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Improvement Some Physical Properties of Nanocomposites Reinforced by Iraqi Nanoclays

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ABSTRACT

The current investigation includes the develolpment of Iraq clay to get nano structures composition and vising them as reinforced materials for Epoxy resin with weight fractions (%1 ,%3 , %5).The studied speciment where prepared by manual molding method. Some Physical tests where carried out(Diffusions and Thermal conductivity), the results showed notable improvements of the composites properties by nano particles.

Introduction:

Nanoscience studies have evolved over the last few years in the fields of production. It offers significant opportunities for material development, including those related to engineering and medical applications, where conventional technologies may reach their limits. Nanotechnology is often referred to as "small science". It represents the technology, design, production and application of materials on atomic, molecular and molecular scales to produce new nanoparticles. [1]

The nanotechnology represents the design, the production and the application of materials to a random step, molecular and macromolecular to produce new materials of size nanometer. The change in the physical properties and characteristics can be attributed to two main reason.

1-The surface area, as an increase in the surface of the material leads to increased interaction of material, ie become a high chemical activity the more reactive surface area.

2- The effect of quantum physics on the properties of these particles, due to the principle of (Hazenberk), when the article smaller the vacuum in which the electron moves inside this particle junior, also resulting in an increase in the electron energy, so as to compensate for this limitation in place which leads naturally to the changes large properties in this body [2].

- Polymer composites are still a solution to the problems caused by the use of homogeneous polymers alone, which suffer from a decline and deterioration in stress resistance and weather effects during fields use or through equipment, household use. To reduce environmental pollution and produce biodegradable composite materials, Natural organic materials are environmentally friendly such as Clays, rather than reinforced with environmentally friendly industrial and hydrocarbon materials such(glass fibers, nylon fibers, and metal wires) have been used. [3][4]

The case of chemical decomposition include several types, including:

A. Hydrolysis: is this degradation mediated by water, or acid, or basal, or saline, and includes adding a molecule of water on the center, which is a break the bond.

B. acid decomposition: Occurs impact of carboxylic acids component with a molecular weight compounds Low, it has been found that the degree of decomposition or acid-base hydrolysis depends on the concentration of the acid or the base and the added time. It is intended to unravel the results of reactions that destroy the chemical bonds between atoms, and depends on the quality of chemical bonds (covalent or ionic); If the bond is covalent the decomposition of molecule leads to the formation of free radicals. [5]

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Diffusion is the movement of atoms or molecules in the direction of concentration gradient, there is a tendency for transferring mass to take place in such a way that the concentration becomes uniform, this phenomenon is associated with the thermal agitation of molecules in a region was molecules concentrated. [6].

Diffusion in polymers can generally be described by Fick's first law. The mechanisms of diffusion, however, are significantly different in polymers from other materials. Since the individual atoms in polymer chains are not free to move independently, the concept of self-diffusion in a polymer must correspond to the motion of an entire thermoplastic polymer chain [7].

Thermal degradation is the scission of molecular chain at elevated temperatures, so some polymer undergoes chemical reactions in which gaseous species are produced. These reactions are evidenced by a weight loss of material, polymers thermal stability is a measure of its resilience to this decomposition. Thermal stability is related primarily to the magnitude of the bonding energies between the various atomic constituents of the polymer.

Thermoset can be protected from thermol degradation by incorporating stabilizers into them Stabilizers are used to keep the polymer chains and the original molecular structure intact and therefore properties such as strength, stiffness and toughness can be retained over a longeperiod[8].

- Epoxy has been used in most commercial applications with fiber glass, graphit Applications include aircraft components, rocket introductions, pressure vessels, vehicle bodies and some engines [9].
- Clays is usually defined as natural materials that offer fine grainy. Often, these materials emit a laminate nature as a result of the crystalline arrangement formed by silicon and aluminum oxide, which are the main components of the clay. It is widely used and also supports chemical reactions as a component of carbon copy sheets. It is likely that the most sour mud used to remove the color, odor and other impurities of cooking oils of plant or animal origin. Although many clay such as bentonite, kaolin, Attaplugate, are known for a long time, there are great orientations to study the geometrical properties of the mud which must be carefully designed to obtain the desired result [10].

