Graphene Oxide Nanoparticles Influence on the Electrical Properties of (PVA– PEG) Blend[1]

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ABSTRACT

In this study, we preparation polymer blend (PVA-PEG) for three samples in different Molecular weight of PEG (4000-8000-20000 g/mol) then preparation anther three samples polymer Nanocomposites (PVA-PEG-GO) by adding Graphene oxide nanoparticles (GO) concentrically (0.01wt) to blend polyvinyl Alcohol (PVA) and Polyethylene colacyl by using casting method after that study the Electrical properties (A-C) and structure (FTIR) and Optical Microscope enlargement (10x). The results of the study showed the effect of the addition of Graphene oxide on the alternating electrical properties have shown that the insulation constant. The electrophoresis and isolation loss of polymer compounds (PVA-PEG-) are reduced with increasing frequency of the electric field dominant and dielectric loss increases with increasing PEG concentration .

The results showed that the alternating electrical conductivity of polymeric composite increased with increasing frequency and molecular weight of all prepared composite. It was also shown that the increase of electrical conductivity significantly with samples of poly nanoparticles (PEG-PVA-GO) by increasing the molecular weight of PEG and be at the highest molecular weight (20000g / mol).

INTRODUCTION

Composite materials have been known since ancient times. Reed fibers were used to strengthen the building layers in the construction of ziggurats and arches, in order to install the huge building layers thousands of years ago by the inhabitants of the Mesopotamia, as they were the first to know the composite materials. As for the Sumerians, they used reeds and papyrus with bitumen in building boats. It is still used today in the marshlands, which are considered the first generation of boats. They also used plywood in (3400) BC as the wood mixed with adhesive glue gives better properties than natural wood [3], and the ancient Egyptians were the first to use bricks to manufacture tomb paintings. They also used layers of cotton, linen or papyrus fibers soaked in plaster (natural resins) (Cartonnage) 2181-2055 BC in embalming the mummy with cotton and linen fibers saturated with natural resins. It is one of the oldest man-made composite materials, which is more than 6000 years old, and is a viscous material usually made from a mixture of wet soil, clay, sand, animal dung, and straw (Wattle and daub) and is still considered an important building material in many parts of the world. , and concrete is also a superimposed material described by Vitruvius in the year (25) BC in his book (Architecture), it consists of cement, sand, water, and distinct types of appropriate aggregates. The strength, durability, and stability of concrete depends on the type of aggregate used and the size of its granules. It is used more than any other man-made materials in the world. It also produces woody plants, whether real wood from trees or plants such as palm and bamboo, natural compounds used by mankind in prehistoric times and are still widely used in construction. As for Cob, it is a natural building material made of clay from the inside. As a result of an extensive study, the term (GFRP) (Glass Fiber Reinforced Plastic) appeared at the beginning, and we mean polymers Reinforced with glass fibers, and a new term appeared in modern science, which is (Carbon Fiber Reinforced Plastic) (CFRP).

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The researcher (Thomas) and Slayter obtained a patent in (1930) in glass fibers, which were used to strengthen the unsaturated polyester resin. Earth, water, and fibrous organic materials (usually straw or gravel as a binder) have been used in construction for thousands of years., as Papier-mâché was used hundreds of years ago, and it is a compound of paper and glue, and in (1957). The best preparation of a cubic solid from mixtures containing boron and nitrogen was done in a metal capsule heated by resistance. In the year (1960), an overlay of cellulose and vinyl polymer was manufactured using ultraviolet rays. In the year (1974) two types of overlays were made of carbon fibers and glass fibers in epoxy resins and the possibility of using them in the production of light, strong and low-cost engineering materials [10], and in the year (1981) the corrosion of the composite material of glass - epoxy was examined using sand from the Mediterranean Sea and it was noted that less corrosion occurred than the compound that does not contain sand. In the year (1998) the microscopic factors that control the strength and ductility of a metal composite were studied. The two Russian scientists (Andrei and Konstantin) arrived in (2004) and used the "tape technique". They applied this tape to the graphite and pulled it apart to create sheets of layered graphene. As more tapes were drawn, thinner layers were obtained until it reached a piece of graphene with a thickness of (10) layers.

