



Physical CHEMISTRY

An Indian Journal

Full Paper

PCAIJ, 10(6), 2015 [179-184]

Polymeric complexes related a rubber basis

Oday H.R.Al-Bodairy*, Shrooq Sabah Al-Murshidy, Eshraq M.Hassa, Inaam H.Kadhim
 Department of Physics, College of Education for Pure Sciences, University of Babylon, (IRAQ)
 E-mail: odayphy@yahoo.com

ABSTRACT

Addition of an inorganic component to polymers leads to improvements in various physical and mechanical properties. These improvements are the result of a complex interplay between the properties of the individual constituent phases: the polymer, the filler, and the interfacial region. Filler morphology such as the particle size, structure, and aspect ratio (length/diameter) have a large influence on the physical performance of the polymer composites, 5 different rubber compound were prepared by using (SBR 1502) type of Styrene Butadiene rubber in level and each recipe reinforced with Titanium Dioxide (TiO_2) at constant ratio (60) pphr (part per hundred), Stearic Acid (S.A) at variable ratio (20,40,60,80 and 100) pphr The physical properties such as Tensile, Elongation, Young Modulus and Compression were Studied. The result show that the hardness, Fatigue, Compression, wear, increase with loading level of (S.A). But the Tensile and Elongation that increase with excited ratio of (S.A) and decrease in another Value at 100 %. © 2015 Trade Science Inc. - INDIA

KEYWORDS

TiO_2 ;
 Rubber;
 Polymers;
 Elongation.

INTRODUCTION

The term rubber (elastomer) is used to describe vulcanized polymeric materials, whose glass transition temperature is sub-ambient and, amongst other properties, has the ability to be extensively and on release of stress, return to its original length The common characteristics of elastomers are their elasticity, flexibility, and toughness. Beyond these common characteristics, each rubber has its own unique properties, often requiring additives to achieve the appropriate behaviors. It is customary when discussing the formulation of rubber compounds to classify the additives by the function they serve. Rubber compounding ingredients can be categorized as: vulcanizing or cross linking agents,

processing aids, fillers, antidegradants, plasticizers and other specialty additives^[1,2].

The rubbers in the marketplace are of two main types: crosslinking system and thermoplastic elastomer. Most of the commonly used rubbers are polymeric materials with long chains, which are chemically cross linked during the curing process. This type of elastomer cannot be reshaped, softened, melted nor reprocessed by subsequent reheating, once formed^[2].

They absorb solvent and swell, but do not dissolve; furthermore, they cannot be reprocessed simply by heating. The molecules of thermoplastic rubbers, on the other hand, are not connected by primary chemical bonds. Instead, they are joined by the physical aggregation of parts of the molecules into hard domains.

Full Paper

Hence, thermoplastic rubbers dissolve in suitable solvents and soften on heating, so that they can be processed repeatedly. In many cases thermoplastic and thermoset rubbers may be used interchangeably. However, in demanding uses, such as in tires, engine mounts, and springs, thermoset elastomers are used exclusively because of their better elasticity, resistance to set, and durability^[3,4]. The reinforcement may be platelets, particles or fibers and are usually added to improve mechanical properties such as stiffness, strength and toughness of the matrix material. (Saturic Acid) that are oriented in the direction of loading offer the most efficient load transfer. This is because the stress transfer zone extends only over a small part of the PbO-matrix interface. The most common advanced composites are polymer matrix composites. Elastomer consist of a polymer thermoplastic or thermosetting reinforced by filler (TiO_2 , A.S)^[5,6]. These materials can be fashioned into a variable shapes and sizes. They provide great strength and stiffness along with resistance to corrosion. The reason for these being most common is their low cost, high strength and simple manufacturing principles. Due to the low density of the constituents the polymer composites often show excellent specific properties^[7].

