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Effect of Fiber (Glass, Poly Propylene) on Hardness, Water Absorption And Anti-Bacterial Activity of Coating Acrylic Polymer

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Abstract

Coating materials have an extraordinarily high use, for industrial or technical applications. This study compares the effect of short glass and polypropylene fibers on the hardness, water absorption and anti-bacterial activity of acrylic composites against Gram positive

(*Streptococcus sp.*) and Gram negative bacteria (*E.coli*, *Pseudomonas aeruginosa*, *Klebsiella sp.*).To prepare acrylic polymer and acryliccomposites (glass fibers and polypropylene fiber) the weight fraction (20 %,) (v_0= lama acrylic, v_1= lama acrylic/ glass fiber, and v_2= lama acrylic /poly propylene fiber), of chopped glass fibers and polypropylene were added to acrylic , the resultant solution was stirred by hand for 5 minutes, using the Hand-lay-up technique.

Results showed that hardness increased in acrylic /fiber glass to 68 compared with acrylic /polypropylene fiber while water absorption was reduce in acrylic /polypropylene because of its hydrophobic nature .The largest inhibition zone against Gram positive bacteria was 23mm , whereas the largest inhibition zone against Gram negative bacteria was 28mm.

Keywords:-Fiber glass, polypropylene fiber, acrylic polymer, hardness, anti-bacterial activity

تأثير الياف (الزجاج ، البولي بروبلين)على الصلادة , امتصاصية الماء والفعالية البايولوجية لطلاء البوليمر

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الخلاصة

مواد الطلاء لها استعمالات عدة في التطبيقات الصناعية ، في هذا البحث درس مقارنة الياف الزجاج مع الياف البولي بروبلين على الصلادة ، امتصاصية الماء والفعالية البايولوجية لانواع من البكتريا الموجبة والسالبة . تم تحضير غشاء من اكرلك البوليمر ومتراكبات من البوليمر مع الألياف وبكسر وزني 20% لكلا النوعين . تم إضافة الألياف الى البوليمر وخلطت باليد لمدة خمس دقائق واستخدمت طريقة الصب اليدوي . النتائج كانت ان فحص الصلادة لمتراكبات بوليمر الياف الزجاج افضل من متراكبات الياف البولي بروبلين وامتصاصية الماء تقل للمتراكبات بسبب الطبيعة غير المحبة للماء لالياف البولي بروبلين اما فحص الفعالية البايولوجية للمتراكبات وجد ان هناك تثبيط للبكتريا من النوع المجب بمقدار 23 ملم وللبكتريا من النوع السالب 28 ملم .

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Introduction

Polymer materials are used in a wide range of applications such as household items, personal elements, coatings of surfaces or pipes and many others [1]. Aging with time and because of long use with different working conditions, these polymers face degradation due to different factors such as environmental: heating, cooling and mechanical stress, chemical: Acids, alkaloids and others [2]. Composites are commonly defined as the combination of a matrix and additives that have at least one material of characteristics different from those of the individual components [3] .

These kinds of injuries result in bad quality of the material because of bacterial colonization that may transfer disease, as well as other undesirable changes of the product [4].

For most industrial applications , white acrylic roof coating is he perfect choice because most of the buildings have horizontal or flat roofs [5]. Polemer materials reinforced with glass fiber (GFRPs) have been increasingly used in the past decades . The main advantages of glass fiber over the engineering plastics are its low cost and Its light weight [6]. Fibers polypropylene (PP), glass) with various physical, mechanical, and chemical properties are used for matrix reinforcement [7]. Polymer matrix composites are also used to varying degrees, as reinforcing materials in order to improve the engineering properties of different types of fiber[8]. Glass Fibers (GF) reinforcement polymers are uesd to improve the physical properties of polymers . [9]. The mechanical properties of fibers depend on the fiber strength and modulus, chemical stability, and the interface bonding between the fiber/matrix to enable stress transfer [10].

Some polymers are more susceptible to bacterial attacks, because of the physical characteristics of its surface or the chemical composition of the polymer. The microbial community increases in polymers that are mostly used in humid environments with high levels of organic matter [11].