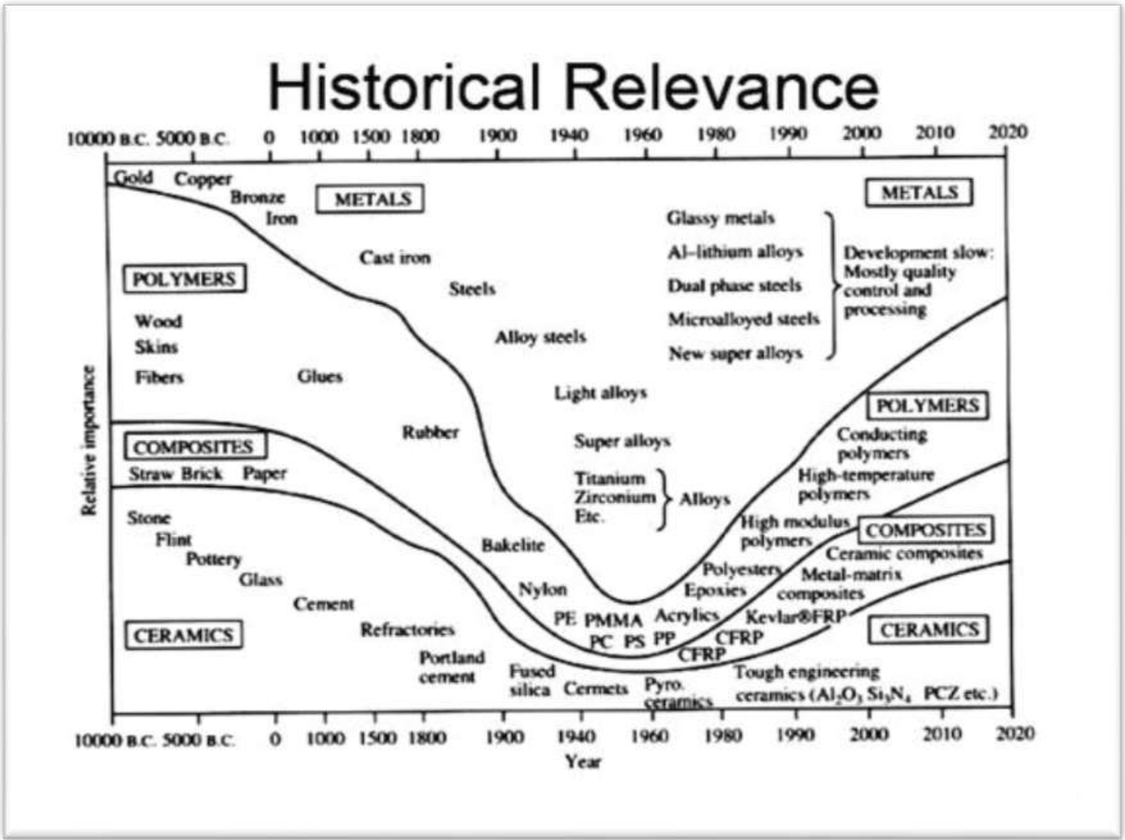

Figure (1): The evolution of superimposed materials from previous centuries until year [2020]

PRACTICAL PART

Materials used:

A - Polyethylene Glycol (PEG) :
In this research, polyethylene glycol (PEG) was used with different molecular weights (4000, 8000 and 20000 g/mol).

B - Polyvinyl Alcohol (PVA):
Polyvinyl alcohol used as a granular form, has a melting point of 230 K and was supplied by Panreac\Spain, with a high purity of 0.99% molecular weight (18000-12000g/mol).

C - Graphene oxide (GO) :
The record is at the University of Sheffield in the United Kingdom.

Preparation of polymeric composite materials:

Dissolve Polyvinyl Alcohol (PVA) for three samples (1.5 g) for each sample with different molecular weights in 50 ml of distilled water at a temperature of 70 degrees Celsius, then rotate using a magnetic cycle (Stuart) for 60 minutes. Then he left it for a period of half an hour for the purpose of bringing the melted to room temperature and adding polyethylene glycol (0.5 g) to three samples and leaving it for a period of half an hour on the magnetic cycler (stuart), then pouring it into the (Petry dish) and leaving it for 96 hours.

