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Study of Beta Particles (β) Effect on Some of Mechanical and Physical Properties For Epoxy Resin Reinforced by (Fe) Particles.

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1-Abstract:

In this research, composite materials samples were prepared by using Epoxy Resin (EP-Polyp rime) as matrix, reinforced with Iron particles (Fe) with weight fractions (2%Wt), (4%Wt) and (6%Wt). And for radiation periods {[4] days (174.72Gy)}, {(8) days (349.44Gy)} and {(12)days (524.16Gy)}.Composite materials samples which prepared by hand-layup method. This research studied the mechanical and physical properties as Hardness, Thermal Conductivity and Dielectric strength before and after irradiation of samples by Beta particles (β^-) or (e^-) by using the Strontium source (Sr90) with energy decay of beta particles (0.546Mev) at dose rate (1.82Gy/hr) Results showed that the reinforced blends with (Fe) better mechanical properties Hardness, Thermal Conductivity and decrease of the Dielectric Strength.

Keyword: (Fe) particles, β particles, Epoxy resin.

2-Introduction:

The use of composite materials a turning point in our time a major transformation due to its material from these several characteristics that led to the approach to be used widely in various fields. It is these qualities costly manufactured low-lying as well as its strength , durability and low density , high thermal and electrical isolation and resistance to chemicals , moisture and corrosion resistant and posed different shapes and sizes and high its Hardness[1].Paying attention to the production of composite materials and development have increased access to the results and get a high material specifications for physical and mechanical properties , and low cost. This prompted many scientists and researchers to carry out studies and research focused much experience included many types of composite materials and testing physical , mechanical and chemical properties .The newly intrigued scientists irradiating composite materials with many types of radiation rays Gamma , Beta and X-rays and Ultraviolet rays and neutrons. In (2011) prepared a researcher HaiderSalim study dealt with the effect of beta rays and gamma on the particle distribution of composites materials, lead and conclude that the polymers have the best protective barrier from gamma rays and show him as well as the mixture of(PU / EP) best stabilizing rays gamma him to beta rays[2].In the same year conducted a researcher (Kunal) discussed included the study of the influence of the thermal conductivity of the composite material subsidized (Fe) particles where he noted that the thermal conductivity has been improved by(18.5), and Article resultant can be used in various applications such as thermal paint and insulate electrical cables[3].In the year (2013), a promising researcher (Turgay) and his search ate the effect of x-ray and gamma tests and neutrons on the imbricated epoxy and remnants of iron (Epoxy-Ferrochromium Slag) turned out for them increased susceptibility article overlapped on the prevention of radiation energy when increasing the remnants (Fe) particles on epoxy[4].In (2015) conducted a researcher Abdul Hadi study the mechanical properties of the epoxy resin (Fe) particles and the results showed that the hardness increased to increase the concentration of (Fe) particles after immersion in water samples , the results showed a decrease in hardness values[5].This research aims to use beta emitted particles from the source of Strontium (Sr90) and the study of their effective on the composite materials that has been manufactured by the researcher and composed of epoxy resin reinforced by (Fe) particles and the different effective on thermal conductivity and hardness and dielectric strength

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before and after irradiated and different periods of time.

3-The theoretical side:

3-1 Epoxy Resin: Epoxy is a Greek term consists of two syllables are (EP) and the mean and the (oxy) and mean oxygen and containing epoxy resin on one or more of the groups (Ecocide group) , which represents the basic unit of epoxy resin ,the simplest his formula is (Oxirane) as it represents a compound in the form of a loop consisting of an oxygen atom linked with two of carbon atoms with each other, The epoxy resin solidifies within temperatures ranging between (5-180C0) and can be thermally stabilized to a temperature of up to (250 C0),There are no volatile materials during the hardening process , and this trait characterized by epoxy resin on the most hardened thermoplastic resins [6].Epoxy resinis characterized by ability to adhesion and does not need high pressure a long time and also features as small shrinkage and has a high mechanical specifications to withstand high stresses inflicted it,It also features a well that is good Electrical insulation properties of epoxy resin and is one of the most common resins used as the basis of (Matrix) in the composite materials since he has the physical and mechanical properties that distinguish it from the rest of the other hardened resins [7] .

