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STUDY THE EFFECT OF ADDING CUSO4 ON THE STRUCTURAL PROPERTIES AND MECHANICAL SPECIFICATIONS OF LOW DENSITY POLYETHYLENE

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Abstract

Polymer composite materials were manufactured The base material was made of low-density polyethylene using the thermal fusion method and supported using $CuSO_4$ powder, which is in the Nano-form and in volumetric ratios by adding (5,10,15,20,25), the manufactured models were thermally treated for three periods (3,6,9) and at temperatures (40,60,80). The models were subjected to a set of mechanical tests that include (shear stress, compressive strength), X-ray diffraction (XRD) and scanning electron microscopy (SEM) examinations. Mechanical properties, where a state of filling the voids occurs regularly and effectively, and this percentage was within the 15%, in addition to the temperature, which played a major role in improving some of the polymeric properties shown by the mechanical properties of the manufactured composite material.

The results of improvement and the change in properties of polymeric materials begin with a gradual increase in temperature, as it shows a change in the mechanical properties of the manufactured composite material. The X-ray spectrum showed that the presence of the common system between the used nanocomposites and the polymeric material does not cause the blocking property in the emergence of phases, as this result is confirmation of the survival of the material as a common high-crystalline nanomaterial within a system of multiple

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materials with spectra closer to continuous spectra, as between the spectrum of X-ray diffraction The presence of materials added to the base material in a nano form leads to the beginning of the disintegration of the elements and molecules of the components of the base material, due to the effect of the heat prepared for the model.
The manufactured models were subjected to scanning electron microscopy (SEM) examinations, in order to determine the structure and composition of the surface being the main part in which the material deals with the ocean. The high bonding between the common materials, which is evidence of a high surface energy. The results also showed that the surface structure contains cavities that the material can create in order to increase its ability to deal with external energies and absorb them, and the multi-layer structure means that the material organized itself in the form of aggregates It can be dealt with as separate units.

Keywords: LDPE, XRD, SEM, Reinforcement powders, Matrix

1- **Introduction**

In the six decades in which plastics have been manufactured for commercial use, more than 8.3 billion metric tons of plastics have been produced that are light, versatile, inexpensive, and virtually indestructible (as long as they don't warm up too much), and these properties make them incredibly useful in an enormous range. One of the many applications of plastics include sterile food packaging, energy-efficient transportation, textiles and medical protective equipment, but its indestructible nature has its cost as most of it degrades very slowly in the environment within several hundred years and this phenomenon is causing a global epidemic of plastic waste whose consequences are still on human and ecosystem health is not fully known but potentially dangerous. (Hashim, 2011)
Only 9% of plastic is recycled even though degraded plastic turns into microplastic particles that are found everywhere from the depths of the sea to mountain tops to drinking water, which has a very bad impact on the ecosystem on land and at sea. The levels of plastic materials described as waste have reached a stage called the Plastic Continent, where the estimated area of plastic dumped

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in the seas and oceans is close to the area of the Australian continent, which made it, due to cumulative factors, a major problem that cannot be postponed. (Amal, 2020) (Webb, 2012)

In light of the COVID-19 pandemic, the consumption of plastic materials has increased due to the extreme necessity to prevent the spread of diseases, as the general trend began to tend to single-use plastics, and supply chains came under pressure to meet the severely escalating demands on packaging materials, packaging and single-use medical supplies, and the opportunity increased as a result of the advantages The well-established characteristic of single-use plastic products that reduces hygiene concerns and extends the shelf life of fresh agricultural produce.

Bloomberg New Energy Finance (BNEF) expects that concerns about food hygiene due to the outbreak of the Corona virus may lead to an increase in the quantities of plastic materials such as those used in medical supplies and packaging materials, noting that this sudden rise in demand for plastic will be temporary and not It is supposed to cause a change in the long-term goals of the economy's dependence on recycled materials, and according to the authors' vision, the future will see continued reuse or recycling of all plastic materials, but plastic medical waste will have to be handled independently from other municipal waste, which has led many researchers to develop special studies in this regard in order to reduce the danger to the planet. (Gregors, 2020)

It included many researches in this field, including the study "Assessment of the Environmental Impact of Plastic Waste During the COVID-19 Outbreak and Integrated Strategies to Control and Mitigate it", where the study urged the use of bioplastics, which is an environmentally friendly option, and the replacement of plastic bags and face masks with cloth bags and masks, recycling plastic materials by chemical treatment to convert waste into useful materials or sterilizing these plastic waste with treated heat and ultraviolet rays for reuse.

