A Study of the Effect of Iraqi Bentonite on Some Properties of Polymeric Blend

Dr. Najat J.Saleh
Chemical Engineering Department, University of Technology
Email:Njt_saleheyahoo.Com
May A. Muslim
Chemical Engineering Department, University of Technology

ABSTRACT
    In this research The specimens of composite materials were prepared from matrix (polypropylene and polymethylmethacrylate)(80 /20) wt%   in different weight fractions(3,6,9,12 &15)wt% and different particle sizes(45,60,70&110)µm of Bentonite.
    The results have shown that after the reinforcement with different weight fraction of Bentonite powder most mechanical properties such as hardness and modulus of Elasticity increase. Elongation decreases with an increase in weight fraction of (3, 6, 9, 12, 15) wt% and decrease with particle size decrease (45, 60, 70, 110) µm.
Also the results have shown that the thermal stability of PP/PMMA increases with addition of Bentonite and the thermal stability of small particle size (45 µm) was higher than larger particle size (110 µm).
    PP/PMMA/BN [(80/20/15) > (80/20/12) > (80/20/9) > (80/20/6) > 80/20/3)].
The results have shown the diffusion coefficient (D) was increased with temperatures (30, 45, 60) C° and decreased with filler content (3, 6, 9, 12, 15) wt% increase.
The activation energy (E) increase with filler content (BN) increase and (E) increases with particle size of BN filler decrease.
    Also the results have shown the addition of BN particles of PP/PMMA blend increases the discontinuity and restricts the growth of crystal therefore crystalline peak intensity is reduced in filler blend composite. Addition of large particle size of BN adversely affects the crystallization of PP.

<div dir="rtl">

دراسة تأثير البنتونايت العراقي على مخلوط بوليمري مكون من بولي بروسلين /بولي ميثاكريليت

الخلاصة

النمـاذج للمـواد المتراكبـة تم تحضيرها من خلط البولي بروبلين بنسبة 80% والبولي ميثل مثيا اكريليت بنسبة وزنية 20% مع مختلف النسب الوزنية من مسحوق البنتونايت وباحجام حبيبية مختلفة

</div>

وبعد ذلك جرت دراسة بعض الخواص الميكانيكية والفيزياوية والحرارية وفحص البلورية ولجميع المتراكبات المحضرة.

النتائج بينت انه بعد التدعيم لمختلف النسب الوزنية (15,12,9,6,3) % والاحجام المختلفة (110,70,60,45) مايكروميتر من مادة البنتونايت فان اغلب الفحوصات الميكانيكية ازدادت مثل (الصلادة، معامل المرونة) مع زيادة نسبة البنتونايت وصغر حجم الدقائق، اما بالنسبة الى الاستطالة فانها قلت مع زيادة النسبة الوزنية (15,12,9,6,3) % وصغر الحجم الحبيبي (110,70,60,45) مايكروميتر.

وكذلك اظهرت النتائج انه بعد التدعيم بمسحوق البنتونايت فان الاستقرارية الحرارية ازدادت مع زيادة نسبة البنتونايت (15,12,9,6,3) % وان الاستقرارية الحرارية تكون اعلى بالنسبة للحجم الحبيبي الصغير (45) مايكروميتر مقارنة بالحجم الكبير (110) مايكروميتر.

اما الامتصاصية فانها تزداد بزيادة درجات الحرارة (60,45,30) درجة مئوية وتقل مع زيادة النسبة المئوية للبنتونايت (15,12,9,6,3) % ، اضافة الى ذلك ان مقدار الطاقة (Ea) فانه يزداد مع زيادة نسبة البنتونايت وصغر الحجم الحبيبي.

اما تاثير اضافة البنتونايت على التركيب البيني للمادة المتراكبة فانه يلاحظ امتلاء الفجوات بشكل جيد بالنسبة للمادة المتراكبة.

اما تاثير اضافة البنتونايت على التركيب البلوري للمادة المتراكبة فانها تقلل من البنية البلورية والحجم الحبيبي الكبير للبنتونايت يقلل من التركيب البلوري بصورة افضل من الحجم الحبيبي الصغير.

INTRODUCTION

Composites are combination of two or more materials presented as separate phases and combined to form desired structures Navin and Vashishtha[1], used x-ray then they developed a new type of fly ash filled PP/PMMA blends system. Effect of incorporation of fly ash particulate on microstructure, strength and thermal stability has been determined and analyzed. Addition of fly ash imparted dimensional and thermal stability, which have been observed in scanning electron micrographs and in TGA plot. Increase in fly ash concentration increases the initial degradation temperature of PP/PMMA blend. The increase in thermal stability has been explained based on increases in mechanical interlocking of PP/PMMA chains inside the hollow structure of fly ash.

Abed-Alhakem[3], studied the effect of Iraqi raw ceramic (Kaoline and boxide) on the epoxy resin, he showed the tensile properties, elongation at break, Young's modules, and stress break of composites filled with proportionally small particles all increase with increasing filler content and decreasing filler size.

BalaMuruaan et al[4], studied the development and spectral characterization of polymethylmethacrylate/ Hydroxyaptite composite for biomedical application. Among the composite materials (ceramic/ metals, ceramic/ polymers and ceramic/ ceramics) available, ceramic/ polymer composite possesses significant advantages of high mechanical reliability (polymers) and excellent biocompatibility (ceramics) for applications in load bearing areas. The study is an attempt to develop a ceramic/ polymer composite made by grafting characterized using spectral techniques.

Suryasaralhi and Mahanwar[23], studied the effect of added (mica) with variable particle size on the mechanical, thermal, electrical, rhetorical and morphological properties of filled Nylon [6]. They showed improved mechanical, thermal as well as electrical properties on addition of filler. It is also observed that mechanical properties, electrical properties as well as thermal properties increase with decrease in particle size.

Anshulshal[5], found that fillers such as carbon black and clay, which are currently used in polymer blends (PS/PMMA) improve the physical properties of the material, also can hinder the adhesion at polymer interfaces. Fillers can block polymer diffusion by interacting with the polymer molecules and pinning them, causing adhesive failure. However, he started demon that this effect can be overcome by the addition of colloidal silica particles, by where the surface interaction is screened.