EXPERIMENTAL

Materials

All materials are used in this research come from Babylon Factory Tire Manufacturing, Iraq. The structure of materials is as follows

- Styrene-butadiene rubber (SBR). with styrene content 23.5 %, Moony viscosity at 100°C = 50, specific gravity 0.94 (gm/cm), ash content 1 %. there are two types of E-SBR in the market. One of them is the hot rubber which is product at 150 °C, Whereby the molecular weight is high and depolymerization Can occur at high temperature. another type of E-SBR, cold rubber is using aredox initiator to lower the polymerization temperature to 5°C and the chain modifier is applied to control the molecular weight^[8,9]

* Titanium Dioxide (TiO_2) is found in abundance in nature as the minerals lmenite (FeTiO_3), rulite (TiO_2), and sphere (CaSiTiO_5) among other. the Theoretical density of (TiO_2) ranges from 3895 Kg/m³ for anatase

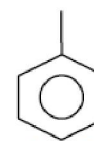


Figure 1 : The chemical formula of SBR

to 4250 Kg/m³ for rutile. The molecular weight is 79.865, melting point 1843°C, Four naturally occurring titanium dioxide polymorphs exist : rutile,anatase, brookite and titanium dioxide. Anatase and rutile are tetragonal boorkite is orthorhmbic and titanium is monoclinic^[10,11].

In all four polymorphs, titanium is coordinated octahedral by oxygen, but the position of octahedral differs between polymorphs. titanium dioxide has also been product as engineered nonmaterial, which may be equidimensional crystals or sheet and composed of either titanium dioxide–rutile or titanium dioxide–anats.

A tubular structure has been product from scrolling layers of titanium dioxide – anats

Which result in fibers with on outer diametr of about 6 nm and inner of about 3 nm. Non-scorlled nanofibers have also been produced from (TiO_2) “anatse” and (TiO_2) with diameter of 20-100 nm and length of (10-100 µm)^[12,13].

* Saturic Acid (A.s) semiconductor nanoparticles were prepared by Chemical synthesis method The molecular weight is 223.2, melting point 888 °C Saturic Acid (A.s) semiconductor nanoparticles were prepared by Chemical synthesis method. 60 ml of 1.0 M ($\text{C}_2\text{H}_3\text{O}_2$)_{2.3} H₂O (II) acetate) aqueous solution was prepared using de-ionized water and heated up to 90 °C. This solution was added to an aqueous solution of 50 ml of 19M NaOH in a beaker and stirred vigorously. Upon adding the (II) acetate, the solution initially became cloudy, and then turned a peach colour, and finally a deep orange red. At this position, stirring was stopped, and the precipitate was allowed to settle. The supernatant was then decanted, filtered on a Buchner funnel, washed with de-ionized water repeatedly, and dried for overnight in a drying oven at 90 °C. The sample was then removed and lightly crushed in a mortar and pestle. Its structural characterizations were done for confirmation of lead oxide nanoparticles^[14].

- Antioxidant (6PPD) is a materials of composition

[N-(1,3-dimethylbutyl)-N-phenyl-P-phenylenediamine] : specific gravity 1.0 (gm/cm³)^[15].

- Sulfur : Pale yellow powder of sulfur element, purity 99.0%, melting point 112°C. specific gravity 2.04-2.06 (gm/cm³)^[16].
- Zinc Oxide : fine powder, purity 99%, specific gravity 5.6 (gm/cm³).

The term rubber (elastomer) is used to describe vulcanized polymeric materials, whose glass transition

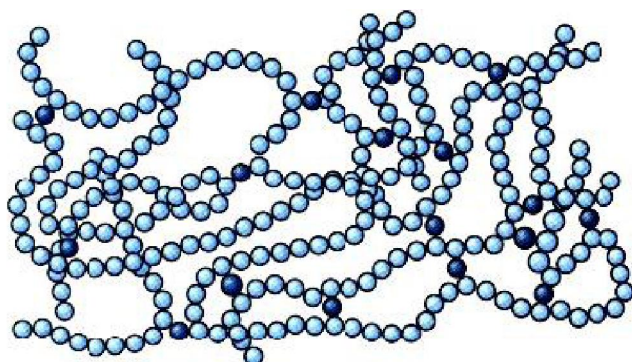
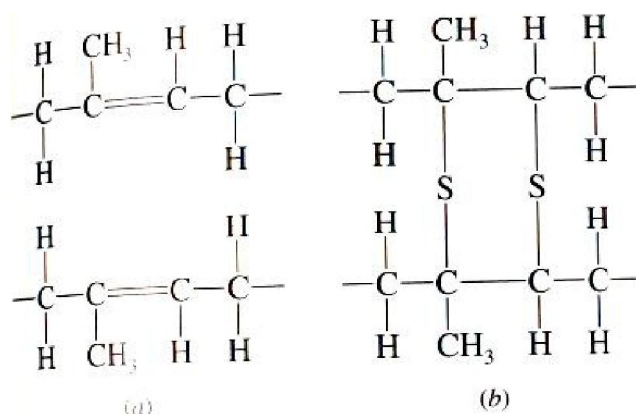