3-2 Hardness: It called on the hardness property as resistant solid material to cut, scratching and penetration. It can also be defined as the resistance of the material bulging and itching and scratching by the number of machines more than hardness ones, which enable it to retain its surface intact together under the influence of external forces so that permanent deformation does not occur in the latter [8].Hardness of materials depends on the type of power Association of molecules or atoms on the surface and the type of material you want to measure the hardness and temperature and other conditions affecting it [9].It is noted that the hardness of materials influenced by the type of solutions that exposed this material values [10]. and the hardness of materials measured in the previous propensity to cut other materials the one who cut the other one is the most hardness .

3-3Dielectric Strength: Called on the maximum electric field is applied to the Insulating material without collapse is resistance of the insulator and also called(Dielectric Breakdown Voltage(.On this basis, the most important qualities that must be taken into account when choosing the insulator is the extent of carrying insulation voltage electric without collapsing .If polymeric material and put it in the electrostatic field it does not pass permanent current but stored energy in the form of material insulation as a result of polarization, Thus, the insulator works as a battery stored energy despite the presence of the leak of the current even in the best insulators [11].The insulating materials in the property collapse in the strong electrostatic fields and field intensity causing the collapse called electrical insulation severity or intensity Electric (Ebr) which is inversely proportional to the thickness (d) of the material, has been the collapse occurs in the lower level of the level of electrical insulation intensity of the measured result of the accumulation of energy, according to the following equation: $Ebr=V\_br/d$ (1)

Where represent (Vbr) voltage collapse, though the intensity of the electrical insulation (Ebr) be significant for several polymeric insulators, The upper limit depends on the severity of the dielectric material on the ionization energy,Electrical breakdown occurs when still electrons from the atoms belonging to her, and this causes a minor collapse sooner or effect [12] .There are influential external variables on unarmed force of which the shape and size of the electrodes used in the field of application and the temperature of the model and frequency voltages and relative humidity.This should reduce these factors for the purpose of obtaining the area of the collapse of the value of accurate [13].

3-4Thermal Conductivity: One of the main physical characteristics would be described composite materials are thermal conductivity property , which is one of the phenomena of heat transfer,And where the heat is moving from one location to another because of the difference in temperature(the fluctuation of molecules Article)Therefore, it can define the thermal conductivity of the material as the material susceptibility to heat conduction and usually expressed by a factor of thermal conductivity (K).The phenomenon of thermal conductivity are subject to the law of Fourier thermal connected shown in the following equation:

Q=-KA dT/dX) 2)

where:

Q: amount of heat transmitted (J / Sec), K: thermal conductivity coefficient (W/m.ko) A: sectional area perpendicular to the direction of heat transfer (m2).(dT/dx): the thermal gradient in the conduct medium(k°/ m) [14].

3-5Radiation effect in Polymer properties:

The high-energy nuclear radiation have a clear impact in polymeric materials due for successive operations where motivates Particles and ionized and emits electrons speeds are relatively low-lying , which in turn leads to attack other molecules and generate the largest number of new ions. It gets two types of interactions , the first (Degradation) series , which in turn leads to a decrease in tensile strength and elongation and the second (Cross-linking) chains which increase the tensile strength and elongation reduce [15] .

3-6 Change of Physical Properties:

To change the color of the polymer during irradiation depends on the temperature at which the irradiation and then being on the user's radiation and the amount of radiation and the irradiation type. As for the radiation effect on the thermal properties When exposing the composite materials to the effect of radiation will not affect the behavior of the thermal conductivity as a function of temperature as the thermal conductivity values continue to grow with high temperatures until the degree of access to the glass transition , which then decreases the thermal conductivity values.The reason is that the impact of radiation contributes to the increase for the process of cross- correlation and the more compromising material polymeric radiation will increase the cross-Linking of the polymeric chains with each becoming more and more polymer hardness period,as the free radicals resulting from the collision of radiation with atoms Article overlapped will be a contributing factor in the increased values thermal conductivity [16].