2- Mechanical Tests:

Compressive Strength Check

Because of the relative weakness in the mechanical properties of polymeric materials and the ability of these materials to resist compression in particular, the Graseby Spesac manual hydraulic press was used. Make a simple modification on the capping surface of the model.

The following mechanism has been adopted for the compressive strength tests of the manufactured models.

1) The dimensions of the sample used in the examination are mm (5 x 30 x 30), and these dimensions are obtained with the same lathe machine mentioned in the previous paragraph.

2) Apply an initial (relatively little) pressure to the model for a duration of (5 min).

3) If the model bears this pressure and does not break, we increase the pressure gradually and for the same approved period of time.

4) At each stage of pressure increase, the model is replaced to ensure that the remaining stresses in the model do not affect the result of the initial examination.

5) The replaced models are of one origin, i.e. one model is cut into several models.

6) The value of the pressure at which the model broke, which represents the maximum value of the compressive strength, is recorded, as it can be calculated from the relationship (2).

Compressive Strength=pursue/Area=(W*g)/(Length*width)=N/mm^2 ...... (3-3)

W: equivalent mass of pressure applied to the model (kg)

g: ground acceleration (m/s2).

Length & width: Model dimensions (mm)

Shear Stress Check

In this type of test, a three-point deflection test was adopted, the parts of which consist of two cylindrical supports

They are both well-polished and made of stainless steel that sit on two slides that allow you to adjust the space between them by a graduated ruler, where the sample is placed on the two supports and then the load is applied gradually from the top by a cylinder with the same diameter and the same quality, and then calculate the shear stress using the relationship (3)

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S = (3PL)/(2Wt2).......(3)

whereas:

S: shear stress (MPa)

P: the applied load (N), which represents the force required to break the sample

L: the distance between the brackets (mm)

W: Sample width

t:sample thickness

3- X-ray tests: X-ray diffraction (XRD) is a versatile, non-destructive analytical method for analyzing properties of materials such as phase composition, structure, texture, and various powder samples, solid samples, or even liquid samples. (Al-Jubouri,2017)

X-ray diffraction tests were carried out for the manufactured models using a Dutch-origin Shematdzu type device, the tube used was (Cu)Kα and The temperature were (±25°C).

4- Electronic Microscope: In order to obtain a clear magnified image, the wavelength of the rays directed at the object must be smaller than its measurements. (Dunlap and Adaskaveg,1997)

Therefore, the wavelength of light must be determined, as the wavelength of visible light is between (380-750) nm, while the wavelength of the electron beam can be controlled and minimized to 3 nm, and its magnification can reach to a million times, and some electron microscopes can show even the circumference of separate atoms in one of the samples, and through it we will obtain more accurate images, the examination of the samples was carried out using a scanning electron microscope (SEM) type (TESCAN) model (MIRA3), the scanning electron microscope is distinguished from the rest of the optical microscopes by using electrons instead of light waves, as it gives a detailed and magnified three-dimensional image (3D) and the image is in black and white because it does not depend on light waves.

5- Results and discussion

Mechanical tests:

The results of mechanical tests showed that the base materials showed the ability to resist shear stresses after being reinforced with powders of nano-additives. The opposite direction, which leads to the occurrence of two cases; The first is a fracture in the material, or what is known as shear, and the second is the yield, which is represented by the response of the material under the influence of shear stress, and the model subject to this stress is deformed. And the shear resistance is a property in the material that makes it resist the shear stress on it, so it does not break or succumb to it. (Wang et al., 2020). The presence of reinforcing materials inside the base material means, from an engineering point of view, reducing the free spaces within these materials, which means increasing the obstruction or increasing the resistance to the movement of parts of the material when exposed to an effort that works to create a shear in the material, which leads to an increase in the material's ability to resist shear stress and thus An increase in the value of the shear stress that can lead to a fracture of the material or model. (Jorden et al.,2016) Therefore, we note that the base materials reinforced with powders of materials reinforced with different nanostructures showed greater resistance to shear stress, and the results in the previous figures showed that the shear stress resistance is generally close with different temperatures. This convergence in the value of the shear stress resistance within the same group can be understood on the basis of the nature of the composition or structure of the reinforcement material by the influence of temperature. Shear in it (containing and storing energy in the case of shear stresses is another form of understanding shear resistance, where shear stress resistance can be understood from the point of view of stored energies as the greater the material's ability to contain and store energy whose general source is the stress that works to cut the material the more The ability of the material to resist the separation of its parts and subject to fracture due to shear stress), in addition to the presence of these powders within the base materials will lead to a reduction in the separation distance between the polymeric chains, as the increase in the energy content leads to the convergence of the polymeric chains from each other and this convergence between the chains

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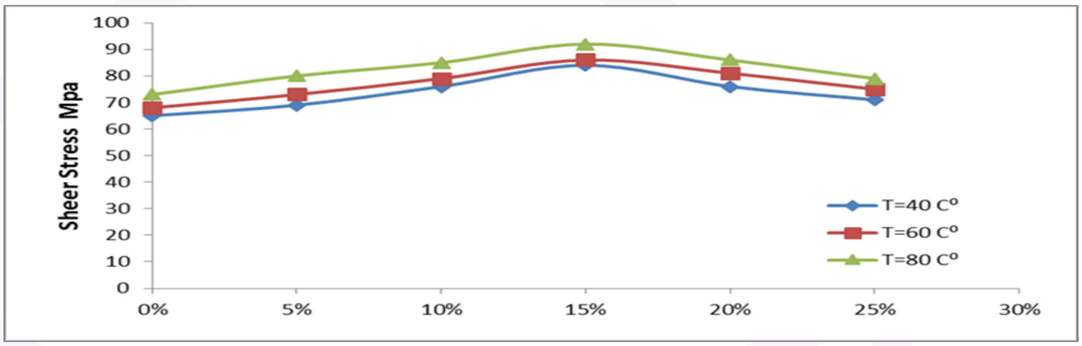
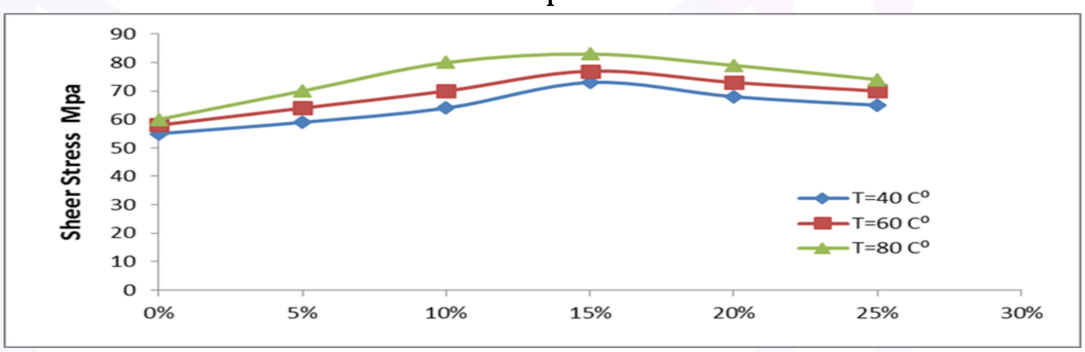
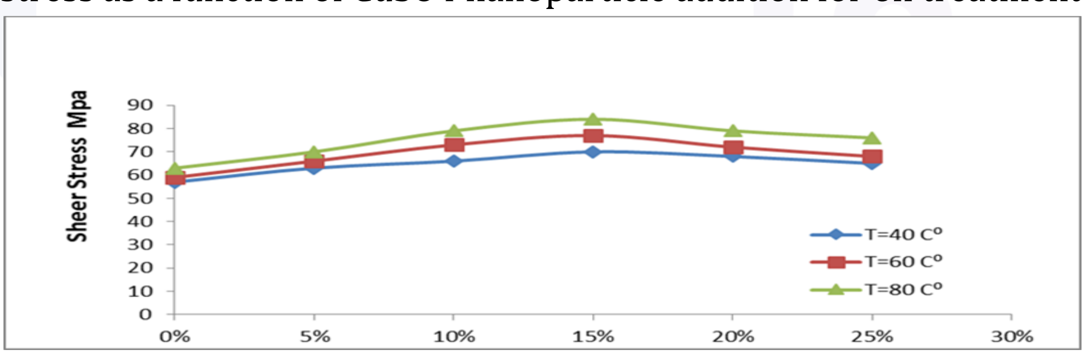
The polymerization will result in an increase in the ability of the base material itself to resist the separation of its parts due to the shear stress). The properties and composition of the material, as we see in the principle of thermal annealing, we find that the treatment of the material at a temperature of 80ºC led to a strong bonding between the molecules and components of the material, which led to showing the highest shear resistance in all models with different nano-reinforcement materials, which gradually decreases with the decrease in temperature.(yao et.al 2018)



