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Study of Thermal Conductivity and Solution Absorption for Epoxy –Talc Composites

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Abstract

In this research prepared Epoxy – Talc powder composites with weight ratio of Talc powder (0,5,10,15,20,25)% . The value of thermal conductivity increase with increasing ratio of talc powder and water absorption increase with increasing ratio of talc powder because the structure from magnesium silicate hydroxide and hydrophilic nature .Ethanol absorption decrease with increasing percentage talc powder compared with epoxy pure

Key words: Epoxy, Talc powder, Thermal conductivity, Solution absorption

دراسه التوصيليه الحراريه وامتصاصيه المحاليل لمتراكبات الايبوكسي – تالك

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الخلاصة

في هذا البحث تم تحضير متراكبات من الايبوكسي – تالك بنسب وزنيه (0، 5,10,15,20,25)% . قيم التوصيليه الحراريه تزداد بزياده النسب الوزنيه للتالك وامتصاصيه الماء تزداد بزياده النسب الوزنيه للتالك بسبب تركيبيه الهيدروكسيد سليكات المغنسيوم وطبيعتها المحبه للماء . امتصاصيه الايثانول تقل مع زياده النسب الوزنيه للتالك مقارنه بالايبوكسي النقي .

Introduction

Composites materials are greatly influenced by the type of reinforcement in the system. In the case of particulate reinforced polymer composites, the properties depend on the shape and size of the filler, the amount that is compounded with the plastic, the bonding between the filler and the plastic, the toughness of the plastic and sometimes the toughness of the filler apart from its chemical composition. Low cost particulate fillers are added to plastics in commercial production primarily for reasons of economy and improvement in molding characteristics[1]. Composites materials can be classified in accordance with matrix and fillers or reinforcements. In accordance with reinforcements, composites are classified as fiber reinforced, particulate reinforced, structural composites and nano or micro composites. For matrix classification, composites are grouped into three namely: metal matrix composites (MMC); ceramic matrix composites (CMC) and polymer matrix composites (PMC) [2].Epoxy resin has been a dominant matrix material used in the development of advanced composite materials because of its following excellent properties: high strength, high adhesion to substrates, high electrical insulation, low toxicity, low shrinkage, low cost and high amenability to various processes

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and applications [3]. Talc is a hydrous magnesium silicate having a chemical composition of Mg3Si4O10 (OH)2 or H_2Mg3 (SiO3)4, referring as talc's white color[4].

Thermal conductivity is a measure of the ease with which temperature is transmitted through a material and is a basic material property. Materials with high thermal conductivity are called conductors and those with low conductivity are called insulators. Solid conductors (such as metals) typically have thermal conductivities in the range of 10 to 400 W/°C m while insulators (such as polymers, glasses and ceramics) have values in the range of 0.1 to 2 W/°C m [5]. Thermal conductivity of polymers is also highly dependent on polymer chain segment orientation. This is because thermal energy transports more efficiently along the polymer chain. Crystalline polymers have highly ordered chain segments, and therefore have higher thermal conductivity than amorphous polymers. Amorphous polymers may exhibit anisotropic thermal transport properties if polymer chains are partially oriented, with thermal conductivity along the chains higher than that perpendicular to the chains[6]. Water absorption in Epoxy, It has been long known that epoxy and epoxy composites easily absorb water when exposed to humid environments. This reduces the stable lifetime of the material. Experiments show that the water in epoxy is present in two states :Evenly distributed water molecules between the polymer chain and in Epoxy with mineral fillers it has been seen that water destroys the bond at the interface between the filler and polymer [7].Thermal Conductivity Because of talc's significantly high thermal conductivity (compared to the polymer), the heat introduced and generated during processing is transmitted through the mixture more quickly . The heat is also transported out of the compound faster during cooling. Incorporating talc in a compound increases the thermal conductivity, resulting in faster production rates. Experience with filled polymers is that conductivity depends only on the filler content, within reasonable tolerances.[4] Moisture diffusion in material composites has three different mechanisms [8] The first involves of diffusion of water molecules inside the micro gaps between polymer chains. The second involves capillary transport into the gaps and flaws at the interfaces between particle and the matrix. This is a result of poor wetting and impregnation during the initial manufacturing stage.