Mustafa [6], prepared polymer blend of polypropylene (PP) and polymethylmethacrylate (PMMA) with Kaoline filler (5,10,15) w% in different particle size (40,60,80,100) mixing of PP, PMMA and Kaoline was carried out then the mixture was further mixed using mixing machine and single screw-extruder operated at a temperature ranging from (120-200C°). In order to determine the performance of polymer blend prepared. in this work several mechanical and physical tests were carried out before and after filler (Kaoline) added to PP/PMMA. Results obtained in this study indicate that most mechanical properties such as (tensile strength, impact, hardness and elasticity) except elongation at break percent increase after adding reinforcement with (5,10,15) w% of kaoline and the same properties also increase with decrease in particle size of filler. The absorption test was carried out in water, the results of absorption show that it obeys Fick's law and after the addition of Kaoline the absorption decreases.

Mahmood [7], prepared polymer blend of polypropylene (PP) and polycarbonate (PC) with carbon black (1%). Mixing of PP, PC and carbon black was carried out then the mixture was further mixed using mixing machine and single-screw extruder operated at a temperature ranging from (120-200C°). In order to determine the performance of polymer blend prepared in this work several mechanical and physical tests were carried out before and after exposing the samples to weathering test. Results obtained in this study indicate that most mechanical properties such as (tensile strength, impact, hardness and elasticity) except percentage of elongation at break increase after reinforcement with (1%) of carbon black. The absorption test was carried out in oil (kerosene) H_2SO_4 (2N) and NaOH (2N), the results of absorption show that it obeys Fick's law and after the addition of carbon black the absorption decreases.

Al-Allaq [9], prepared polymeric blends from epoxy resins, unsaturated polyester and polysuliphed rubber with (0%-100%) ratio as binary blends. To study the mechanical properties and thermal properties and microscope structure, then she prepared two types of composite which consist of matrix of (pure polymer and polymer blends) and carbon fiber + glass fiber as filler. Al-Allaq Found that when comparing the mechanical properties of composite materials based on the pure polymer matrix and those of composite materials based on polymeric blend it can be seen that composite materials based on blends matrix have improvements in the tensile strength as well as in the thermal stability In this work development of a new type of PP/PMMA blend filled with local Iraqi Bentonite as filler using single screw extruder and molding compression. Determining the morphology, ultimate tensile strength, thermal properties, x-ray, diffusion, hardness, elastic modulus and elongation of filled and unfilled PP/PMMA blends.

EXPERIMENTAL WORK
Matrix (polymer raw materials)

Commercial grade polypropylene (pp) was supplied by Sabic – Saudi Arabia. The
melt flow index and the density of this material were 11gm/10min and 0.98
(gm/cm³) respectively, melting temperature was (168C⁰).

Commercial grade of polymethylmethacrylate (PMMA) was supplied by M/S
Monika Plastic – India. The density of the material was 1.19 (gm/cm³). Melting
temperature was (160C⁰) and the melt flow index was 1 gm/10 min [10].

Reinforced (filler) materials

Bentonite clay (BN) has particle size of 110μm and density (2.55) g/cm³. It has a
good strength, stiffness, and it is able to absorb moisture and available at low cost.
Bentonite was supplied by Iraqi National Company for Geological Survey and
Mining. Mineralogy of Bentointe: ca-montmorillonite. Its chemical composition is
shown in the following table: - [11]

Table (1) Chemical composition of Bentonite [11].

Sio_2%	Al_2O_3%	Fe_2O_3%	CaO%	MgO%	Na_2O%	K_2O%	P_2O%	So_4%	CL%	LiO_3%
56.77	15.67	5.12	4.48	3.42	1.11	0.60	0.65	0.59	0.57	9.49

PROCEDURE
Extrusion procedure

(PP, PMMA) granules and (Bentonite powder) were dried in an air circulating
oven type (Hs.31A, Germany) at 70C° for 4houres.Weighed amount of material
were mechanically mixed, at various composition were prepared (PP/PMMA)
(80/20) %wt blend and (0,3,6,9,12,15) %wt concentration filler (Bentonite) of
different particle size (45,60,70,110) μm were prepared. This mixture was then fed
into 25mm single screw extruder. The barrel temperature was monitored and
controlled by thermostats. The die temperature was also controlled by a thermostat
and was adjusted together with barrel temperature yield uniform output. Feed,
compression and metering zone temperature listed in table (3).

The extrudates produced in the form about of (1.5-2) mm diameter sheet were
cooled in water). The composite sheet was cut and put in the mold.

Table (3) Extrusion Parameter [10].

polymer	Temperature C°				Screw speed r.p.m
	Zone 1	Zone 2	Zone 3	Zone 4	
PP/PMMA	190C°	220C°	240C°	220C°	20
PP/PMMA/BN	190C°	220C°	240C°	220C°	20

Molding process

The mold was prepared, wrapped with glycerin solution.
(Three to four mm) thick sheet was prepared by hot pressing the sheet between
hydraulic press at 180C° for (PP/PMMA/Bentonite).

A pressure of 20 kg/cm^2 was applied for 5 minutes to allow the composite to melt and spread out between plates.

Pressure was then increased to 200 kg/cm^2 for further 5 minutes. The compression molding parameters are listed in table [4].

The pressure was removed and the mold sheet was quenched in water at room temperature.

Table (4) Compression Molding Parameters.

Temperature C°		Pressure (kg/cm^2)	Time (minute)
Upper Plate	Lower Plate		
180C°	180C°	20	5
180C°	180C°	200	5

PHYSICAL PROPERTIES

Diffusion and permeability of the prepared polymeric blends

The prepared samples (composite different weight and different particle size) were weighted by using digital balance (Sartorious – Germany). The weight gave the value m_1. all the specimens were immersed in acid (H_2SO_4 solution) with concentration of (1N), (28ml H_2SO_4/1L H_2O). after that the specimens were placed in a water bath (electro – MAGAS) ikitelli O.S.B, Demircilersitesi (B$_7$ BLOK NO: 153) (M96K) at different temperature (30C°, 45C°, 60C°).the samples were reweighed after the immersion. The samples in water bath and this gave the value m_2.the process was repeated for several weeks and the percentage of absorption was calculated by using the below equation:

$$\text{Absorption \%} = \frac{M_2 - M_1}{M_2} \times 100 \qquad \text{….. (1)}$$

Then from Fick's second law, diffusion coefficient can be determined by using equation

$$[D \; \pi \cdot \left(\frac{kb}{4m\infty}\right)^2] \qquad \text{…… (2)}$$

Where K is the slope of the linear portion of the plot of Mt versus t1/2. **Mt** (change of weight with time). b is thickness of specimen [24]. E is the activation of diffusion process. E can be calculated from relationship between Ln D (Diffusion coefficient) with 1/temperatures. Slope of straight line of this relation equals E/R. R is the gas constant .Temp at (30, 45, and 60).