Shear stress as a function of CuSO4 nanoparticle addition for 3h treatment time



Shear stress as a function of CuSO4 nanoparticle addition for 6h treatment time



Shear stress as a function of CuSO4 nanoparticle addition for 9h treatment time

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Figure (1) represents the shear stress values for models supported by $CuSO_4$ with different temperatures and different heat treatment

Compressive Strength Check

The materials supported by the additives in the form of nano-structured $CuSO_4$ sulfate, respectively, showed different temperatures. There is an improvement in the ability of the base material to resist compression, and this result that the base materials reached after being reinforced with additives in a nano form can be understood from the point of view that one of the most important factors that lead to enhancing the ability of the material to resist compression is the flawless compact structure and Continuity in the nature and form of its formation, this characteristic can be subjective, that is, it is by nature of a tightly compact structure, almost free from defects, with a wide range of continuity, and it is also possible that it is a characteristic that can be developed through formation processes, thermal and mechanical transactions, or through Additions in different ways (Wang et al., 2020). The presence of reinforcement materials within the substrate may lead to an increase in the agglutination of the polymeric chains as well as reduce defects within the structure of the substrate and lead to a kind of reinforcement for the engineering structure of the material (Krundaeva et al., 2016). All of these cases will lead directly to the development of the capabilities of the base material in resisting compression and to show a greater degree of the material's ability to maintain its shape and entity when exposed to loads that impose a compressive force on one or a number of its faces.

We also note that there is a critical percentage of the amount of material added to the base materials with a value of (15%), which gave the best result for the compressive strength of all groups and materials within the same group. Although the base material has a role in the emergence of this ratio, but in the case of the compressive resistance of the material, there is another factor that may have an impact on the value of this ratio. When exposed to the compressive force, it is in the stage of storing energy, and despite the enhancement of its continuity, it suffers from the problem of energy accumulation, which is unable to find suitable storage places in it, and this surplus of energy will lead to a kind of