3-7 Change of Mechanical Properties:

The process of irradiation of polymers lead to a change in the mechanical properties have this amount of change over for any of the processes of decomposition and tangles depends (cross- linking),When the decomposition process for making polymeric chains short and weakens the internal structure of the polymeric composite materials,It becomes fragile and less tensile strength between molecules and increases its density due to increased its crystals This leads to a decrease in Yong modulus,But when you get cross-linking process of standing, branching chains and increasing composite materials hardness and less susceptibility melt and increase the tensile strength and you get an increase in Yong modulus[17].

4-The practical side:

4-1 The Matrix Material: Was used in this research epoxy resin Type (EP-Polyp rime) factory by a company (Henkel) UAE as a matrix in the preparation of composite materials, and the advantage of epoxy resin being a transparent liquid and viscous with a density (1300 kg /m3) turns epoxy resin to the solid state after adding Hardener the type Matavnlen Damon (MetaphenylenDiamine) (MPDA) and the factory of the same company and by (2:1).

4-2 Reinforcement Materials: Was used in this research (Fe)particles as a reinforcement Material which is made from the company (BDH British) and the density of(7.8gm/cm3)and atomic weight (55.85gm/mol) it has been used in reinforced the epoxy resin and characterized these particles high mechanical characteristics but more roughness of copper particles, these particles have been used in this research different weight fractures.

4-3Samples Preparation:

In this research method was used (Hand lay-up molding) in the preparation of polymeric complexes, one of the easiest ways and common use, Where the user has been the creation of the mold cast composite materials will then be put on thermal paper , glass base of the mold and under the strips to prevent the adhesion of glass mold base model. After that a matrix was the weight of the foundation and the additive using sensitive electronic balance type (Sartorius) and manufactured by the company (Sartorius German) who fumbles for four places (0.0001gm),After that has mixing epoxy resin genitive its hardener process and by mass equivalent (1:2) with (Fe)particles thoroughly mixed using a blender, Then pour a little of this mixture is homogenized on the block (base) glass and on a regular basis, Where Pour the mixture into the mold homogenized center and slowly seeps into the mixture to all points of the mold and evenly until it is filled template size fully to get the desired thickness (4mm),And then leave for the model (48) hours in the atmosphere of a room in order to be solidifies, Then after the expiration of the (48) hour samples are placed in a convection oven and temperature (50C°) for a period of (6) hours to complete the process of hardening and cross-linking chains. After that samples were examined thermal conductivity in a circular cutting diameter (40mm). And cutting samples examined hardness and dimensions (20mm×10mm). And cutting samples examine the dielectric strength and the dimensions (55mm×10mm). After that, anti-aliasing samples refrigerant iron and silicon carbide paper to get the standard dimensions.

5- Hardness Test Results for (Fe) Samples Before and After (β) Radiation:

From table (1) , which shows the hardness values of (Fe) samples for natural state (without irradiation) and periods of irradiation (4 ,8, 12) days and from (Figure 1).

No.	Sample	Hardness ?? ?????			
		Normal Condition	Irradiation Time (day=43.68Gy)		
		0	4	8	12
1	$Fe_{(2gm)} + Ep_{(98gm)}$	65.666	74.333	77.5	78.83
2	$Fe_{(4gm)} + Ep_{(96gm)}$	72	74.333	78.3	78.5
3	$Fe_{(6gm)} + Ep_{(94gm)}$	72.666	78	80	81

Table(1) represent the hardness values of (Fe) samples before and after radiation

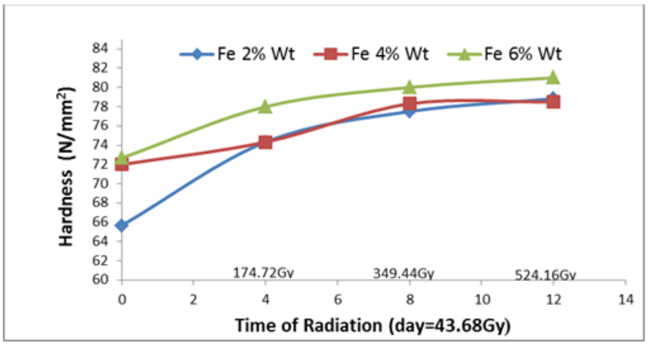

Figure (1) represents a Shore hardness of (Fe) samples as a function of the time of irradiation

