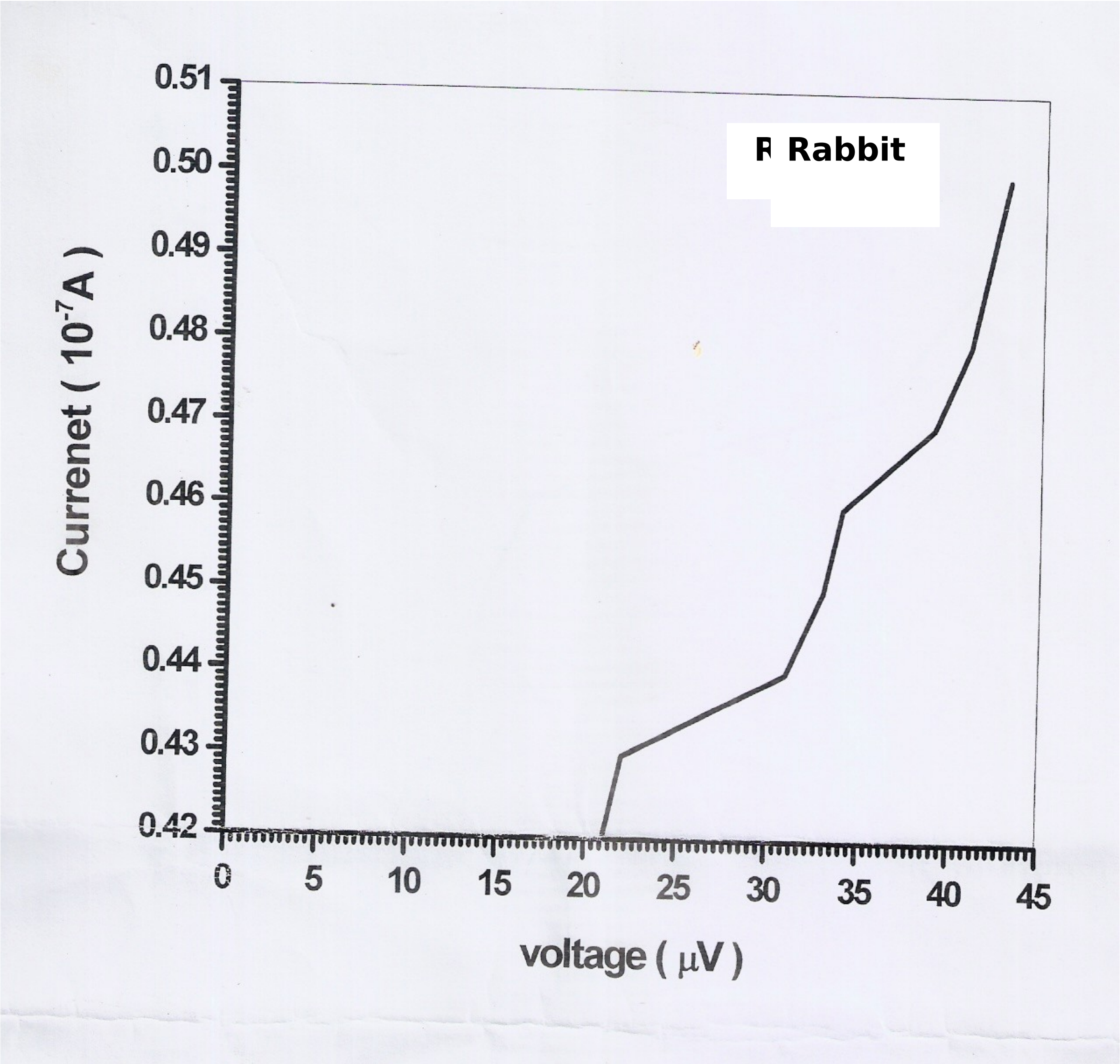


Fig (3.3.2.5): I against V for rabbit

(3.3.3.2) Relation of *I* against *V* for Caw bones

A	**V**
0.4	9
0.42	9.3
0.43	10
0.44	12
0.45	26
0.46	29
0.47	33

Chapter Four

Discussion & Conclusion

4.1 Discussion:

In view of fig (3.3.2.1) the energy gap of rabbit is 4.22 ev which indicates that Rabbit is an semiconductor. The absorption line for UV shows sharp beak around

λ 200nm

Corresponding to energy gap

$$\mathrm{Eg} \quad \frac{hc}{\lambda} \; 6\mathrm{ev}$$

However the result of I against V for rabbit shows narrow band gap of

$Eg = 50\mathrm{X}\, 10^{-6}\, volt$

The discrepancy in the result for UV and electrical method may indicate the existence of small amount of impurities that cannot absorb UV science radiation have small probability to reach them. However the electric current can have good chance to stimulate these impurities which have energy level very near the conduction band the above explanation holds also for the caw where fig (3.3.2.2) shows energy gap of $Eg \;\; 5.3\, ev$ obtained by UV techniques, while electrical techniques. In Fig (3.3.2.6) shows energy gap

$Eg \;\; 10\mathrm{X}\, 10^{-6}\, ev$

4.2 Conclusion:

The UV technique is powerful is determining the energy gap of matter, but is not sensitive for determination of donor or acceptor level. However the electrical method is more sensitive for determination of donor or acceptor level of impurities.

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