Preparation of nanocomposite materials:

Three samples were prepared in the same way as before by adding graphene nanoparticles suspended in distilled water after sonication for 30 minutes, then adding them to the polymer composite, and after adding it to the polymer composite, it was mixed for 2 hours, and after ensuring its homogeneity with the samples, the hybrid nanocomposite was poured into a dish (Petry dish) and left it under the air for 96 hours to dry and obtain a film.

polymeric mixture Nanocomposite

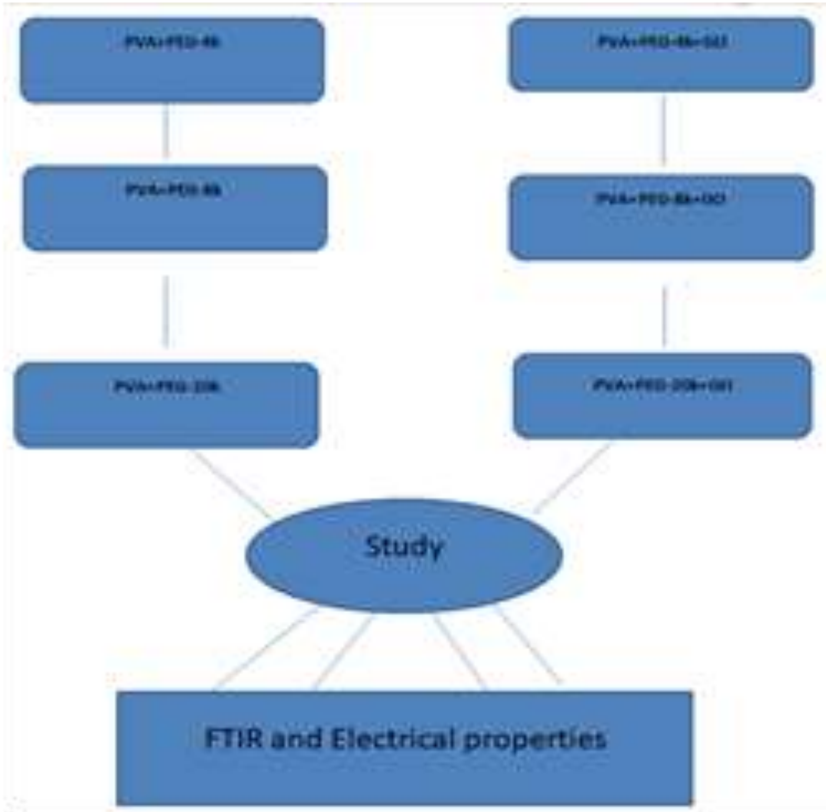

Figure (2) : A chart showing the materials used and the molecular weight of (PEG)

Table (1) shows the concentration of nanocomposite materials:

Material	GO	PVA	PEG
wt. %100	1	64	35

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The devices used and some pictures of the devices:

A device for measuring alternating electrical properties:

Alternating electrical properties (A.C), which included tangent angle loss and capacitance, were measured with a (LCR meter) type (HIOKI 3532-50 LCR HI TESTER). A sample was taken from each sample and placed between electrodes at different frequencies. From (1000Hz - 5MHz) at room temperature as in Figure (3-3) which shows a diagram of an alternating electrical circuit (A.C).The insulation constant, insulation loss and conductivity were calculated using special equations in AC electrical conductivity.

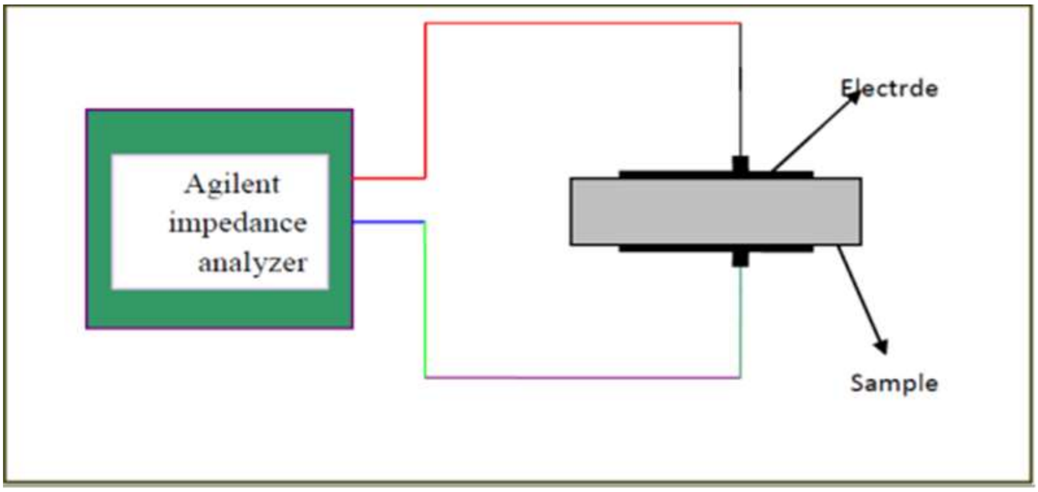


Figure (3): The electrical circuit used in measuring AC properties

Optical microscope:

The polymeric composites (PVA-PEG) with the addition of nano-graphene oxide were tested with a light microscope, which was equipped by (Olympus of the type Nikon - 73346) as shown in Figure (2-7), and it also contains a controlled light-intensity camera. it automatically. Under the power of magnification (10 x) and (20 x) located at the University of Babylon / College of Education for Pure Sciences.