Results show that the highest value for the hardness of a sample of (Fe) No. (1) of the weight fraction (2%Wt) was when the irradiation (12) days , reaching the value of hardness to (78.83N/mm2) and the lowest value for hardness appeared in normal conditions (without irradiation), where the results showed that the value of the hardness was (65.666N/mm2).But when analyzing the results of a sample of (Fe) No.(2) of the weight fraction (4%Wt) has been shown that the highest value for hardness was for a period of irradiation (12) days , reaching the value of hardness then to(78.5N/mm2),while the lowest value for hardness was when the situation natural (without irradiation) and then the value of hardness (72 N/mm2).But when analyzing the results of a sample of (Fe) No. (3) of the weight fraction (6%Wt) it has been shown that the highest value for hardness was at a period of irradiation (12) days , reaching the value of hardness to (81N/mm2),while the lowest value for hardness was when the natural state (without irradiation) as the value of hardness (72.666N/mm2). As shown above, to us that the hardness of the composite material reinforced by(Fe) particles is increasing with increasing periods of irradiation. Results from the previous adopt us that hardness increases with the irradiation of samples of iron (Fe) using isotope Strontium (Sr90) radioactive particles negative beta (β-) or (e-) and a half-life (28.8 y).To explain this, we can say that the beta negative or electron differs from the interaction of photons (□-ray, UV, X-ray,) with the material, as the beta particle or electron passes a series of collisions with the material and then can be stabilized in the beam interaction the medium, during passing through the ionization process occurs in the

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medium to be stabilized or come out of it if the sample thickness less than (3mm).This kind of interaction with the polymer can lead to disintegration of the polymeric chains and re-(cross-linking) and as a result of this series of collisions in each collision will lose the electron part of the energy to be able to stability within the medium has been given enough time to form crystalline regions within this composite material has led to an increase degree of crystallization and then increase in (cross-linking) and this in turn has led to increased hardness. The increase in collisions series through which loses beta particle negative (e-) energy in the form of phases of (dE/dX) in the medium that can ionize the largest increase the time period for irradiation is happening and that means a greater number of rays negative beta and more electrons (e-), which settles in the material leads to disintegration the polymeric chains more and re-(cross-linking) in a greater or fences be crystalline regions within the composite material, and this leads to increase the degree of crystallization and increased cross-linking and this in turn leads to increased hardness. And to discuss the hardness property increased the weight fraction in the case of reinforced by(Fe)particles after it has been read and hardness values for each point several times and then average the readings made for the purpose of obtaining high precision results and Figure (2) below.

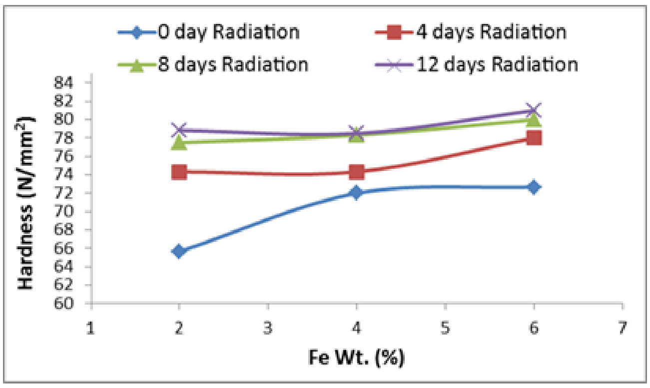

Figure (2) represents a Shore hardness of (Fe) samples as a function of the weight fraction

Notes from the previous figure increased hardness of samples of (Fe) values increased weight fraction. An reason for this is due to the volume of particles used in reinforcement the matrix was the size (100 µm)where these particles be of high mechanical properties easy to penetrate the process inside the matrix during the manufacturing process leading to a two-way bridge voids formed during the preparation of composite material operation which in turn leads to increased contact area between the components of the prepared composite material thereby increasing interdependence among themselves and in an integrated manner , leading to the strong linkage at the interface between the epoxy and particles of iron (Fe) , which led to better readings when checking hardness.