Figure 2 : Vulcanization of rubber. (a); fragments of two chains of rubber. (b) Crosslinking of the chains by sulfur. (c) sketch of rubber chains with sulfur crosslinks. The crosslinking inhibits the elastic deformation of the chains and hardens the rubber.

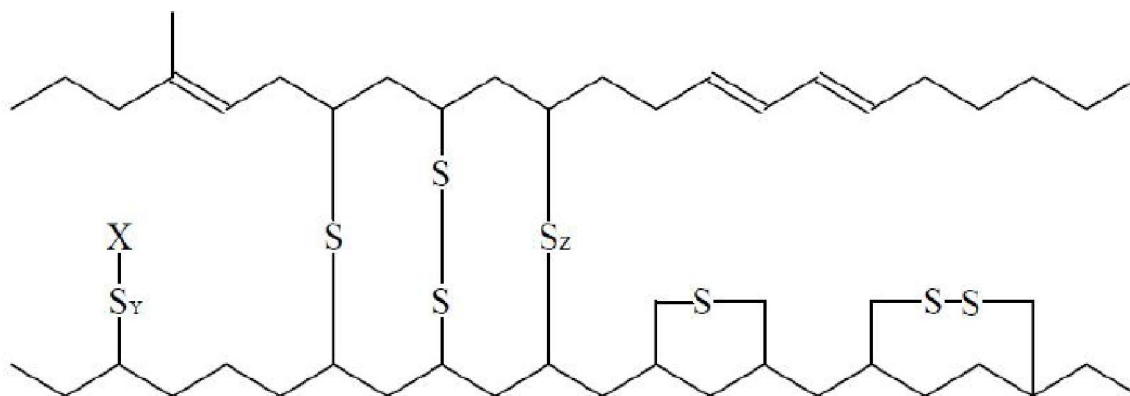


Figure 3 : Structural features of an accelerated sulfur vulcanizate of SBR Rubber (X= accelerator fragment).

temperature is sub-ambient and, amongst other properties, has the ability to be extensively and on release of stress, return to its original length. The common characteristics of elastomers are their elasticity^[17], flexibility, and toughness. Beyond these common characteristics, each rubber has its own unique properties, often requiring additives to achieve the appropriate behaviors^[18].

Rubber compounding ingredients can be categorized as: vulcanizing or crosslinking agents, processing aids, fillers, antidegradants, plasticizers and other specialty additives. The production sequence in the rubber manufacturing industry can be defined into three stages: mixing (mastication and compounding), forming, and curing. A general rubber formulation is given in TABLE 1.

Rubbers without fillers have limited end applications because of the lack of strength. With addition of particulate fillers, strength could be increased by 10 times^[18]. The properties of fillers such as size, shape, surface area and surface activity control the effectiveness of the reinforcement^[20]. The interactions between fillers and rubbers are also one of the most important factors that affect the strength of filled rubbers^[21].

This work aim to improve the properties of

TABLE 1 : A general rubber formulation^[19]

Parts per hundred parts of rubber	
rubber (SBR)	100
TiO ₂	60
Satiric acid	variable
Antioxidant	1
Zinc oxide	3
Accelerator	0.6
Sulfur	2

Full Paper

composite materials by adding the reinforcing filler (TiO_2) at constant ratio 60 %, (Satiric acid) at different loading level in addition (20,40,60,80,100), other materials like (ZnO, Rubber SBRetc) to Elastomer Styrene Butadine rubber SBR and show the Effect of (PbO) loading in pphr of SBR.