The third involves transport of micro cracks in the matrix arising from the swelling of particularly Generally, based on these mechanisms, diffusion behavior of composites can further be classified according to the relative mobility of the penetrate and of the polymer segments, which is related to either Fickian, non-Fickian or anomalous[9],

2-Experimental part

2.1 Materials

Epoxy : epoxy (105) Don construction products (DCP) , Amman –Jordan The ratio of epoxy to hardener used in this study was approximately weight ratio 3:1. Density 1.2 gm/cm^3.

Talc powder (magnesium silicate hydroxide) the particle size (250 micron).

Ethanol : Ethanol (EtOH) ,GCC/Gainland chemical company ,C_2H_5OH Molecular Weight (g/mol) =46.07 ,density= 0.785 gm/cm ^{3}, purity= 99.9% Liquid.

2.2 Thermal conductivity

Thermal conductivity coefficient was calculated to the data that measurement by using the lee's disk {manufacture by Griffin and George / England},thermal conductivity coefficient was calculated by using the following equation [10]

$K [T_B-T_A /d_s]= e[T_A+ 2/r[d_A +d_S/4] T_A+ 1/2r (d_S T_B)$ ……………………………………………….(1)

$H=IV=\pi r^2 e (T_A+T_B)+2\pi re[d_AT_A+(1/2)d_S(T_A+T_B)+d_BT_B+d_CT_C]$………………………………… …(2)

K:- Thermal conductivity Coefficient

e: - Represents the amount of thermal energy passing through unit area per second disk material

H: Represents the thermal energy passing through the heating coil unit of time

d:- Thickness of the disk (mm) ,

r:- The radius of the disk(mm).

d_S :- Thickness of the sample(mm) ,

T:- The temperature of the disk(° c).

2.3 solution absorption

The specimens were placed in a close tube containing water and ethonal maintained at a temperature of approximately 24°C and the samples cut as ASTM D 570-98 . in the beginning every 24 hours , each specimen is removed from the water and ethonal , wiped with a dry cloth free of surface moisture, and weighted to the Sensitive balance, *Metter H35AR* of accuracy 10^{-4} g. This

procedure was repeated consecutively for 15 days until the composites were substantially saturated. The percentage water absorption was calculated by the difference between the weights of fully saturated specimens to the weight of dry specimens.

2.4 preparation epoxy – talc composites

Preparation the samples Performed by with hand layup method. The composition of the matrix materials epoxy and hardener the ratio (3:1) the liquid hardener was slowly added epoxy resin at room temp. , this mixture was stirred at 10 min and added talc powder the weight ratio to (5,10,15,20,25)% with epoxy resin and cast the mixture into the mold for 24 hours at room temperature and extracted samples from the mold and cut according to the specifications and dimensions with lee's disc. The samples of composites epoxy and talc with different ratio shows in are shown Figure- 1.