Figure (4) : A picture showing the light microscope used to photograph samples with magnification (10x).

Figure (5): A picture showing an electronic weighing device

Figure (6) : A picture showing the magnetic stuart

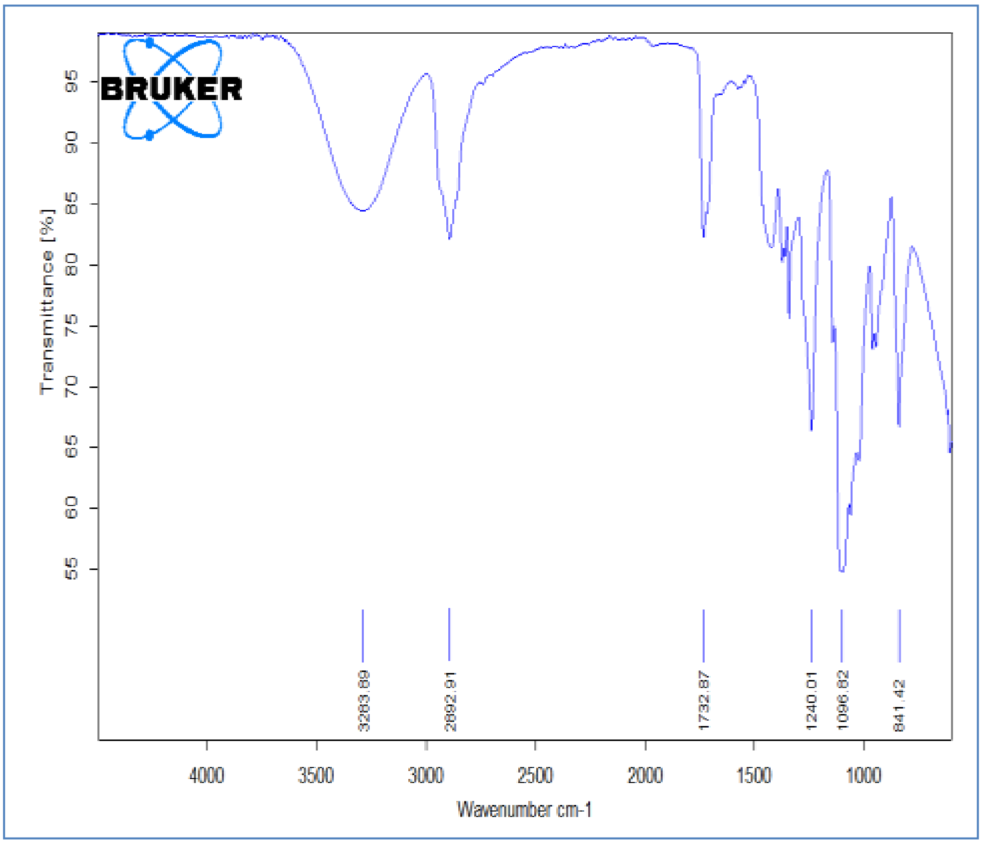
RESULTS ANALYSIS PART:

This chapter includes the results of electrical measurements (alternating A.C) of the polymeric mixture (PVA-PEG) and the nanocomposites (PVA-PEG/ GO nanocomposites) and their impact on the addition of (GO) material with different PEG molecular weights (4000- 8000- 20000 g/mol) in addition to The effect of electrical and alternating conductivity on temperature changes for the range 0C (30-80C) and also deals with the diagnosis of models using light microscopy.