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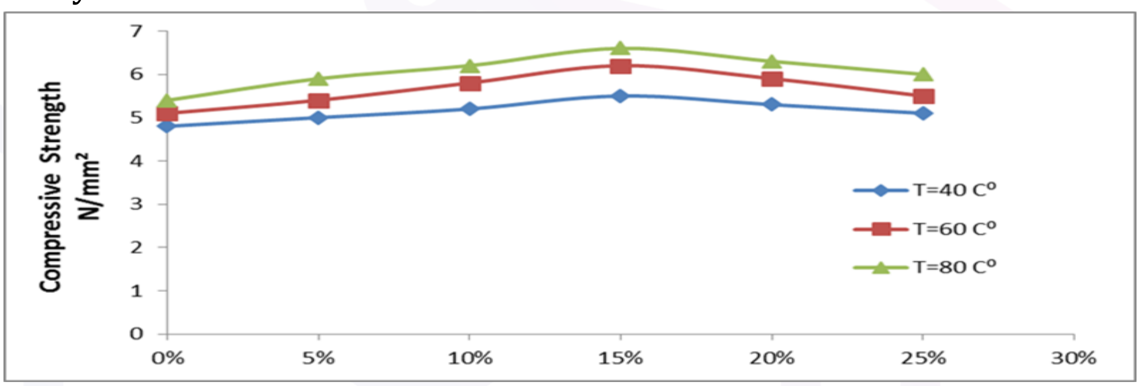
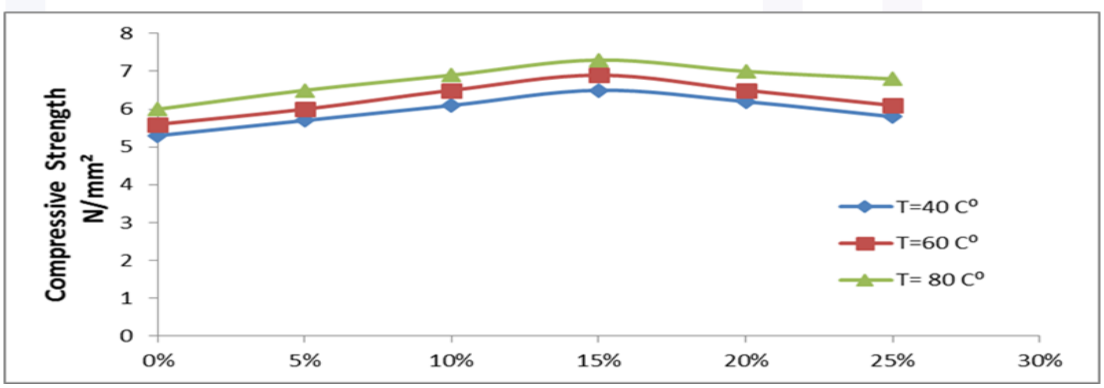
dismantling the link between The different parts of the material, which makes it unable to maintain its shape and shape when exposed to an external pressure factor, which means a loss or decrease in the material's ability to resist compressive strength, this case occurs when there is a heterogeneity in the amount of the additive to the base material (less or more than the ratio critical) (Al-Salem et al., 2009). Since the critical ratios of the amount of the additive give the best ability for the material to store or exchange the energy generated as a result of the compressive force, then we find that (15%) of the amount of the additive is the optimal ratio that suits the nature of the base material, as well as the best percentage that leads to the highest ability to Storage, distribution and exchange of energy, which is also the optimum ratio to achieve the best state of continuity in the material.



Compressive strength as a function of CUSO4 nanoparticle addition for treatment time (3 hours)



Compressive strength as a function of CuSO4 nanoparticle addition for treatment time (6 hours)

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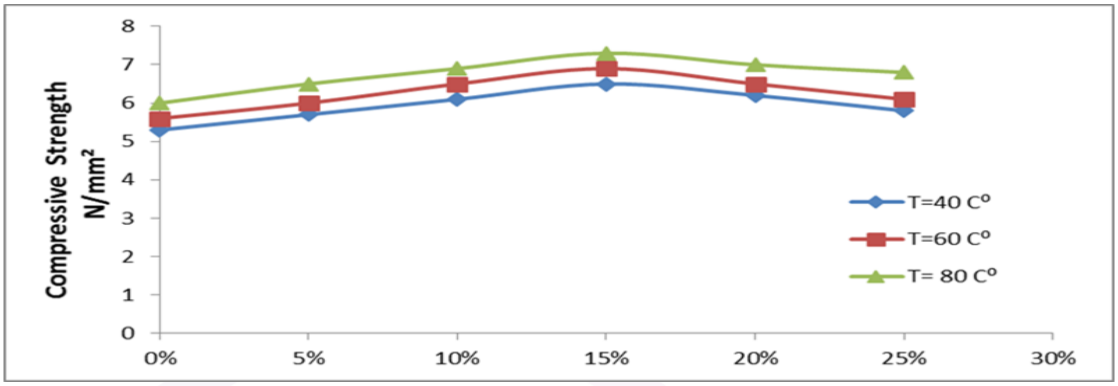

Compressive strength as a function of CuSO4 nanoparticle addition for treatment time (9 hours)

Figure (2) represents the compressive strength values of CUSO4 reinforced models with different temperatures and heat treatment periods

X-Ray Tests

Model CuSO4 + matrix

As for the results of the X-ray spectrum for all models, it initially shows a significant decrease in the background value, as it appears at first that there is no effect of the additive on the base material which appeared from the spectrum of the base material, which is in fact a linear spectrum that contains distinct peak locations and random regions and a large mid-bandwidth rate And the end of one minute.