For a long time protection of polymers against such undesirable damage it is advisable to incorporate antimicrobial agents into the polymer matrix during industrialization. This will stop microbial access and colonization. Such antimicrobial agents may be organic or inorganic which can be used as additives through polymer matrix production [12].

Alexandre Landesmann et. Al. [13] studied the mechanical properties of glass fiber reinforced polymer and improved the mechanical test produced by the Brazilian industry to classify it for structural applications.

Tassew and Lubell [14] studied mechanical properties of fibers. The results showed that adding fibers to polymers had no drastic effect on compressive strength or elasticity module but considerably increased the flexural strength.

Experimental part

1-Materials

Elastomeric material (LAMA Acrylic polymer): white elastomeric roof coating liquid, tough, hard, and flexible made in the Fosroc LLC, Dubai, U.A.E. Glass fiber (E-Class): density 2.58 gm/cm^3, tensile strength 3445 Mpa, white in colour and comoressive strength 1080 Mpa . Glass fibers made by Chennai, India, Polyproplene fiber: density 0.91 gm/cm^3 , Very good elasticity, melting point 170 °C , White in color and supplied by BHD chemical LTD, England .These are shown in Figure-1

a- Glass fibers ***b- poly propylene fibers***

Figure 1- types of fibers used in this research

2-Preparation of composites samples: To prepare elastomeric acrylic / glass fibers and polypropylene fibers with volume fraction 20% .The samples are (v_0,v_1,v_2,) , (v_0= lama acrylic , v_1= lama acrylic/ glass fiber , and v_2= lama acrylic /poly propylene fiber). The composites solution was put in glass tubes , stirred by hand for 15 minutes using Hand-lay-up method and put in The . composition was left at room temperature for 24 hours . Samples were cut according to ASTM of all test.

3-Hardness test: Hardness s a characteristic of a material, is defined as the resistance to indentation.

4-Water absorption: The absorption of water is defined as the amount of water absorbed under certain conditions such as the type of plastic, the type of additives used, temperature and the time of immersion in water.

Water Absorption% = [(Wet weight - Dry weight)/ Dry weight] x 100 ……(1)

5-Disk diffusion assay: This method was used to detect the antibacterial activity of the prepared polymers and their different concentrations against a group of Gram negative and positive pathogenic bacteria, which include ;*E.coli*, *Pseudomonas* , *Klebsiella*, *Salmonella*, *Staphylococcus aureus*, *Streptococcus* , which were previously identified by biochemical methods at the biology department/college of Science- university of Baghdad. All bacterial strains were previously inoculated in nutrient broth and incubated at 37 for 18hr. From each nutrient broth culture, 0.1ml ($1*10^8$ CFU/ml) was transferred and inoculated on Muller-Hinton agar plates using a glass spreader, the polymer disks of different concentrations were placed on the surface of the inoculated plates and were then incubated at 37 for 24 hr. Inhibition zones around the disks were measured in millimeters.

Results and Discussion:

1-Hardness test: Figure-2 shows the values of hardness increase with added the fibers with polymer because the strength of fibers and the bonding (interaction) between the matrix and fibers increases . The reinforcing fibers of advanced polymer composites are responsible for their high strength and stiffness. This means that physical and chemical homogeneity compatibility exist between fiber and matrix. Therefore, the structure and properties of bonding of the fiber–matrix interface has played an important role in the mechanical properties of composite materials [15]. Fiber–glass shows a high value of hardness of 68 compared to that of polypropylene fiber of 65 .This is due to the hardness of the polymer which is the material's resistance to localized plastic deformation of the surface. Also, hardness is a function of the relation between modules and fiber loading of the composites.