Morphology tests

Suited plates were chosen of microscope examination, they were put on a glass holder, were covered with a glass slide, and were watched at 100 fdd magnification.

MECHANICAL PROPERTIES

Hardness Tests

Shore a hardness was measured using ZWICK hardness machine available in National Company for Chemical and Plastic Industries. Tester type 7901, Test was carried out according to DIN 53505, ASTM (D1706 – 61) and (ISO DR 988)[12].

Tensile tests

 Tensile properties were obtained using an Instron tensile tester machine (model 1445) on dumbbell – shaped die – cut sample according to ASTM (D638)[13]. Specimens were cut and their thickness was determined with a micrometer having resolution of 0.025 mm (0.001 inch). Available in National Company for Chemical and Plastic Industries.

Elongation

Elongation was measured by using ZWICK machine. The measurement was carried out according to the test specification of ASTM (D638) [13] available in National Company for Chemical and Plastic Industries

X – Ray measurement

X- Ray analysis of the samples was done on Phillips X- Ray diffractmeter (Model pw1840) Intensity value was recorded between $10° – 70°$, 2φ angle, scan speed 3 degree / minute. Wide – angle X- Ray Diffraction (XRD) was used to examine the extent of dispersion of clay (Bentonite) in filled sample. XRD patterns were obtained on the SCINTAG pad V theta - 2φ Goniometer with SI (LI) PELTIER detector, using CUKA radiation with wave length $\lambda = 1.54$ angstroms. Typical power setting is 20mA and 40 KV. The scan rage is 2 – 30 Degree with scan rate of 3^0 /minute.

Thermal properties

Thermal analysis

Thermal analysis of samples before and after reinforcement was done on ZWICH thermal analyzer (Z405 ZWICK), (DIN 16927) specified polymer sheet duration of 60 minutes and 4 mm thickness[12]

RESULTS AND DISCUSSIONS

Physical properties:

Morphology:

The microstructures of (PP/PMMA) (80/20) wt% blend are showed in Fig. (1). PMMA, which is a brittle polymer, was presented as a second phase in (PP) matrix. (PP) acts as a matrix and is of white color in the micrograph spread all over the surface as spherulite and (PMMA) was in discrete from a block portion. (PMMA) was reported to be in the form of small balls distributed evenly in the (PP) matrix[1]. This system shows the morphology of incompatible blend. Both the phases are observed in the micrograph. Our result, is in good agreement with result obtained by Hashmi[2], Frank[16] and Navin Chand[1].
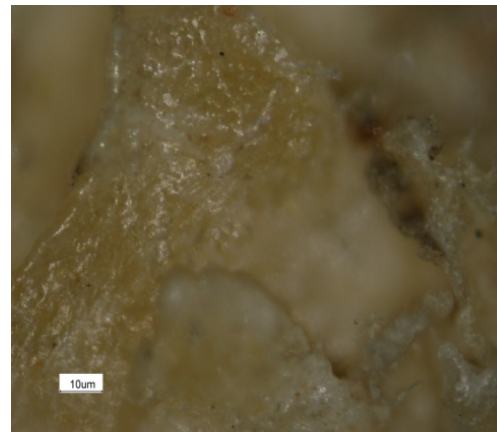
Figure (2) and (3) show optical surface microstructure of 15% (75gm) of Bentonite at (70 and 45 µm particle size) filled (PP/PMMA) (80/20) wt%. (PP/PMMA) blend were an incompatible blend. PMMA was found evenly distributed in the form of small balls / globules in the PP matrix. Shape of PMMA globules were not uniform and the size in the range (2-30) µm.

It can be seen that globules of PMMA were poorly bonded with the matrix phase (PP) during fracture of blend. It has been observed the PMMA present in the form of globules which comes out and creates cavities and fracture in brittle manner.

(PP/PMMA) blend fractured surface has river pattern type morphology. Due to a large difference in melting point of PP and PMMA and lack of co-crystallization owing to difference in the molecular structure, both the polymers showed incompatibility in the solid state. It was clear that, the filler (Bentonite, yellow portion) filled the cavities which were present in PP/PMMA blend. Also it shows that the filler with particular size 45µm (15% of Ben.) filled these cavities more than filler with particular size 70μm (15% of Ben.). Our results are in good agreement with the results obtained by NAVIN CHAND [1]. Other samples show the same behavior (for example 3%).

Figure (1) Optical Surface Microstructure Of Pp/Pmma (80/20) Wt% Blend.

Figure (2) Optical Surface Microstructure of 15% Ben. (70µm particle size).
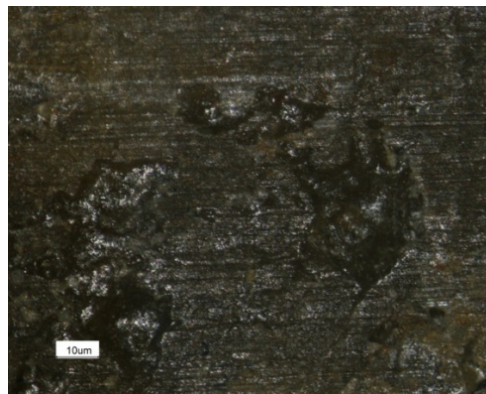
Figure. (3) Optical Surface Microstructure of 15% Ben. (45µm particle size).

Diffusion coefficient for H_2SO_4:

 Figurs. (4 to 10) show the relation between the weight gain with the square root of time of exposure for filled PP/PMMA unfilled with different amount of Bentonite (3-15) wt% at different particle size (45-110) µm, at three temperatures (30,45 and 60) C°. It is clearly seen that the behavior of the tested samples fills obeys the Fickian law. The weight gain of these samples increases with the increase in time of

exposure until it reaches a maximum value after which it will decrease. The diffusion coefficients for the above samples were calculated using equation (D= $\pi(kb/4m_\infty)^2/60$, k was obtained from the slope of the straight lines in figs. (4 to 10). It is clearly shown that the calculated values of (D) decrease as the amount of filler increases Table (5).

Table (5) Diffusion coefficient calculated for PP/PMMA unfilled/filled with different filler content and particle size.