With the increase in temperature, there was growth in some peaks, specifically the peaks that fall at the values of 2θ, which start at (25.3-73.244), This growth in the peaks means the beginning of a disintegration in the material, which means that the molecules in the material take on the random character if it is separated from the system and begins to form a crystalline phase, and when comparing the spectrum of the CuSO4 model with the spectrum of the base material (Matrix), we notice that there is a kind of change that is summed up in an increase in the width of the middle of the band at the beginning of the spectrum, which means an increase in the value of the quantum dote, which is a clear indicator for the beginning of the transformation of the material into larger sizes and the beginning of the change in shape and composition of the material.

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We also notice an increase in the width of the ends of the peaks, which is an indication of the weak crystallization of the material and another evidence of the beginning of the disintegration of the material, and the presence of a disturbance in the background value is an indication of the heterogeneity of the model system.

All of these observations indicate that the model began to give a response to the external influence, and that this effect turns into a state of disintegration or decomposition in the material.

The materials supported by the additives in the form of Nano-structured CuSO4 sulfate, respectively, showed different temperatures. There is an improvement in the ability of the base material to resist compression, and this result that the base materials reached after being reinforced with additives in a Nano form can be understood from the point of view that one of the most important factors that lead to enhancing the ability of the material to resist compression is the flawless compact structure and continuity in the nature and form of its formation, this characteristic can be subjective, that is, it is by nature of a tightly compact structure, almost free from defects, with a wide range of continuity, and it is also possible that it is a characteristic that can be developed through formation processes, thermal and mechanical transactions, or through Additions in different ways (Wang et al., 2020).

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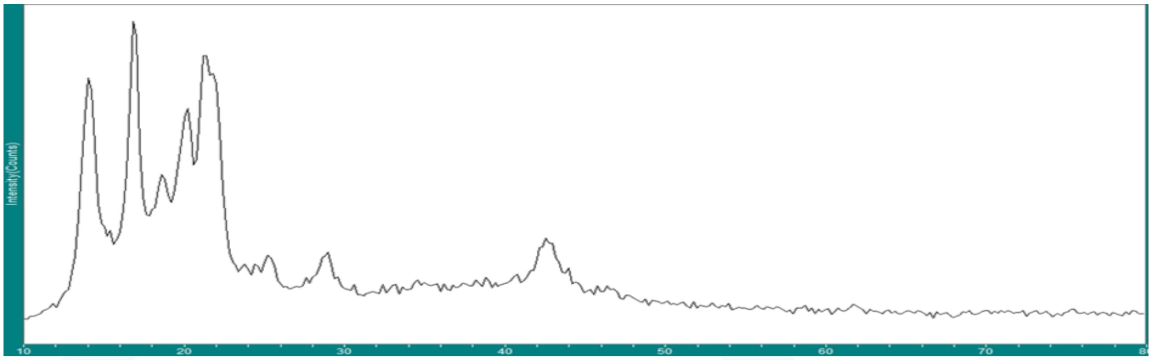

When exposed to the compressive force, it is in the stage of storing energy, and despite the enhancement of its continuity, it suffers from the problem of energy accumulation, which is unable to find suitable storage places in it, and this surplus of energy will lead to a kind of dismantling the link between the different parts of the material, which makes it unable to maintain its shape and shape when exposed to an external pressure factor, which means a loss or decrease in the material's ability to resist compressive strength, this case occurs when there is a heterogeneity in the amount of the additive to the base material (less or more than the ratio critical) (Al-Salem et al., 2017). Since the critical ratios of the amount of the additive give the best ability for the material to store or exchange the energy generated as a result of the compressive force, then we find that (15%) of the amount of the additive is the optimal ratio that suits the nature of the base material, as well as the best percentage that leads to the highest ability to Storage, distribution and exchange of energy, which is also the optimum ratio to achieve the best state of continuity in the material.