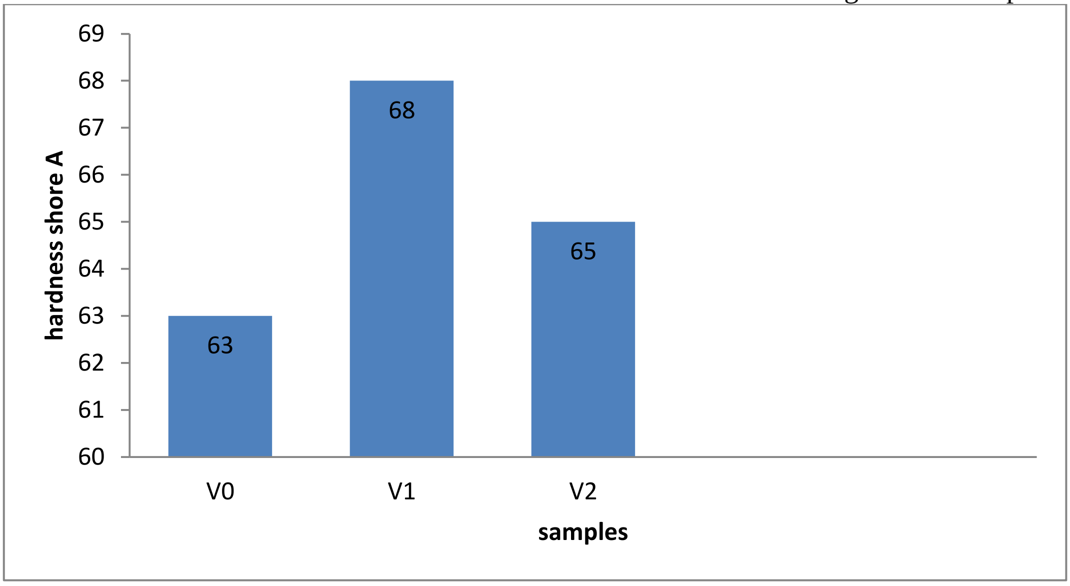

Figure 2-hardness values as a function of samples

2-Water absorption: water absorption is the amount of water absorbed under specified conditions, was calculated using eq. (1). Figure-3 shows the absorption of water as a function of time when the samples were immersed in water. It is observed that acrylic polymer water absorption is 0.6% this means that the quantity of water absorbed is small and it reduces with the time of immersion. For acrylic /fiber glass , water absorption isless(0.5%) because fiber reinforcement in polymer matrix could reduce the penetration of water in composites. Water absorption of acrylic /polypropylene fibers is 0.4% by property of hydrophobic [16]