Fourier Transforms for FT-IR Spectra Analysis

The main benefit of using the infrared spectrometer is to identify the type of bonds formed in the materials used, that is, to determine the nature of the materials constituting the resulting mixture, in order to distinguish between the occurrence of a chemical reaction or obtaining a good physical mixture between the two materials used (PEG-Polyvinyl glycol) alcohol (PVA), in Figures (3-4-5-6), the infrared spectrum of (PEG-Polyvinyl Alcohol PVA) is shown. Since each group of infrared spectra is characteristic of certain bonds of matter that appear within the ranges of the wavenumber that ranges between cm−1 (841-2885), the spectra curve in Figures (7-8-9-10) is divided into Three bands, where each band is represented by a group of depressions that indicate the distinct wave numbers for each bond of the PEG--PVA molecule, as the first band that is located in the region of strong bonds between cm-1 (2700-3600), which indicates the presence of the bond (C – H) found in polyethylene glycol [25] and includes the bottoms that indicate cm-1 wave numbers (2885, 1340, 1239, 1108, 841,988). As for the second range, which is located in the region of medium-strength bonds between cm-1 (1555-1850), which indicates the presence of the bond (C = C) and includes the positive numbers cm-1, and the third range represents the region of weak bonds and indicates the presence of The bond (C – C) as it lies between cm-1 (700-1500) and includes the wave numbers cm-1 (748-1492) found in Figures (3-4-5-6).

In figures (7-8-9-10), which represent the infrared spectrum curves of polyethylene glycol and polyvinyl alcohol films by adding nanoparticles of graphene oxide compound (PEG + PVA + GO) and in weight ratios (1wt%), we note that the behavior of The infrared spectrum of the polymeric films after the addition of (PEG + PVA + GO) is similar to its behavior in the polymeric film before the addition of (GO) except for some changes that occur in the very weak bonds region between (approximately 700-1400 cm), which represent the existing bonds in The added compound, this clear similarity indicates that no new bonds are formed between polyethylene glycol, polyvinyl chloride and graphene nanoparticles. This indicates that no chemical interaction occurred between the two materials and that each of the prepared films is a good physical mixture.



Figure(7): Infrared spectrum of a polymeric mixture (PVA-PEG/4K) film

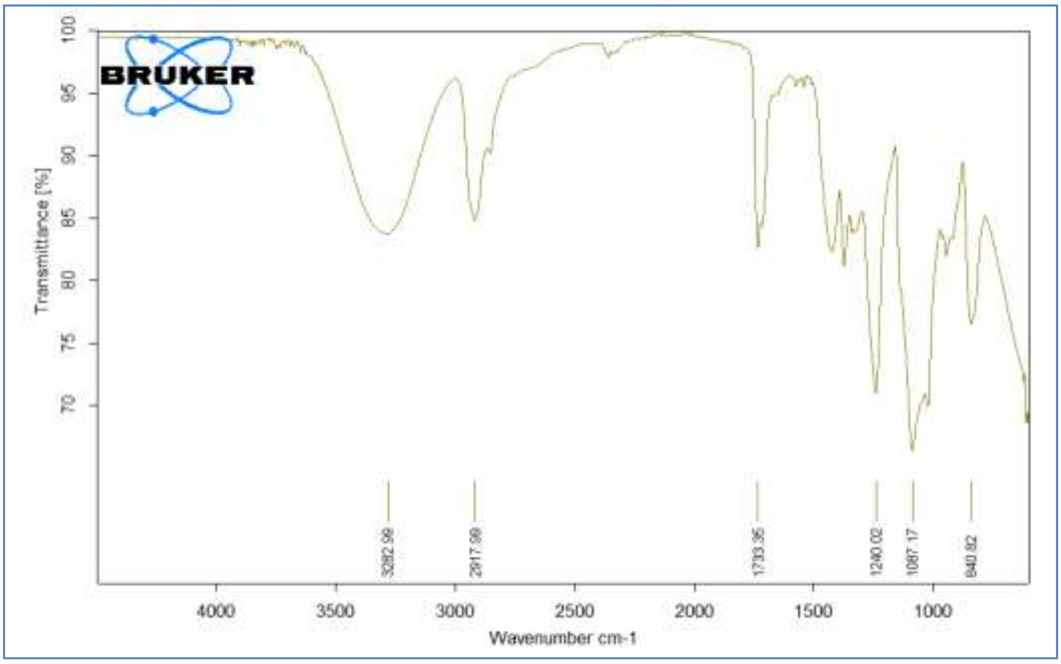


Figure (8): Infrared spectrum of a polymeric mixture film (PVA-PEG/8K)