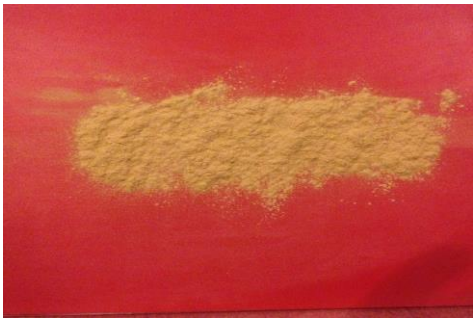
Aim of Study:

This research aims to prepare environmentally friendly nano composite material reinforced by natural material such (Kaoline,Bentonite,and Attaplugate) to reduce the use of industrial adhesives with bad effect on living organisms and to obtain with high properties composites to resist stress and reduce absurption when used.

Experimental Part:

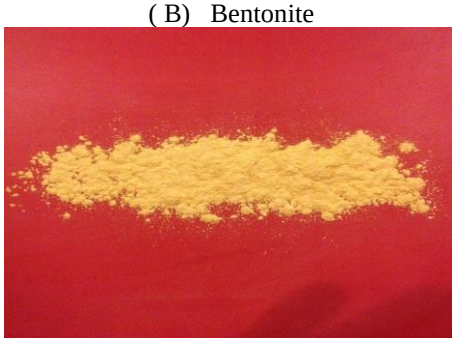
The use of Epoxy resin matrix material manufactured from acompany (Sika) of America to form a viscous liquid transparent at room temperature, one of the types of polymers (Thermosets) density (1200Kg/m^3) turn into a solid state when adding Hardener of the production company (Sika) of America.

Epoxy resins form thermosetting materials by being combined with a hardener which enables the cross-links to be established between the epoxy molecules and so give a thermoset material. [9]
at room temperature Used the three types of reinforcement materials purpose of strengthening the material basis of three types of clays Iraqi nano particles (kaoline, Attaplugate, and Bentonite) as in Fig. (1) reinforced the resin material in the form of powder average of diameter (50-90) nm were prepared in the laboratory.



(A) Kaoline

(B) Bentonite



(C) Attaplugate

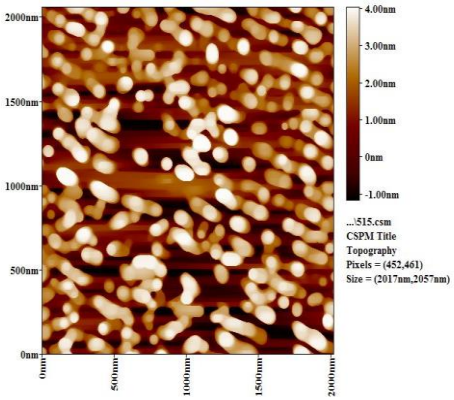
Fig. (1) Kinds of Iraqi Clays

Table (1) Chemical analysis of Clays from XRD test

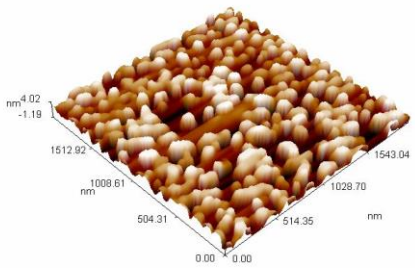
Constitunet	Wt% Bentonite	Wt% Attaplugate	Wt % Kaoline
SiO2	56.7	31.04	48.57
Al2O3	15.42	7.113	35.05
CaO	4.48	20.65	0.6
MgO	3.42	2.993	0. 77
K2O		0.231	0.08
Fe2O3	5.12	4.266	1.34
TiO2		0.7511	1.19

Preparation of nanoparticles:

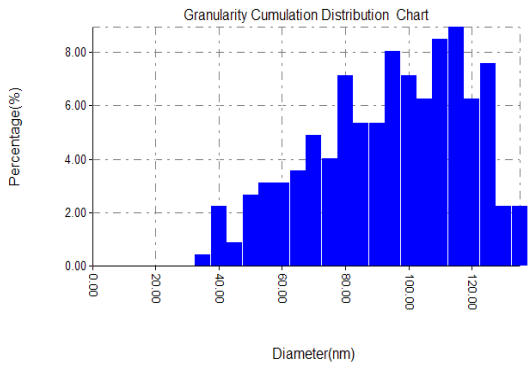
The abrasives (Attoplugate, Caoline and Bentonite) were washed with distilled water twice and dried by a drying Furnace at a temperature of(70-80) ° C, then grinded to obtained with a 53 µm by sieve. Preparation is done first by adding 2.7 g of German-made alkali ammonium salt (CTAB) into a glass flask with 75 ml of duoble distilled water twice as well as 3 ml of Hcl acid 4M. Adding the Clays particle in diameter 53 µm to the solution and then expose the mixture to the laser 50 mJ for half an hour. and then the mixture is filtered and the solid is taken for the AFM test as in Fig.(2).



(A)



(B)



(C)

Fig. (2) Atomic Force Microscopic Analysis of nano Clays

Preparation of specimens:

The samples were prepared by manual molding using a glass mold, and then to make a homogeneous mixture of epoxy material with clays types. And adding the hardener with 1: 2 of epoxy to help harden the material and then leave the material for 24 hours, and put it in furnace at temprature (50-60)°C, then be cut by a small electric saw and then softened by the

device and the samples were in accordance with ASTM.

Classification of samples:

Samples were divided into three groups and according to weight fractions (1%, 3% and 5%) of the nano Clays

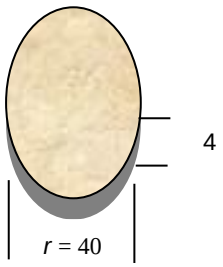
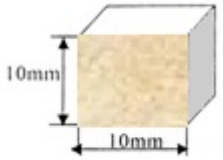
Instrument and samples test:

Diffusions and Lee's disc American standard for Testing Material (ASTM) has been used for Thermal conductivity as in table (3).

Table (2) Sample's of EP reinforced Clays in Weight Fraction

Sample	Weight Fraction
EP	Pure
K1	EP+ 1% Kaoline
K3	EP+ 3% Kaoline
K5	EP+ 5% Kaoline
A1	EP+ 1% Attaplugate
A3	EP+ 3% Attaplugate
A5	EP+ 5% Attaplugte
B1	EP+ 1% Bentonite
B3	EP+ 3% Bentonite
B5	EP+ 5% Bentonite

Table (3) Sample's dimensions and standard specifications for the testing [11]

Standard Specifications	*Sample's dimensions*	*Test*
Lees' Disk		**Thermal conductivity**
ASTM-D570		**Diffusivity**

Lee's disc instrument is used to test the thermal conductivity for the specimen.Fig.(3), shows this instrument which consists of two discs of Cu and a heater. The heat supplied from the heater across the sample to the lower disc. The temperatures of the discs (TA ,TB , TC) can be measured using a thermometers which are located in them. The surfaces of these discs should be clean to obtain the optimum heat transfer through them.[8].

(A)

(B)

Fig.(3) show Lee's disc Instrument and sampeles

Fig.(4) Samples of Diffusivity

Result and Discussion:

The polymers and composites of more materials susceptible of different weather conditions, such as parts of the buildings, or aircraft, and missile parts, as well as boats, containers huge water; therefore, the study of changing environmental conditions on such materials has become necessary to measure the extent incurred in these circumstances, which represents decomposition factors Article (degradation), such as: light, and all kinds of solutions, ozone, heat, radiation, as well as all kinds of work on

breaking bonds with the polymer and decompose. Some of the factors to be natural, such as sunlight, rain, ozone, and some industrially such as radioactive sources, and some kinds of acids and solvents etc. [10].