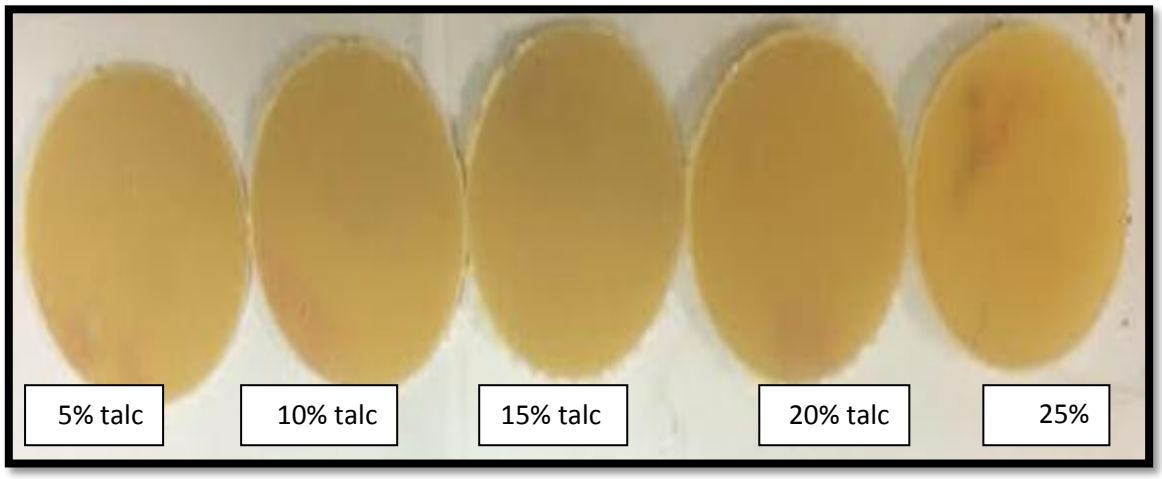

Figure 1- samples of different ratio of talc

3- Results and discussion

1. Thermal conductivity

Figure -2 shows the values of thermal conductivity increasing with increaseing of weight ratio talc powder. is due to the fact that particle size led to the lower void spaces in composites that arise at better bonding between particles and resin. The results observed in this study attributed that the fillers had created some reinforcing effect and had been responsible for the increase in thermal conductivity. The formation probabilities of thermal conductive chains & networks, Results in resulting in a higher thermal conductivity. In agreement with with (A. Suplicz and J.Kovacs) [11].

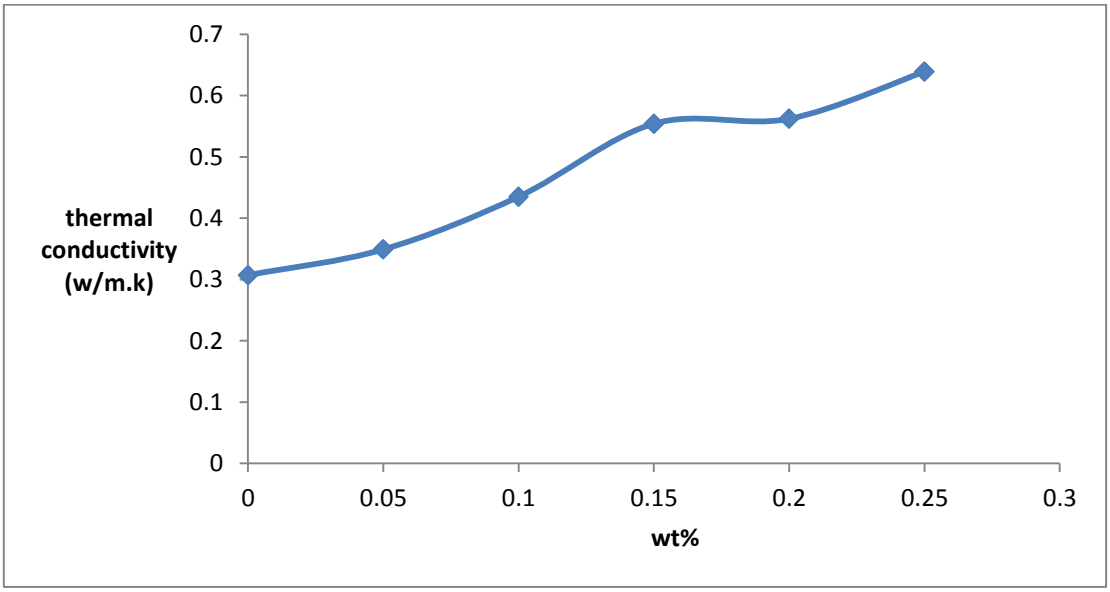

Figure 2- Thermal conductivity as function of weight ratio.

2. Solution absorption

2.1Water absorption

The water absorption depend on many parameters like polarity and the structure for materials [12] . water absorption values obtained from the tests are presented in Figure-3. It has been observed from the water absorption test that, quantity of water absorbed in the composite increases with time and later it happens to be constant. The percent amount of moisture absorbed in the composite for the first day is greater than in subsequent days. From the results, particle size. It is due to the fact that increase in the water content of the natural plant particle results in swelling, because the cell wall polymers of the material contain hydroxyl or other oxygen-containing groups that attract water through hydrogen bonding. Talc powder with epoxy increase these percentages will increase the weight gain of water absorption because the hydrophilic nature and installed component from magnesium silicate hydroxide [13] . It is known that surface of talc powder has hydrophobic silanol groups (Si-O-Si), and Mg-OH, and Si-OH groups form hydrophilic which agree with [14]