6- Thermal Conductivity Test Results for (Fe) Samples Before and After (β) Radiation:

From table (2), which shows the thermal conductivity of the samples (Fe) particles natural state values (without irradiation) and periods of irradiation (4,8,12) days and equivalent radiation dose (174.72Gy)and(349.44Gy) and (524.16Gy) respectively under the effect of beta rays.

No.	Sample	Thermal Conductivity (w/m.k°)			
		Normal Condition	Irradiation Time (day=43.68Gy)		
		0	4	8	12
1	$Fe_{(2gm)}+Ep_{(98gm)}$	0.206491	0.276034	0.294830	0.309978
2	$Fe_{(4gm)}+Ep_{(96gm)}$	0.266034	0.353224	0.374071	0.386819
3	$Fe_{(6gm)}+Ep_{(94gm)}$	0.286285	0.376971	0.393224	0.404898

Table (2) represent the thermal conductivity values of (Fe) samples before and after radiation

And Figure (3). Results show that the higher the value of the thermal conductivity of a sample of (Fe) No.(1) with the weight fraction (2%Wt) was a period when irradiation (12)day son which amounted to (0.309978w/m.ko),while the lowest value appeared in normal conditions (without irradiation), where the results showed that the value of the thermal conductivity was (0.206491w/m.ko).But when analyzing the results of a sample of (Fe) No.(2) of the weight fraction (4%Wt) it has been shown that the highest value of the thermal conductivity was for a

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period of irradiation (12) days , reaching the value of thermal conductivity then to(0.386819w/m.ko) while less valuable when it was the natural state (without irradiation) and the value of the thermal conductivity then (0.266034w/m.ko).But when analyzing the results of a sample of (Fe) No.(3) of the weight fraction (6%Wt) has been shown that the highest value of the thermal conductivity was at the period of irradiation (12)days on which amounted to (0.404898w/m.ko) , while the lowest value of thermal conductivity when was the natural state (without irradiation) where worth (0.286285w/m.ko).

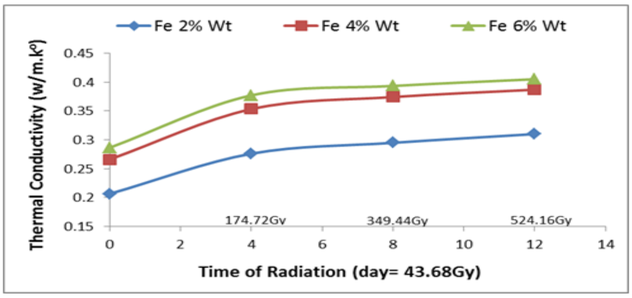

Figure (3) represents thermal conductivity of (Fe) samples as a function of the time of irradiation

As shown above, for us to thermal conductivity of the composite materials reinforced by(Fe) particles is increasing with increasing periods of irradiation. an reason for this is due to the negative interaction of beta particles (β-) or (e-) with composite materials. Which led to the disintegration or biodegradable polymeric chains or led to the cross-linking of molecules , which explains that the rays negative beta , which is a high-energy electrons with the electrons would lose energy in the medium as a result of a series of collisions In the end, these electrons will settle into the medium and that while passing in the middle, leading to the occurrence of ionization in the atoms or molecules that the medium and the loss of energy by (dE/dX) of any energy per unit length loss and which could lead to break ties and removing the hydrogen atoms from the totals (CH3, CH2, CH) and the formation of new chains , while retaining some of the original characteristics leads to change attributes based on polymeric chain length (molecular weight) due to the composition of (Cross-Linking) produces by complex combinations of these compositions is responsible for increasing the thermal conductivity of the composite materials with increasing duration of irradiation. And to discuss the thermal conductivity increased the weight fraction in the case of consolidation (Fe)particles and figure (4).