•Immersion of specimens in water

Specimens have been immersion in water in Special containers made from glass to keep the specimens immersed completely in the water for 14, 28, 32,and 46 days as in Fig(4) After these periods, specimens are extracted from these water and tested for Diffusion

Weight gain (M_t%) of water has been calculated from equation

$$\text{Weight gain} = \frac{M_2 - M_1}{M_1} * 100\% \ldots (1)$$

the values are listed in Fig, (5). It was showed that the samples of EP/A5% have relatively high values of weight gain (M_t%) of water as compared with EP/K5% and EP/ B5% composites. The reason behind this was ascribed to the degradation of the binder or weakening of the interaction between reinforcement lead to penetration of water to the EP/ Attaplugate. This would swell and plasticize that samples. The swelling causes changing in dimension and weight of samples. This changing depended on percentage of weight gain (M_t%) of water for sample.

In the same Figure, it is shown that the samples of EP / K1% composite have a lowest value of weight gain (M_t%) of water due to the adhesion between matrix and Kaoline reduction penetration of water to the material. Also EP/K1% has absorption of water lesser than Ep/ K5%. The changing in dimension and weight was little. While samples of EP/ Bentonite have amidst value of weight gain (M_t%) of water between above value of EP/Attaplugate and EP / Kaoline composite..

Noticing figures (5), the composite material formed from reinforced epoxy with B5% had the highest values of diffusivity in the water, while the lowest diffusivity value for the same water was for the composite material formed from the EP reinforced with K1% .

Diffusion coefficient for all the samples was calculated in every state by applying Fick's Second Law which is clarified in the formula

$$D = \pi (K_t d/4M_m)^2 \quad \ldots\ldots\ldots\ldots (2)$$

The results are shown in Fig (6), it can be seen, that the diffusivity coefficients of water in the materials (under test) has increased compared with that of pure matrices except EP/ K1 and EP/ A1, due to the interface defects or in-homogeneity of composites.[12]

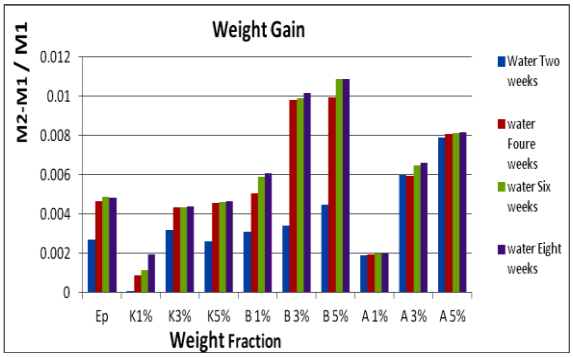


Fig.(5) Weight gain (%) of composites in a water,as a function of √time.

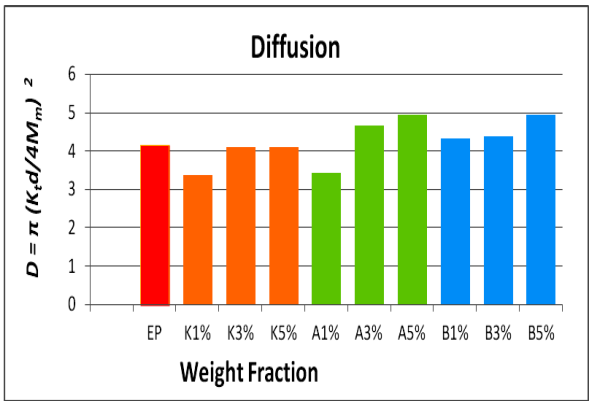


Fig. (6) diffusion of the samples as a function of weight fraction

Noticing fig.(6), the composite material formed from reinforced epoxy with B5% had the highest values of diffusivity in the water, while the lowest diffusivity value for the same water was for the composite material formed from the EP reinforced with K1% . And the highest value of diffusivity for the other composites was for the composite material formed from the EP reinforced with (B3%,A5%).

The lowest diffusivity value for this composite material formed from the EP reinforced (K1%). Finally the highest value of diffusivity for the EP reinforced with Attaplugate while the lowest value was for the Kaolin.

Nano composites had high resistance for the water since Kaoline; generally speaking, clays materials contain many pores in addition to its high resistance to water.