45 µm particle size of BN			
Filler content	Filler content	Filler content	Filler content
3%	3%	3%	3%
6%	6%	6%	6%
9%	9%	9%	9%
12%	12%	12%	12%
15%	15%	15%	15%
PP/PMMA	PP/PMMA	PP/PMMA	PP/PMMA
110 µm particle size of BN			
Filler content	Filler content	Filler content	Filler content
3%	3%	3%	3%
6%	6%	6%	6%
9%	9%	9%	9%
12%	12%	12%	12%
15%	15%	15%	15%
PP/PMMA	PP/PMMA	PP/PMMA	PP/PMMA

The diffusion coefficient value decreases, this is due to the fact that as the filler increases the local stress on the sample increases. Thus the permeability of acid inside the sample will be difficult [14]. In this work it is also clear that as the particle size of the filler increases the diffusion coefficient obtained increases. This may be due to the fact that as the particle size increases, the surface area increases, thus pore size and interspaces' between pores will increase; therefore the absorption will be increased [15].
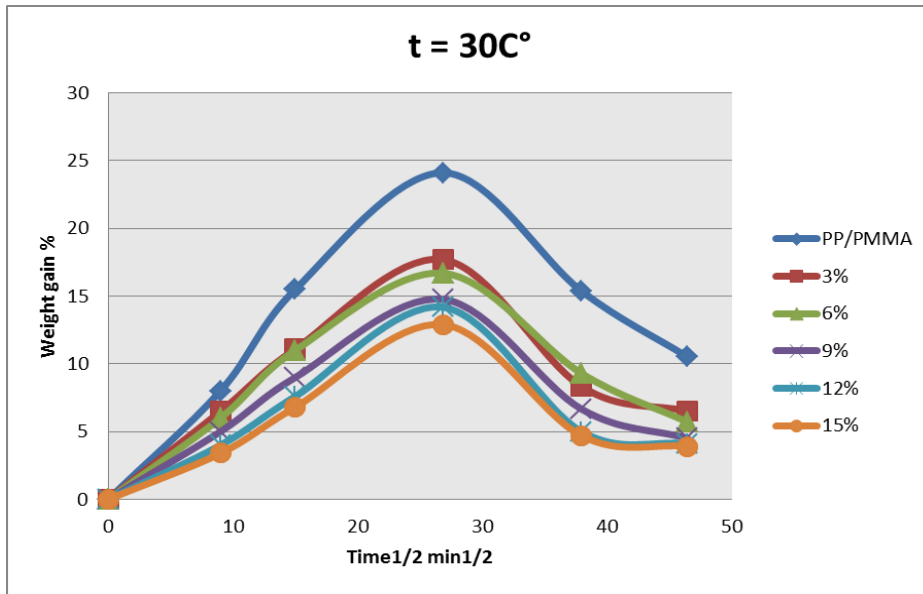
Figure (4) Relation between weight gain % and time$^{1/2}$ of PP/PMMA/unfilled/filled with different weight and particle size of BN at 110 µm at t= 30C°.
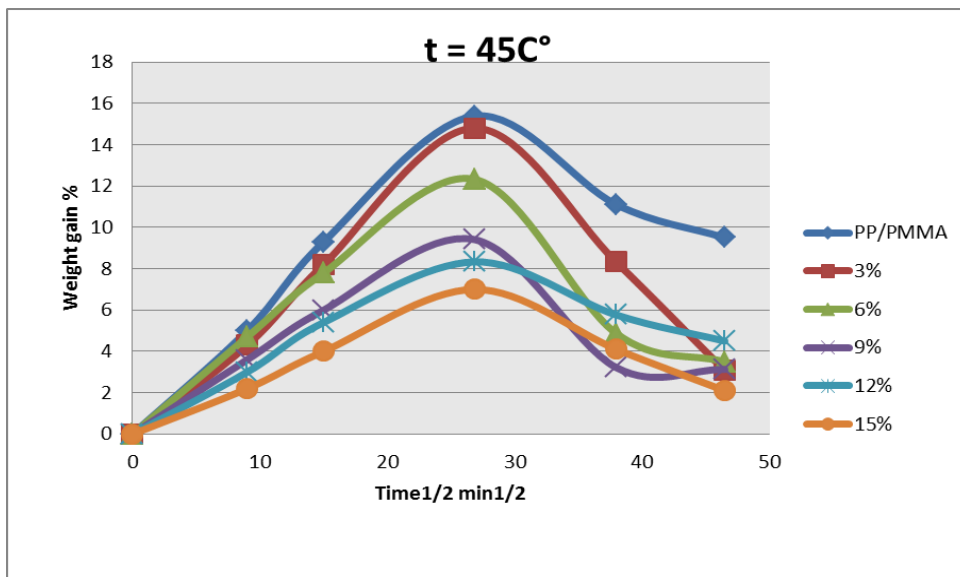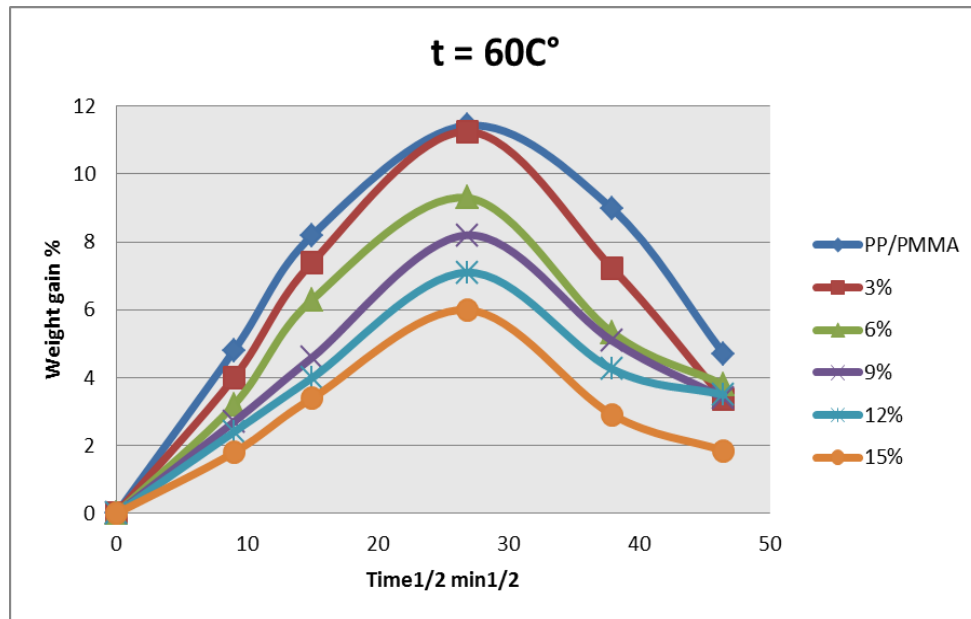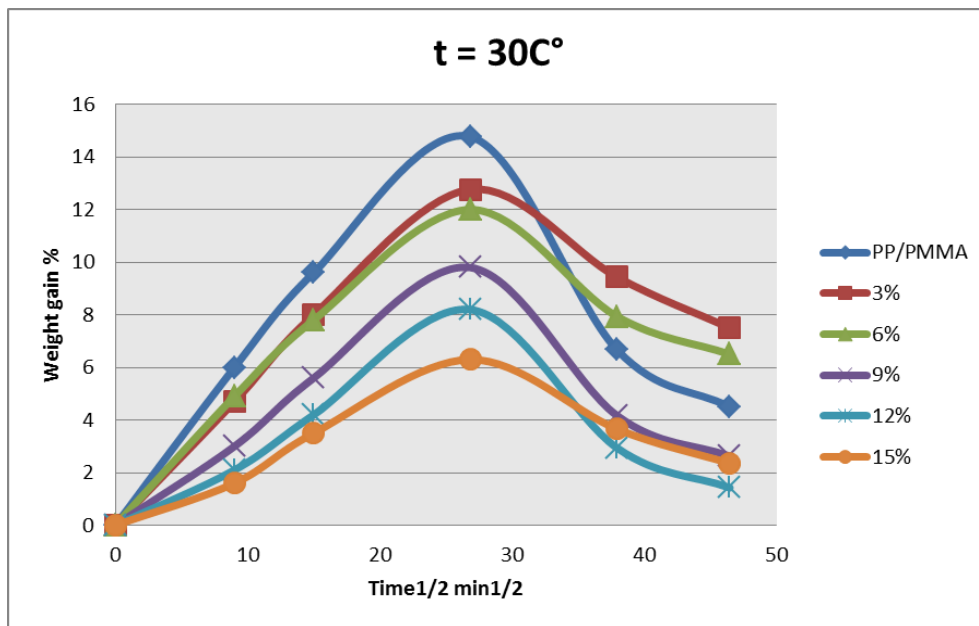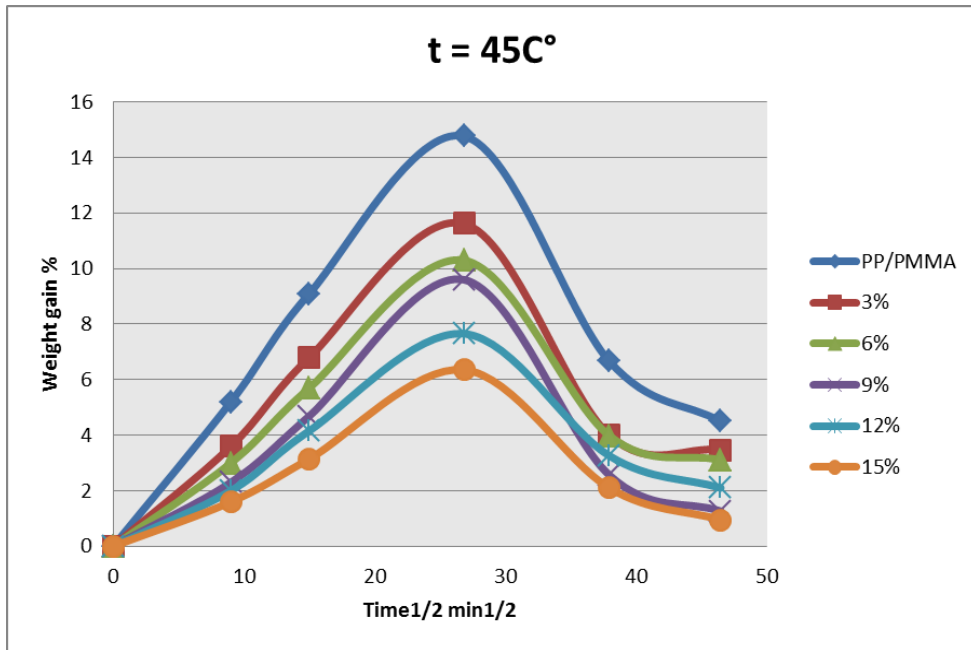