RESULTS AND DISCUSSION

Many tests is carried on to define the extent of The addition effect of the different of (PbO) on the properties of (SBR) rubber,such of this test are:

Tensile test

This test is doing on according to ASTM D-471-57T specification. The test result for tensile strength are shown in Figure (4). in addition to Rubber Compound Distinguishing that having (TiO_2) at ratio (60% pphr) that best compound because have best properties of Tensile, Elasticity Modulus and Elongation, (Satiric acid) adding to compound and frome figure that show simple increasing from Tensile in simple ratio of (Satiric acid) but cross linking increase between (Satiric acid, TiO_2) and cross linking between (Satiric acid, TiO_2) and Rubber Chain, but after (80% pphr) from (Satiric acid) notice tensile decrease When Rubber chain cannot having Filler practice.

Modulus of elasticity

This test is doing on according to ASTM D-471-57T specification. The test result for tensile strength are shown in Figure (5). in addition to Rubber Compound Distinguishing that having (TiO_2) at ratio (60% pphr) that best compound because have best properties of Tensile, Elasticity Modulus and Elongation, (Satiric acid)

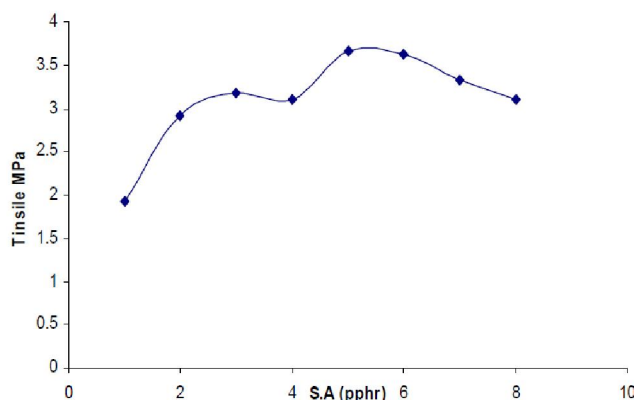


Figure 4 : Effect of (Satiric acid) on the SBR Tensile

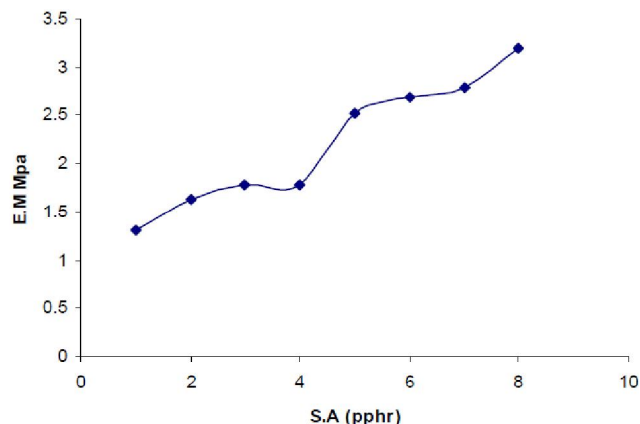


Figure 5 : Effect of (Satiric acid) on the SBR Elasticity

adding to compound and frome figure that show simple increasing from Tensile in simple ratio of (Satiric acid) but cross linking increase between (Satiric acid, TiO_2) and cross linking between (Satiric acid, TiO_2) and Rubber Chain, but after (80% pphr) from (Satiric acid) notice tensile decrease When Rubber chain cannot having Filler practice.

Elongation

The test result for Elongation are shown in Figure (6) it is seen Elongation increase with percent of (Satiric acid) at second tow value and become decrease because Physical interaction between (Satiric acid) and Rubber chain, When the grain size of filler resistance Elongation.

Hardness

Figure (7) shown the shore hardness is plotted against the loading level of reinforcing filler (Satiric acid) for SBR respectively. From this figure it can be seen that rubber hardness shows signification increment with the increasing loading level of reinforcing of (Satiric acid).