The addition of the Clays leads to their homogenous because of their hydrophilic properties, in addition to adhesion and epoxy interlock. The composites Preparation were homogeneous

- results of this test show that the highest values of thermal conductivity are achieved by the composite material consisting of reinforced EP with K1% particles. This is attributed to the crosslink density of the composite. Also the composite material consisting of epoxy reinforced with both K3% and K5% particles had high value of thermal conductivity. The explanation of the above is as follows:

The reason of that is related to the grain size of Nano particle which permeate into the matrix (Epoxy), this helped to high stacking density of (Nano clays) , which leads to reduce air spaces already exist in composite material (manufacture during) this results in reduced air spaces that function as insulator so increasing thermal connectivity of composite [13]. as dependent (K) on the density of insulation apart from the volume effects of the components, a significant effect is played by the dispersed phase and the adhesion between the components. An increase in the adhesion between the components in the polymer or filled polymer produces a decrease in the heat resistance at the component boundaries and an increase in the coefficient of heat transfer of the material [14].

The Bentonite have 56.7% silica, often found as quartz, thus; as expected, the greatest increase was seen in the samples filled with quartz. Because the thermal conductivity of the quartz is more than 10 times greater than that of pure resin [15].

From the results of this test. It can also be noted that the resins with Bentonite and then reinforcing them with B3% or B5% will increase (k-values).This may be related to presence the interface between the components of composite which acts as channel to transfer heat across the material.[16]

The low values of the thermal conductivity were recorded for composite material consisting of the epoxy resin reinforced with A1% particles which may be attributed to the density of the particles which reduce the number of voids existing in the composite material resulting in decreased thermal conductivity. From fig.(7) we shows the thermal conductivity of a value EP/K decrease with increasing the weight fraction.

The fire resistance of a polymer can be increased by adding fire retardant clays. The degree of flammability of polymer is afunction of; [17]

1-Matrix type and amount (dominant).

2-Quantity of fire-retardant additives.(It is common practice to add this to thermosets).

3-Type and amount of reinforcement a lot of Clay particles helps to improve fire resistance in thermosets as in Fig (7).

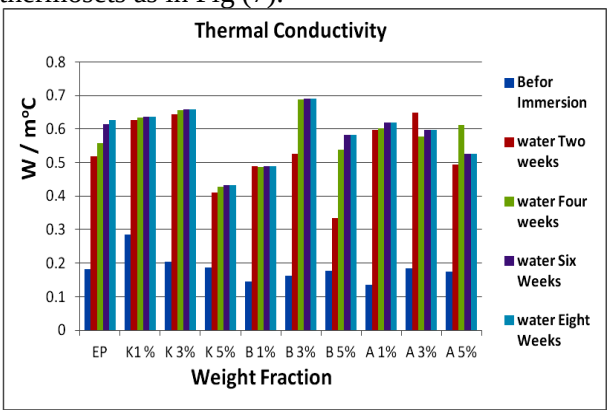


Fig. (7) Thermal conductivity of the samples as a function of weight fraction

Conclusion:

We conclude from the research that use the clays increases their synergy and improves physical properties. The results show that as the exposure times in water increase the thermal conductivity decreases. The highest value of thermal conductivity is for the reinforced Ep with Kaoline. Diffusion tests indicate that all properties of test samples are affected by water. Water have limited effect on EP/K, EP/B and their composites reinforced with EP/A, so these materials can be used in humid, alkaline and acid. The use of nanoparticles increases the properties of the composites for the better and becomes more resistant to the conditions of stress and low Absurbtion. Non-polluting and environmentally friendly composites and minimizing the use of industrial reinforce materials contaminants that affect environmental on organisms such as (glass fiber, nylon, and metals).

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تحسين بعض الخواص الفيزيائيه للمتراكبات النانويه المدعمه بالاطيان النانويه العراقيه

خالد محمد خليفة بلقيس محمد ضياء طارق عبد الجليل منديل

الخلاصة :

شمل البحث الحالي تطوير الأطيان العراقيه للحصول على جسيمات نانوية التركيب واستخدامها كمواد للتدعيم مع الايبوكسي وحسب الكسور الوزنيه (5%, 3%, 1%) وحضرت عينات الدراسة بطريقة القولبة اليدوية. أجريت الاختبارات الفيزيائيه (الانتشاريه، والتوصيليه الحراريه) فأعطت نتائج الدراسة تحسنا كبيرا في خواص المتراكبات النانويه المحضرة.