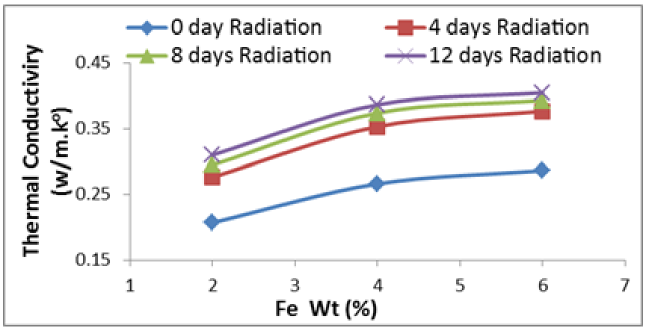

Figure (4) represents a thermal conductivity of (Fe) samples as a function of the weight fraction

Notes from the previous figure increased thermal conductivity of samples of (Fe)increased the weight fraction[18], that the reason for this is due to the heterogeneous distribution of theseparticles, and this in turn led to the parity in the number of electrons unit volume, which in turn led to the lack of difference in the density of points per sample and this in turn, led to the lack of variation of the values of the thermal conductivity of some samples per series coefficient in addition to the lack of the presence of gaps and pores in the samples and this in turn has led to increased stacking density as well as increased seam metal surfaces minutes. All these factors led to the increase of thermal conductivity coefficient of the samples increased the weightfraction.

7-Dielectric Strength Test Results for (Fe) Samples Before and After (β) Radiation:

From table (3), which shows the Dielectric Strength of the samples (Fe) particles natural state values (without irradiation) and periods of irradiation (4,8,12) days and equivalent radiation dose (174.72Gy)and(349.44Gy) and (524.16Gy) respectively under the effect of beta rays.

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No.	Sample	Dielectric Strength kv/mm			
		Normal Condition	Irradiation Time (day=43.68Gy)		
		0	4	8	12
1	$Fe_{(2gm)} + Ep_{(98gm)}$	11.481	9.68	9.11	8.5
2	$Fe_{(4gm)} + Ep_{(96gm)}$	11.2	9.493	8.52	6.5
3	$Fe_{(6gm)} + Ep_{(94gm)}$	9.787	8.219	7.2	7

Table (3) represent the Dielectric Strength values of (Fe) samples before and after radiation

And from Figure(5) . Results show that the highest value for the dielectric strength of a sample of (Fe) No.(1) of the weight fraction (2%Wt) was at the natural state (without irradiation) which amounted to (11.481kv/mm) The lowest value appeared in the period of irradiation (12) day where the results showed that the value of the dielectric strengthwas (8.5kv/mm).But when analyzing the results of a sample of (Fe) No.(2) of the weight fraction (4%Wt) has been shown that the highest value dielectric strength was when the natural state (without irradiation),reaching the value of the dielectric strength then to (11.2 kv/mm), while its minimum value It was at the period of irradiation(12) days and the value of the dielectric strength then(6.5kv /mm). But when analyzing the results of a sample of (Fe)No.(3) of the weight fraction(6%Wt) has been shown that the highest value was at the natural state(without irradiation)which amounted to(9.787kv/mm),while the lowest value was when the irradiation(12)days where the worth (7kv/mm).

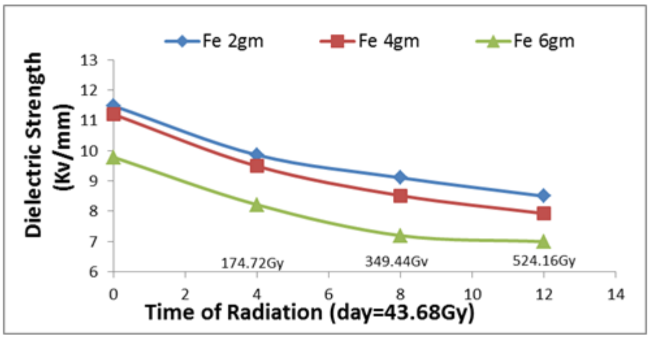

Figure (5) represents Dielectric Strength of (Fe) samples as a function of the time of irradiation