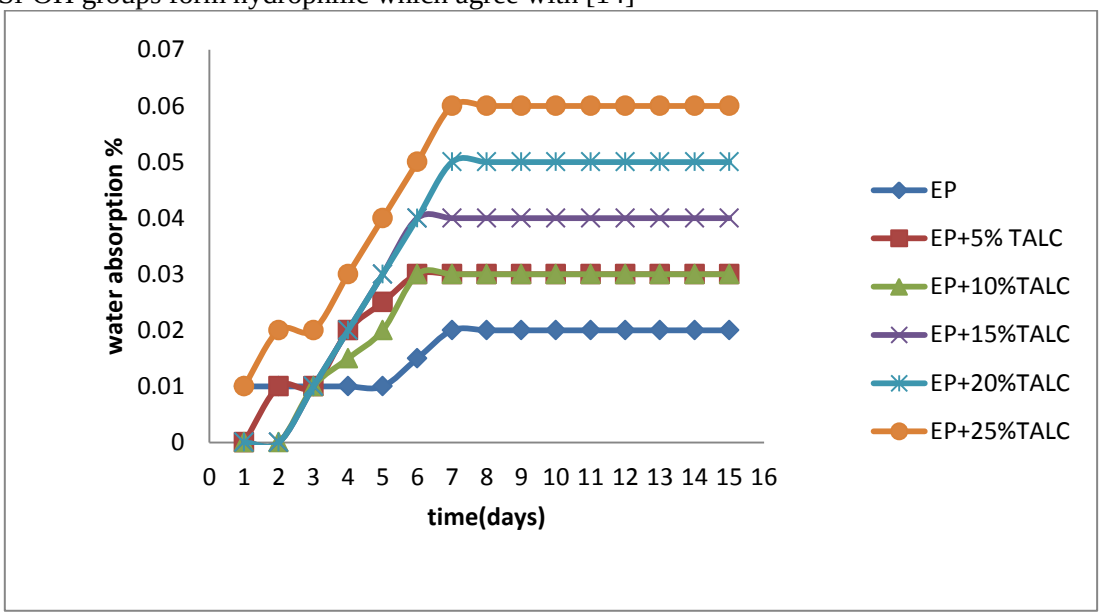

Figure 3- water absorption as function of time.

2.2 Ethanol absorption

Figure-4 shows that the ethanol absorption decrease with increasing percentage of talc powder compared with epoxy pure because the talc powder resist the chemical solution .

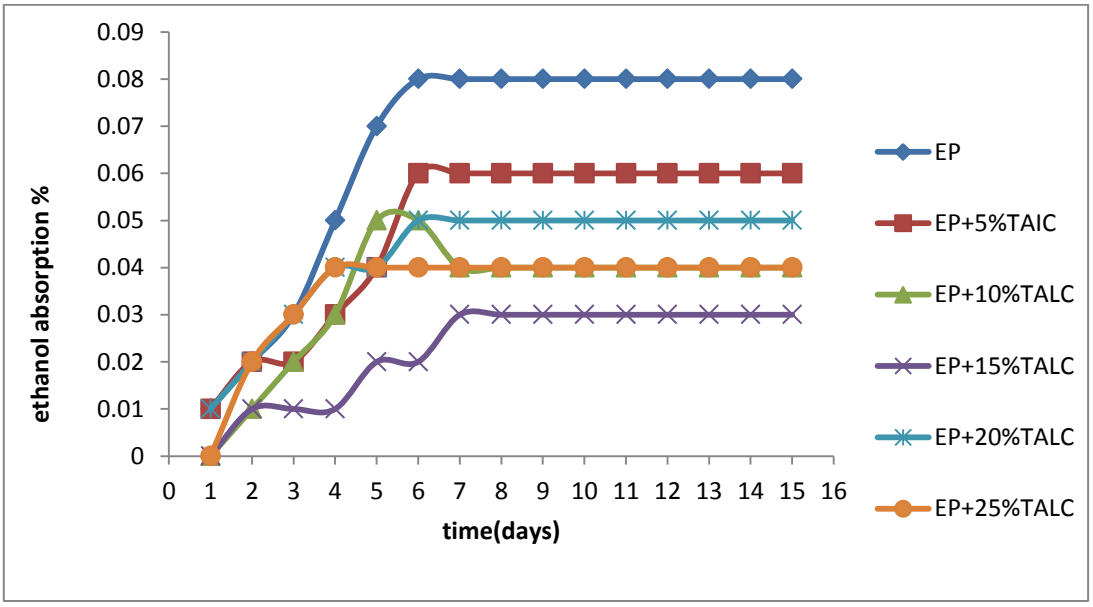

Figure 4- ethanol absorption as function of time

Conclusions

The thermal conductivity increases with increasing of weight ratio of talc powder. Weight gain(water) of composites materials increase with increasing of talc powder because the hydrophilic nature but the (ethanol) decrease the weight gain with increasing talc powder ,the talc resist the chemical solution . the thermal conductivity increase with increasing ratio of talc powder .

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