Figure (5) Relation between weight gain % versus time$^{1/2}$ of PP/PMMA/unfilled/filled with different weights and particle sizes of BN at 110 µm at t= 45C°.

Figure(6) Relation between weight gain % and time$^{1/2}$ of PP/PMMA/unfilled/filled with different weights and particle sizes of BN at 110 μm at t= 60C°.

Figure (7) Relation between weight gain % and time$^{1/2}$ of PP/PMMA/unfilled/filled with different weights and particle sizes of BN at 45 μm at t= 30C°.

Figure (8) Relation between weight gain % and time$^{1/2}$ of PP/PMMA/unfilled/filled with different weights and particle sizes of BN at 45 µm at t= 45C°.
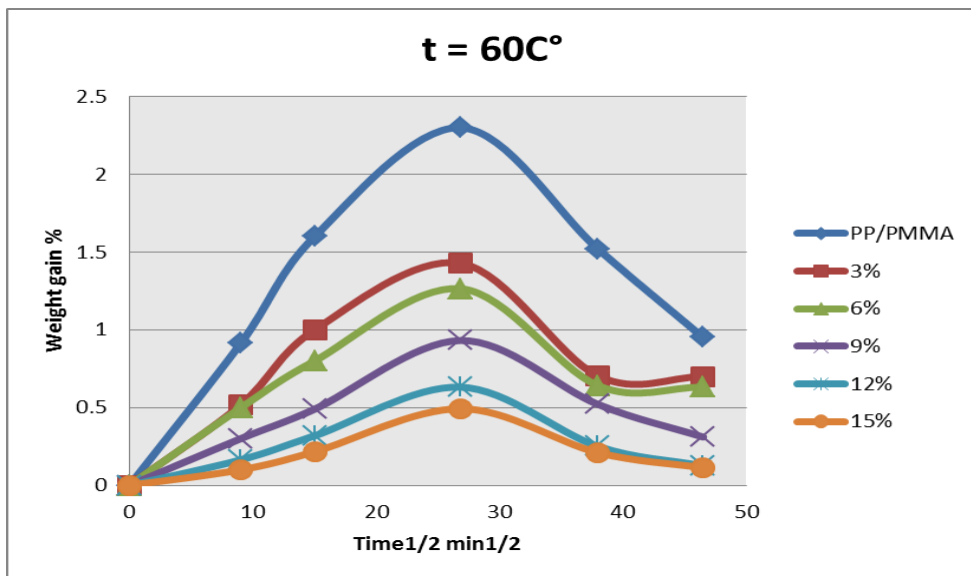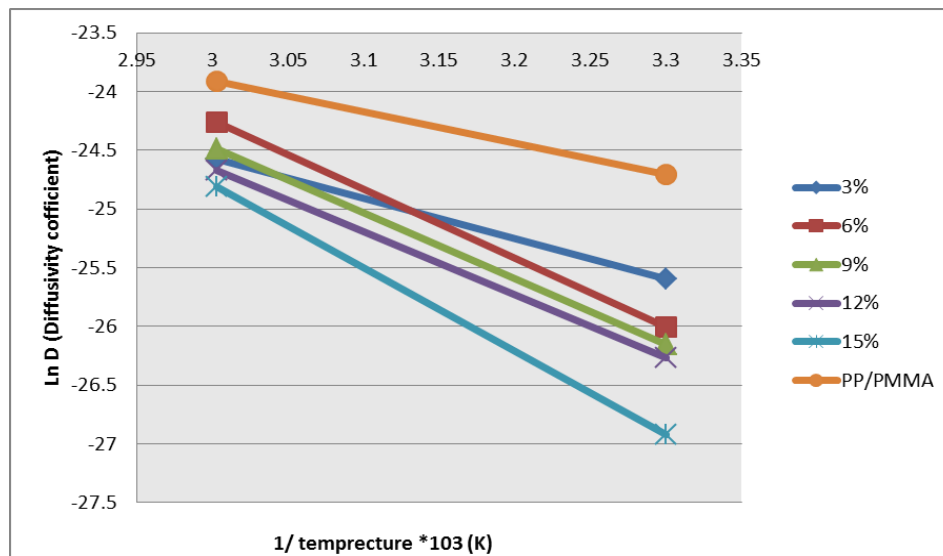