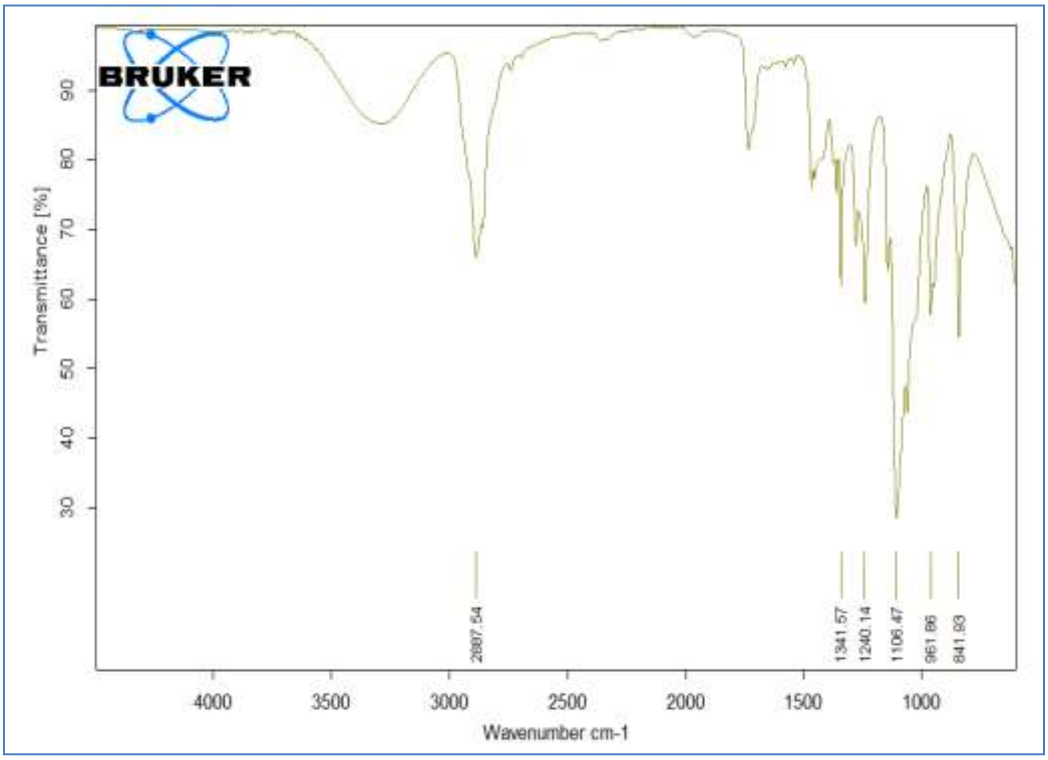


Figure (9): The infrared spectrum of a PVA-PEG/20K polymeric mixture film

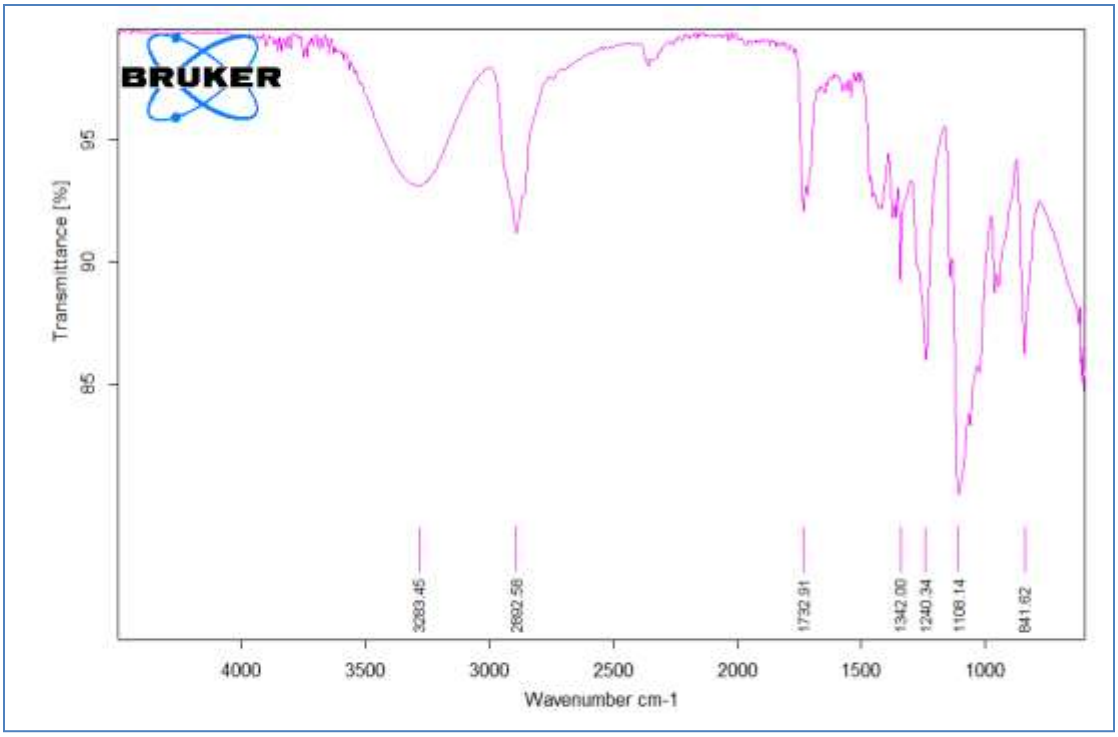


Figure (10): Infrared spectrum of nanocomposites (PVA-PEG4K/GO)

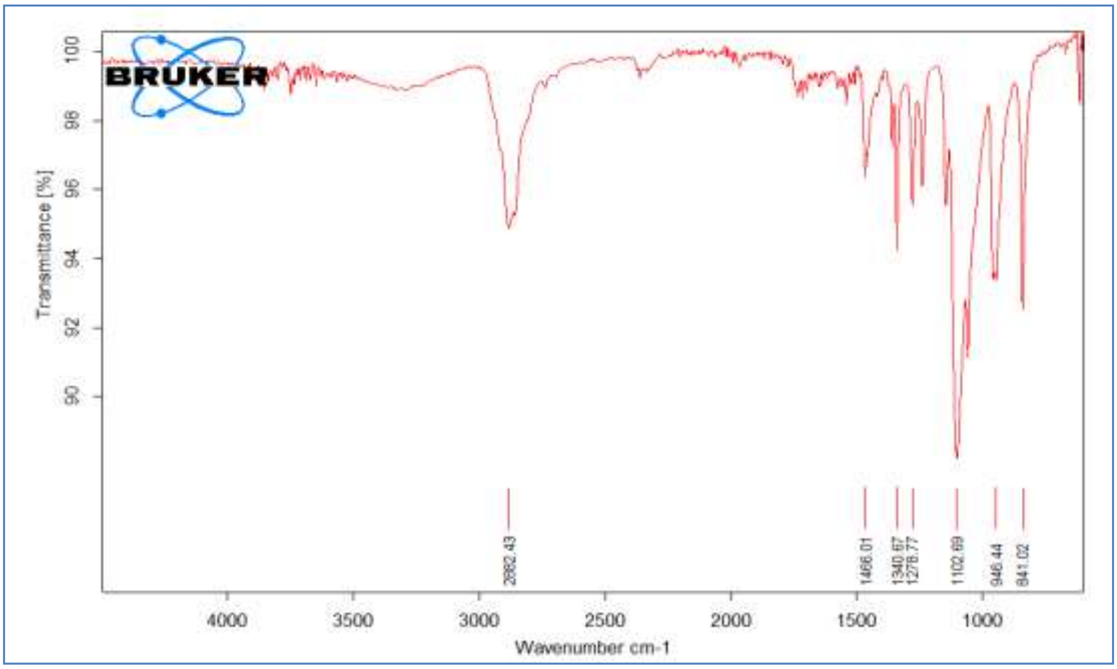


Figure (11): Infrared spectrum of nanocomposites (PVA-PEG8K/GO).

Alternating electrical measurements:

The AC electrical properties of (PVA-PEG-GO) composites were studied within the frequency range (100Hz - 5MHz). The dielectric constant, which is one of the most important AC electrical properties measured using Equation (2-20), was calculated through the ratio between the capacitance with the dielectric (Cp) to the vacuum capacitance (C°). As for the dielectric loss, it was calculated from equation (2-24) using the measured value of the dielectric constant and the loss factor (tanδ), while the alternating electrical conductivity (A.Cσ) was calculated from equation (2-25) after Compensation for the measured value of the dielectric loss.