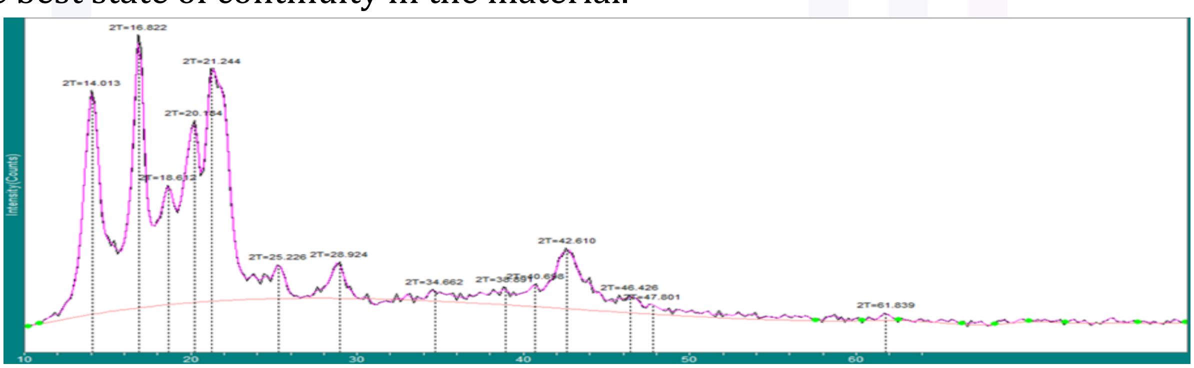

Figure (3) represents the X-ray spectrum of the Matrix.