Figure (9) Relation between weight gain % and time$^{1/2}$ of PP/PMMA/unfilled/filled with different weights and particle sizes of BN at 45 µm at t= 60C°.

Figure(10) Relation between Ln D (diffusion coefficient versus 1/ Temp.) for PP/PMMA unfilled/filled with different wt% of BN filler at particle size (110) µm at three temps. (30C°, 45C° and 60C°).

X – RAY MEASUREMENT

Figures. (10) and (11) illustrate the x-ray diffraction pattern of (PP/PMMA) blend unfilled/filled with (45µm, 15% Bentonite). The characteristic intensity peaks of (PP) are recorded at (10.0, 13.4, 18.1 and 20.6) 2θ values and the calculated d-spacing of (8.799, 6.58, 4.88 and 4.28) angstrom. Diffraction patterns of (PP/PMMA) filled with (45µm, 15% Bentonite) exhibit all reflection of (PP/PMMA) blend/along with the addition of Bentonite peaks at (26.3, 36.3, 42.0 and 42.4) 2θ angle value and the calculated d-spacing of (3.38, 2.466, 2.144 and 2.126) angstrom as shown in Fig. (11). It can be observed from these results that the particles Bentonite modified the intensities of peaks of the crystalline PP polymer present in the matrix. Peak intensity for 2θ angle at (13.4, 18.1 and 20.6) reduced to 3647 from 4843, 2862 from 4745 and 3156 from 4705 respectively. This may be explained by the fact that Bentonite particles adversely affect the crystallization of PP by increasing the discontinuity and restrict the growth of crystal and therefore crystalline peak intensity reduced in the field blend composite, this decrease in crystalline of PP due to the presence of PMMA at the time of crystallization of PP reduces the strength of PP.. The results agree with result obtained by Hashmi[2], NAVIN CHAND[1]. Figs. (11) and (12) illustrate the x-ray diffraction pattern of (PP/PMMA/ 45µm Bentonite) of (80/20/15) wt% and (PP/PMMA/70µm Bentonite) of (80/20/15) wt%. The characteristic intensity peaks of PP are recorded at (10.8, 11.7, 12.2, 13.9, 15.7, 16.4, 18.2, 19.6 and 21.2) 2θ values and the calculated of d-spacing of (8.1, 7.5, 7.2, 6.3, 5.6, 4.8, 4.5 and 4.1) angstrom as shown in Fig. (12). The peak intensities for PP at (13.7, 16.4, 18.2 and 21.2)2θ values are reduced to 3352 from 3647, 2725 from 3901, 2529 from 2862 and 3117 from 3588. This may be explained by the fact the addition of (70 micron of 15wt% Bentonite) adversely affects the crystallization of PP than (45 micron of 15wt% Bentonite) by increasing

the discontinuity face and restricting the growth of crystal in the blend composite. This result shows that large particle size of filler is better than small to reduce the crystallization of PP. this result agrees with results obtained by Navin[1], Hashm(2).

Figure (4-11) X-Ray diffraction pattren of PP/PMMA (80/20) wt%.
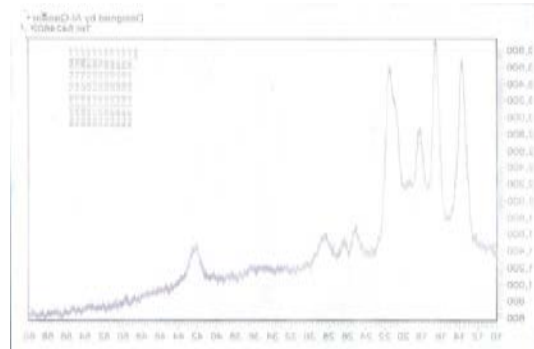
Figure(4-12) X-Ray diffraction pattren of PP/PMMA/45 Mic. meter Bentonite (80/20/15) wt%.
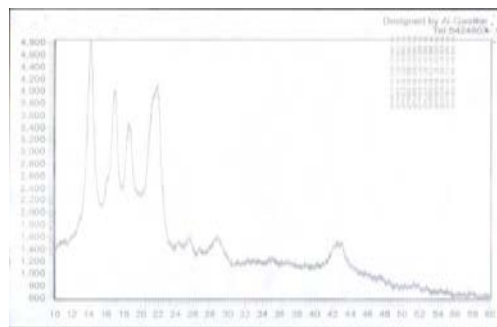

Figure (4-13) X-Ray diffraction pattren of PP/PMMA/70 Mic. meter BN (80/20/15) %wt.