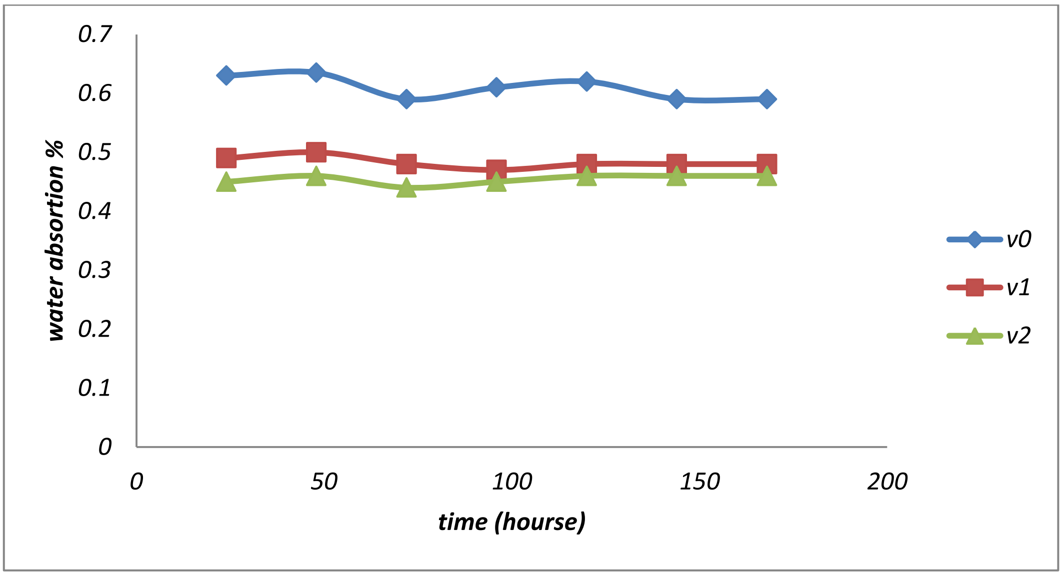

Figure 3-water absorption as a function of time

3-Antibacterial activity of the polymers: The results showed the ability of the polymer to inhibit the growth of different kinds of bacteria as shown in Table-1. The highest inhibition zone against Gram negative bacteria was 28mm for *E.coli*, and 21mm for Gram positive bacteria for *Streptococcus sp*. as shown in Figure-4. A recent study referred to the antibacterial activity of such polymers and its inhibitory effect on bacterial growth due to its physical and chemical characteristics that may interfere with the bacterial attachment and adherence to its surfaces and as result inhibit its growth [17].

Table 1-Inhibition zones of composites

Bacterial strains	**Inhibition zone (mm) of the three different fibers on bacterial growth**		
	v_0	**v_1**	**v_2**
E.coli	25	28	20
Klebsiellasp.	16	25	15
Salmonella sp.	R	R	R
Pseudomonasaeruginosa	17	24	22
Staphylococcus aureus	R	R	R
Streptococcus sp	11	23	21

v_0= lama acrylic; **v_1=lama acrylic/glass fiber**;**v_2= lama acrylic /poly propylene fiber**; R= resistant.

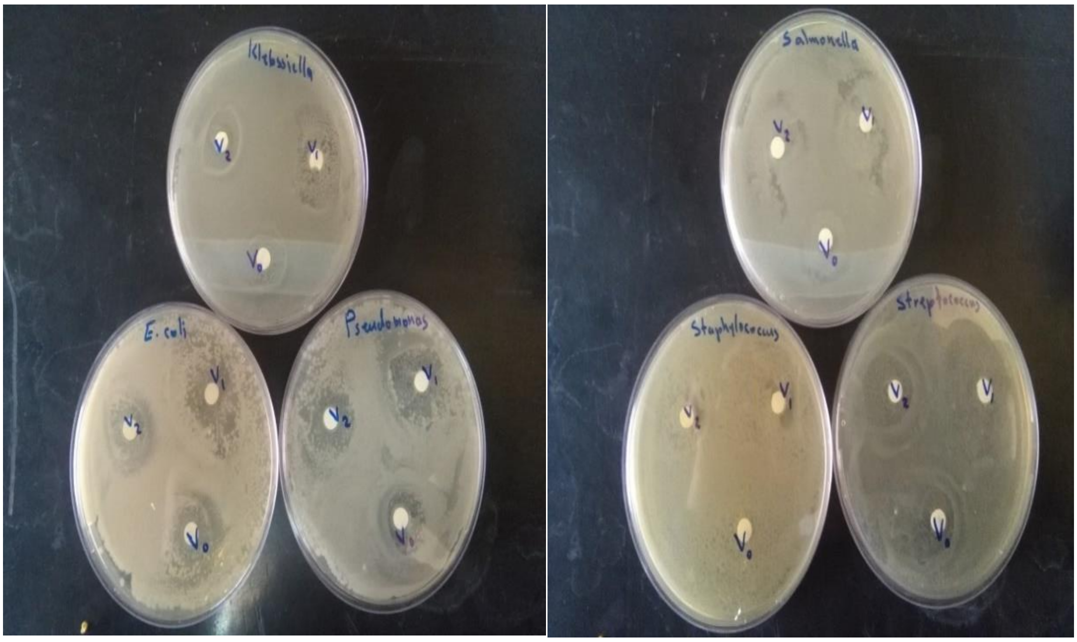

Figure 4-Inhibition zones of composites

Conclusions

Hardness results showed that he lama acrylic composites with glass fibers have a high value compared with the other samples. The water absorptionfor the lama acrylic was 0.6% which means it absorbed a small quantity of water. The amount of water absorption fof glass and polypropylene fibers was less .These fibers showed the ability to inhibit the growth of some pathogenic bacteria that usually cause infectious diseases.

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