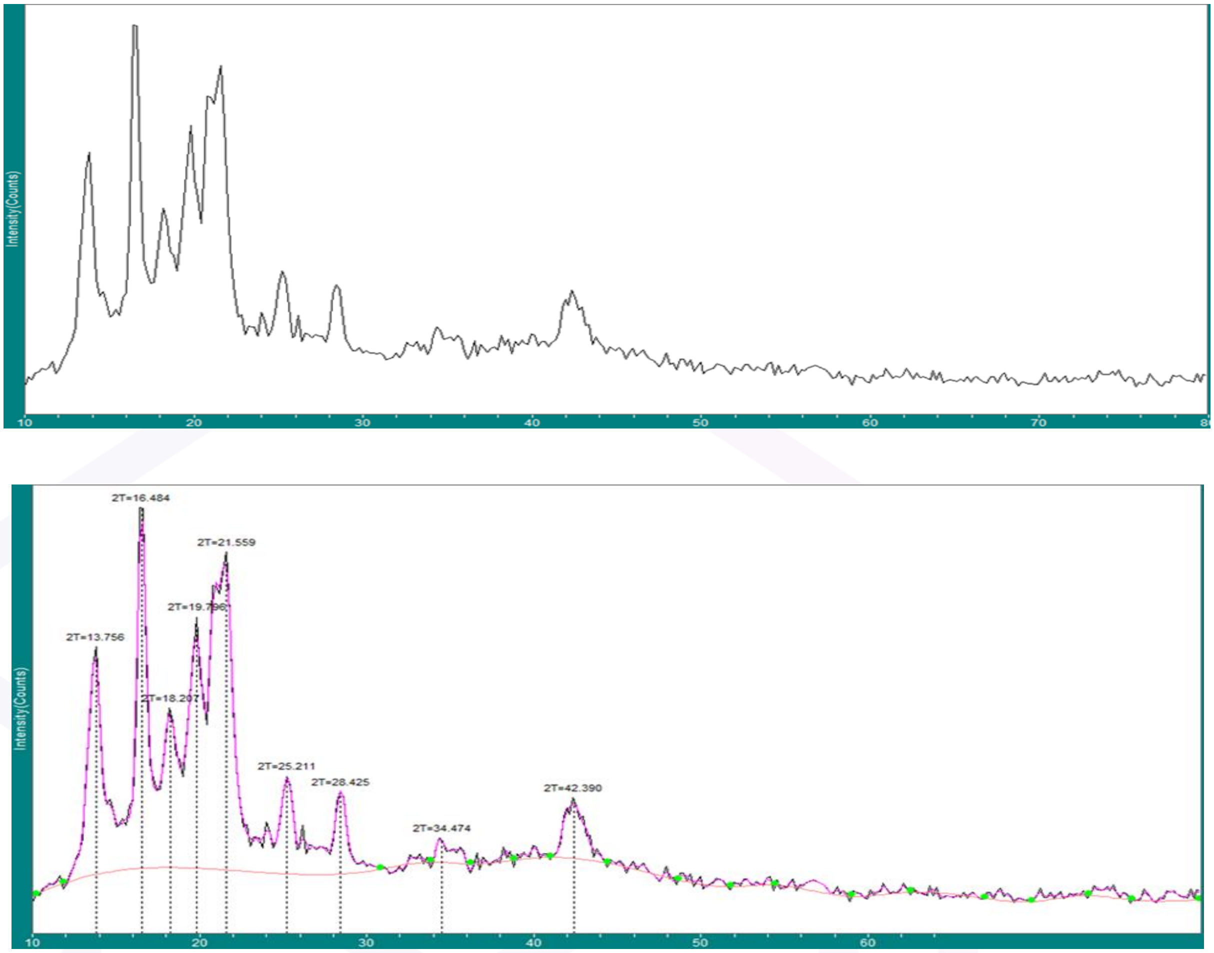

Figure (4) represents the X-ray spectrum of the matrix supported by $CuSO_4$ powder represents 15% at 80 Cº .

Electron Microscope Scans

$CuSO_4$ model

We can see note from the phases appearing in the above model the appearance of quantitative diameters ranging between (25.53-40.0) and this result is expected because copper sulfate is one of the non-overlapping and additive compositions, as well as the emergence of clear gaps that lead to the body of the model with the emergence of the multi-layer property, that the characteristic The characteristic in this model is that it contains a large and wide amount of cavities in a large and wide amount, which means the possibility that the amount of energy storage and receipt is high in these models, as well as the above results showed the emergence of some areas in which the base material appears clearly and that this appearance is an indication of rejection of mixing Additive material with the base material.

The EDS phase again shows the absence of the Lα, Lβ phase and the Lα phase has disappeared and the rest of the phases have begun to propagate along the applied voltage as in the previous model

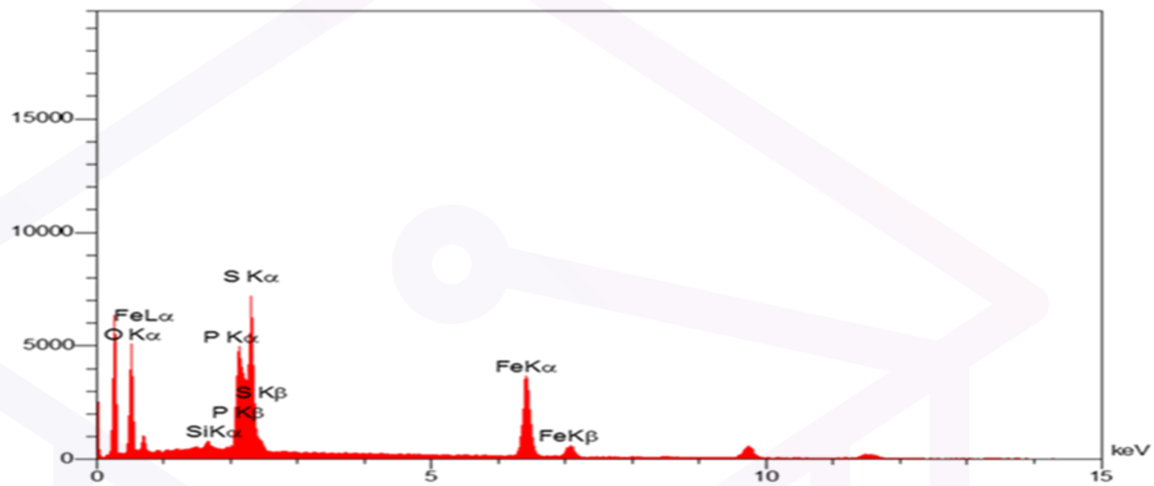

Figure (5) shows the phases of the polymeric materials shown in a scanning electron microscope of CuSO4

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