MECHANICAL PROPERTIES
Hardness

Figure (13) shows the effect of weight fraction and particle size before and after reinforced (Bentonite) addition on shore hardness. It was clearly seen that the increase weight fraction of the filler increase in hardness and the hardness increases with decreasing particle size. The addition of Bentonite filler increases the hardness of composite material due to increase in the resistance strength of polymer to plastic deformation(6, 3). This result agree well with results obtained by Abed Al-Hakem[3],Mustafah[6], .
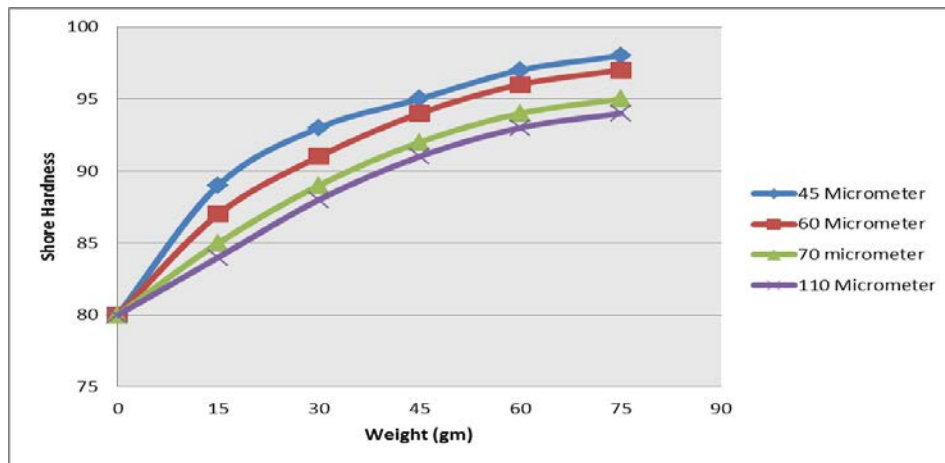
Figure (14) Relation between the shore hardness of PP/PMMA sample and weight fraction of Bentonite filler with different particle size.

Tensile strength
Eelastic modules

It is clearly seen that the modulus of elasticity increases with increasing weight fraction of filler and decreases with increase particle size of filler, this may be attributed to the fact the Young's modulus of composite depends on the Young modulus of the weight fraction and particle size of filler. These results agree well with results obtained by Sumita[17], Mustafa[6], Mohammed[20] they found that the Young's modulus of composite increases with increases filler content and decreases with filler size. This variation in Young's modulus in both cases indicates good dispersion of smaller particle size of the filler than of larger particle size at lower filler loading. The smaller particle size filler agglomerate hence reduces the strain value restriction of mobility of matrix chains. The mobility of matrix chains and agglomeration of smaller particle size filler are clearly indicated by the increase in Young's modulus with higher rate

than that of large particle size of filler[19].The value of elastic modulus increases because the Bentonite material is a brittle materials (ceramic material) therefore, it decreases the strain rate and increases the value of the matrix, this leads to increase the elastic modulus according to Hooke's Law. When the weight fraction increases in the polymer blend then that leads to agglomeration, consequently, the distribution of tensile stress will be irregular(21 , 25). The results agree well with results obtained by Ahmed[21], Abed Al-Hakem[3].

Elongation

It is clearly seen that the elongation increases with increasing of the applied stress before reinforcement. After reinforcement this depends on the type of matrix material, the elongation decreases; at the same applied force; when the weight fraction of filler increases and the elongation will increase when the particle size of filler increases because the elongation of polymeric composite depends on the elongation of filler, polymer, weight fraction and particle size[18]. These results agree well with the results.

Thermal properties
Thermal stability

Figur (18) and Fig. (19) show residual weight percent changes with respect to temperature for different contents of filler (0, 3, 6, 9, 12, and 15) wt% and different particle size of filler (45 and 110) µm. an increase in filler content leads to increase in thermal stability of the composite. It's clear that the composite material of PP/PMMA/45µm Bentonite has higher thermal stability than that of composite material PP/PMMA/110µm Bentonite because smaller particle size increases interstitials volume or increases matrix filler surface contact. Also a significant increase in heat temperature was expected because inorganic filler have high thermal stability [23].

These results agree well with results obtained by Hashmi, he showed that increase in red mud content raises the thermal stability of PP/PC blend[2]. Also these results agree with results obtained by NAVIN CHAND [1].

btained by Hassan[22].
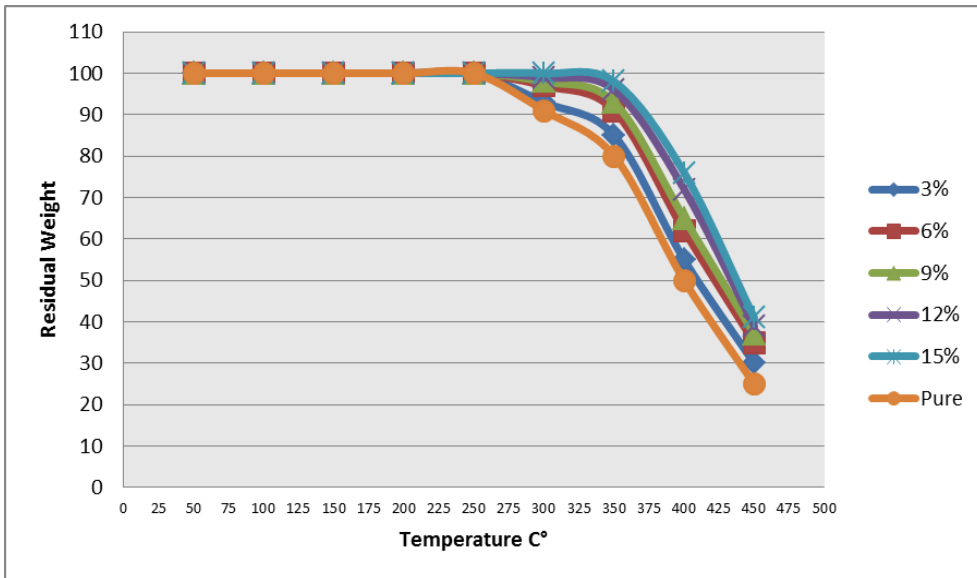
**Figure (15) Effect of addition of 110 µm of BN filler on
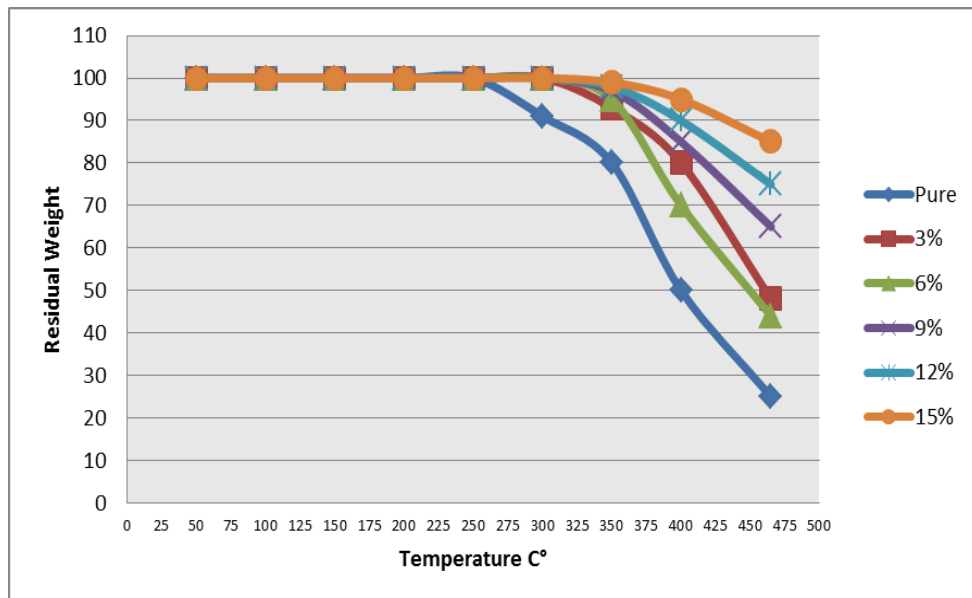thermal stability of PP/PMMA blend.**