Dielectric constant polymeric mixtures and nanocomposites:

Table (2) shows the effect of molecular weights on the value of the dielectric constant at a frequency of (100 KHz) and at room temperature, as we note from the figure that the dielectric constant increases with the increase in the partial weight of (-PVA-PEG) for a polymeric composite, and significantly for a polymeric nanocomposite (PEG-PVA-GO) The reason for the increase in the value of the dielectric constant when the molecular weight of (PEG) is increased is due to the formation of a network of graphene oxide particles within the nanocomposite material. . At low molecular weights, the graphene oxide particles are in the form of clusters or aggregates separated from each other, and then the dielectric constant is almost constant. Therefore, it is believed that the slight increase in the value of the dielectric constant is due to the increase of charge carriers by increasing the molecular weight of (PEG), which results in an increase in polarized charges, but when the concentration of the additive has a high molecular weight ((20000), the particles of the added water form a connected network within the polymeric medium. It is like a cluster consisting of an unlimited number of (GO) particles, and thus the value of the dielectric constant increases, and these results agree with the results of the researcher.

Table (2) shows the change of the dielectric constant with increasing molecular weight of (PEG 4000-8000-20000).

Sample	Dielectric constant
PVA-PEG\4K	45.9
PVA-PEG\8K	46.6
PVA-PEG\20K	48.3
PVA-PEG-GO \4k	49.1
PVA-PEG-GO \8k	51.4
PVA-PEG-GO \20k	53.7

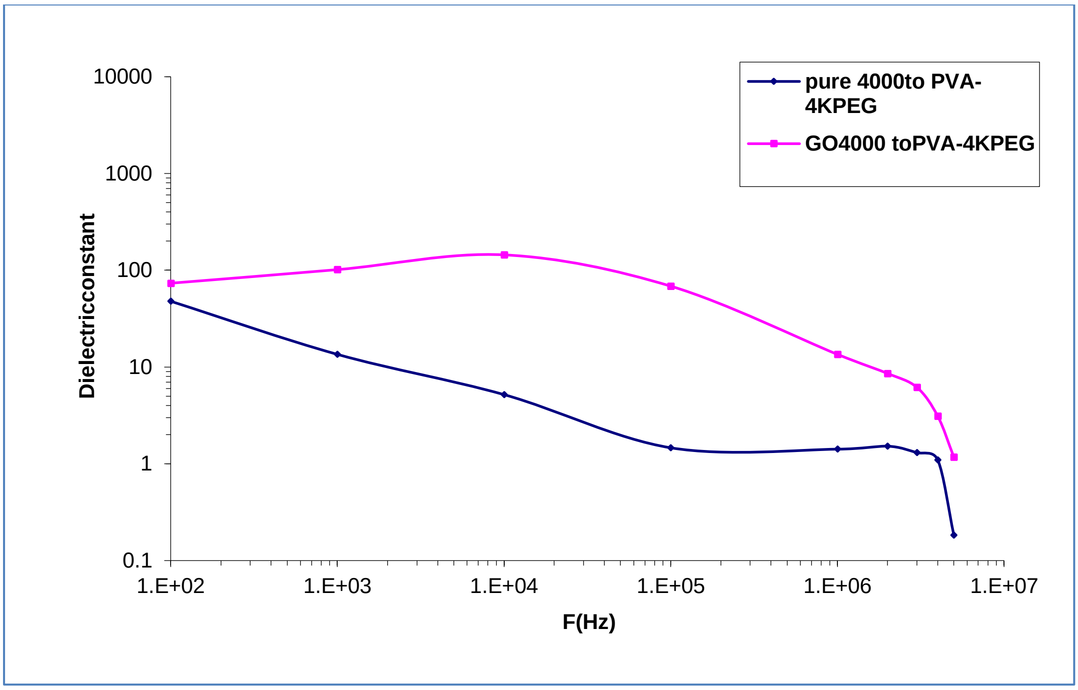


Figure (12) : The relationship between the dielectric constant and the electric field frequency of the polymeric composites (PVA-PEG-4k) and nanocomposites (PVA-PEG-4k/GO nanocomposites)

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Conflict of Interest: None

REFERENCES

1. www.ma.r-bal.com/ language/en/applications/history,of composites .
2. Shaffer, Gary D. (1993), An archaeomagnetic study of a wattle and daub building collapse; *Journal of Field Archaeology* 20.1: 59-75.
3. Vinson, Jack R., and Sierakowski., Robert L. (2002), *The Behavior of Structures Composed of Composite Materials*, 2nd Edition, Kluwer Academic Publishers.
4. "Quality Protocol for Aggregates". Aggregain.org.uk .
5. US United States Geological Survey,"Minerals commodity summary – cement – 2007", 1 June 2007. Archived. https://www.compositespress.com/wikicomposites/composite-material/
6. Donald F Adams, Leif A Carlsson and R. Byron Pipes (October 2002), *Experimental Characterization of Advanced Composite Materials*; 3rd Edition, CRC Press.