As shown above, to us that the dielectric strength values of composite materials reinforced by (Fe) particles decreases with increasing periods of irradiation. From the above study this axis included the study of the dielectric strength as a function to the time of irradiation and periods of different irradiation .The irradiation process led to a decrease in the dielectric strength and the reason is because the rays negative beta which are electrons high-energy words these electrons will lose energy in the medium, as a result of a series of collisions in the end will settle these electrons inside the medium and that while passing in the middle, leading to the occurrence of ionization in the atoms or molecules that the medium and the loss of energy by (dE/dX) of any energy per unit length loss, which could lead to break the bonds or the forces that bind of composite materials, which are classified into two types:

a-Covalent Bond: It a vast majority in the polymers and be responsible for polymeric chains any atoms that connect the structural units with each link and these bonds broken by the high-energy beta particles, which in turn leads to generate free roots inside the composite materials leading to a decrease in the dielectric strength of these materials increase the period of irradiation.

b-Secondary forces: They are many kinds of molecules bind composite materials exist between parts per series and know the forces between the composite materials powers (Vander alls)effect on the physical properties of composite materials .This forces shattered by the high- energy beta particles, which in turn lead to a decrease in the strength of the dielectric strength. And to discuss the dielectric strength to increase the weight fraction in the case reinforced by(Fe)particles and Figure (6).

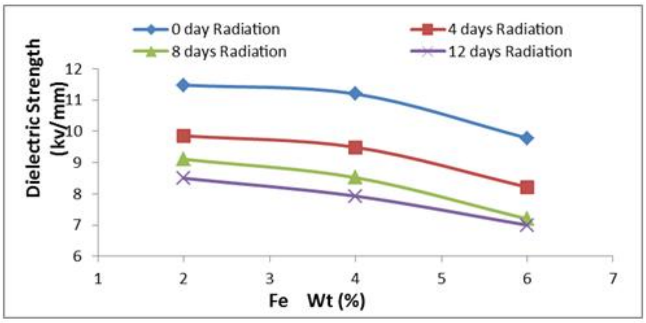

Figure (4) represents a Dielectric Strength of (Fe) samples as a function of the weight fraction

It showed results set forth in the preceding formats decreasing dielectric strength for samples of (Fe) and all the cases and that the values of this decrease exponentially with the increase shows the weight fraction when the composite materials reinforced by (Fe) particles . The reason for this is due to the strong linkage in the case of reinforced by (Fe) particles too big for that note with increased voltages article maintains composite materials reinforced by (Fe) particles on decreasing the strength of the insulation exponentially.

8-Conclusions:

After research and study on the composite materials samples prepared from epoxy resin reinforced by (Fe) was reached the following conclusions:

1-Hardness and thermal conductivity of the samples prepared in this research values increase with increasing weight fraction reaching the highest values of hardness and thermal conductivity for(Fe) particles at weight fraction (6%Wt). Also, the hardness and thermal conductivity of the samples prepared values in this research increases with increasing duration of irradiation particles beta negative (β-) or (e-), reaching the highest values of hardness and thermal conductivity of (Fe) particles when the irradiation (12) days that the reason for this is due to the cross-linking accidental molecules epoxy resin on the one hand and metal particles on the other.

2-The dielectric strength of the samples prepared in this research values decrease with increasing the weight fraction reaching the highest values of the dielectric strength for(Fe)samples at weight fraction (2%Wt), and that because of that those particles increased the electrical conductivity of the samples process by filling in the blanks and gaps formed during the preparation leading process to decrease the distances evidence samples prepared and thus lower the dielectric strength to those samples. While dielectric strength of samples prepared in this research values has been shown that it decreases with increasing period of irradiation by particles negative beta (β-) or (e-), reaching the highest values for dielectric strength for (Fe) particles when the natural state (without irradiation).

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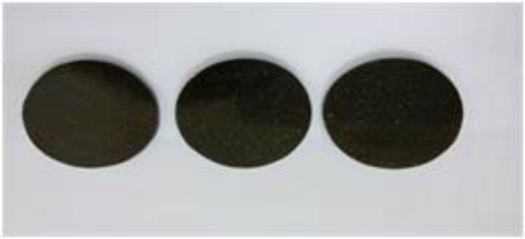
1.

Fig(7) represents Hardness test of(Fe) samples

Conductivity. (2%, 4%, 6%)Wt.

2.



Fig(8)represents Thermal test of (Fe) samples (2%, 4%, 6%)Wt.