Figure (16) Effect of addition of 45µm of BN filler on thermal stability of PP/PMMA blend.

CONCLUSIONS

At the end of this study about polymeric reinforced with mineral   clay some conclusions are drawn:

The mineral clay (Bentonite) was found to improve the modulus of elasticity and hardness. The modulus of elasticity and hardness increase with increasing wt% and decrease in particle size for PP/PMMA blend after reinforcement with Bentonite filler.

The elongation of unfilled (PP/PMMA) blend is large. After addition of different amounts of Bentonite filler, the elongation is decreased with increase in filler content and decreases with particle size decrease.

Bentonite particles of PP/PMMA blend increase the discontinuity and restrict the growth of crystal and therefore crystalline peak intensity is reduced in filler blend composite. Also large particle sizes of Bentonite adversely affect the crystallization of PP. The thermal stability of PP/ PMMA blend increases with the addition of Bentonite and the thermal stability of small particle size is higher with large particle size.

The diffusion coefficient (D) is increased with temperature and decreases with filler content increase, also activation energy (E) increases with filler content (BN) increase and (E) increases.

REFRENCES
[1]. ANAVIN CHAND and VASHISHTA S. R., Bull. Mater. Sci, Vol.23, No.2, April (2000),www.ias.ac.in/ matersci/bmsaper2000/103.pdf .

[2]. Hashmi SAR "Development of Redmud Filler Polymer Composite Rheological, and Mechanical Properties, Ph.D. Thesis, Barkatullah University, Bhopal, (1996). (Internet).

[3]. AAbed- Al Hakem, RH "The effect of Iraqi raw ceramic (Kaolin and Boxide) on the Epoxy Resin", M.Sc. thesis U.O.T., (2003).

[4]. Balamurugan A., Kannan S., Selveraj, and Rajes Waris., Trends Biomater Artif. Organs., Vol. 18(1), p.41, (2004), (www.angelfire.com/sd/sbaio/vol.18(1).htm).

[5]. Anshul Shah, File://A the/ effect/ filler/ on/ adnesion/ of/polymer/ blend/ interfaces, 2005.

[6]. Mustafa, S. N. "Study of Physical and Chemical Properties of polymer blend with Iraqi filler" M.Sc. Chem. Eng., Thesis U.O.T., (2006).

[7]. Mahmood, W.K. "processability and effect of UV padition on some mechanical properties of polycarbonate, polypropylene blends" thesis of M.S. Chemical Engineer University of Technology, 2006.
particle size of BN filler decreases.

[8]. Hamid, A.M., "Development and investigation of blended polymeric matrices composites", thesis of Ph.D., University of Technology, 2006.

[9]. Al-Allaq N.A., "investigation of thermo-mechanical properties of blends polymer composites", thesis of Ph.D., University of Technology, 2006.

[10]. Manna A. K., P. P. De, Pendyala V.N.S., and Xavier S.F., "Plastic Rubber and composite processing and Applications", Vol.26, NO.1, (1997).

[11].

د. خلدون بصام "المواصفات الفيزياوية والكيماوية للصخور الصناعية المستخرجة". الشركة العامة للمسح الجيولوجي بغداد / العراق ، 2004.

[12] . H. Walter, "Laboratory Methods for Testing Thermoplastic Formulation and Semis which have been processed and Manufactured on Anger APM Extruders", Vienna, June 1996 Page (13).

[13].Annual Book of ASTM, section 8, Vol. 08.01 Plastic, "Am. Soc. Test. Mat." Philadelphia, (1989).

[14]. Dewimille, B. and Bunsell, A.R., "J. of composite", Vol.14, No.1, P.35 January (1983).

[15].Comyn J., "Polymer permeability" Elsevier applied Science Publishers LTD, 1985.

[16].Frank H. P., "Polypropylene, polymer monographs" (New York: Gordon and Breach Science), Vol. 2. 1968 (Internet).

[17]. Sumiata, M., "Journal of material Science", V.17, No. 10, (October 1982).

[18]. Xavier, S. F., Schultz, J. M., "Journal of material science", Vol. 25, No. 5, P.(2411-2420), part 2, May, (1990).

[19]. Yoshinobu Nakamura, Miholya Maguchi, Masayoshi Okubo, and Tsunetaka Matsumoto, J. Appl. Polymer Sci., Vol. 44, P. 151, (1992).

[20].Mohammed J. W. "Study the effect of addition of mineral clays on mechanical properties of PP/PA6 Blend composite" M.Sc. chem. Eng., Thesis U.O.T (2005).

[21].احمد مكي "دراسة الخواص الميكانيكية لمواد مركبة باستخدام مسحوق معدني" رسالة ماجستير. هندسة المكائن والمعدات، الجامعة التكنلوجية، (2001).

[22]. Hassan, Sh. S. "Study on PE. Alumina powder particulate composite" M.S.C., Thesis U.O.T., (2002).

[23]. Survasara, Thi Bose and P.A. Mahanwar "Effect of particle size of filler on properties of Nylon-6" Journal of minerals and materials characterization and Engineering, Vol.3, No. 1, pp 23-31, 2004.

[24]. Wright, W.W., "the effect of Diffusion of water into Epoxy Resins and their carbon-Fiber Reinforced composite" J. of composite, Vol. 12, No.3, pp. 201, 1981.

[25]. Ahmed, S., Jones, F.R., composite Vol. 10, P. 277, (1988).