Titanium dioxide reinforcing filler have fine graen

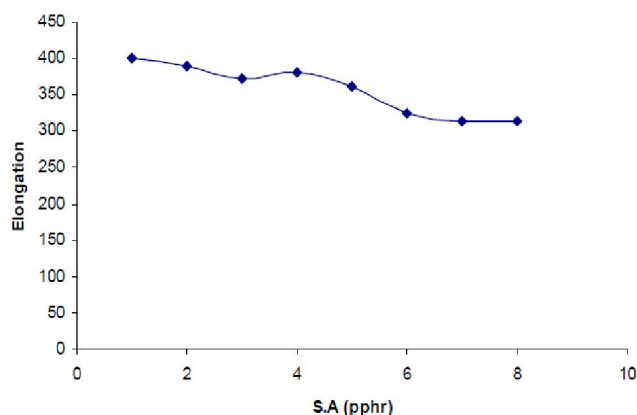


Figure 6 : Effect of (Satiric acid) on the SBR Elongation

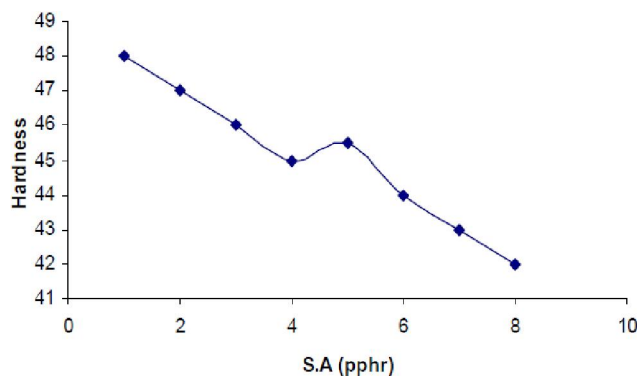


Figure 7 : Effect of (Satiric acid) on the SBR Hardness

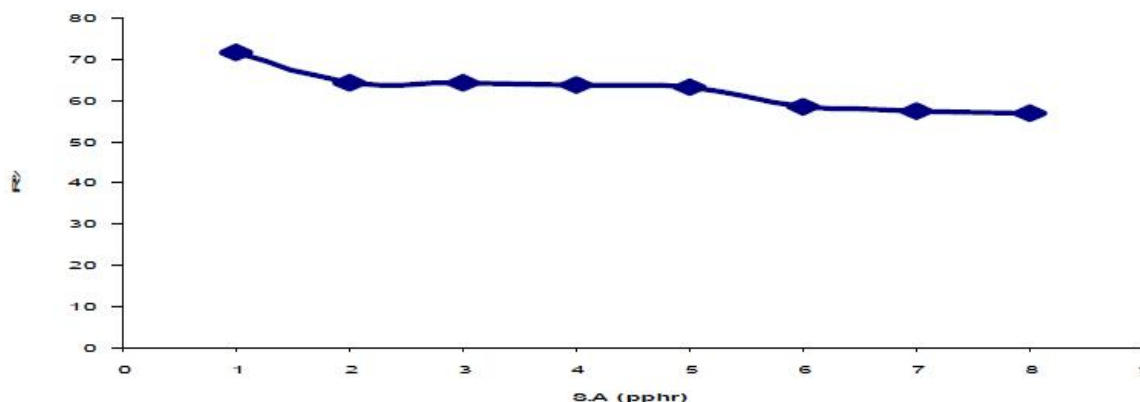


Figure 8 : Effect of (Satiric acid) on the SBR Resilience

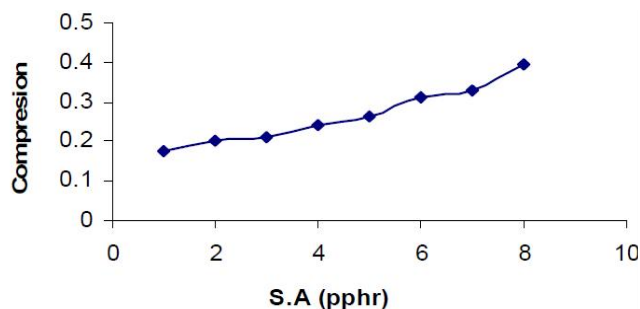


Figure 9 : Effect of (Satiric acid) on the SBR Compression

value of resinonance decrease when hardness or cross linking increase

Compression

This test is caeeded on according to ASTM D-471-57T specification. The test result for Compression are shown in Figure (9).

Because interaction between filler (Satiric acid) and rubber (SBR) that lead to increasing of cross linking at 3-dim. (Satiric acid) properties same grain size that mean it have large surface area helped it to connected with all chain polymer and resistance the load and pressure instead of covalent bond or hydrogen bond when keep surface without Buckling.

size, this mean that (Satiric acid) has larger surface area, which in contact with rubber mostly by physical bond composite with strong bond made it harder by impeding the matrix motion along the stress direction

Resilience

The relation between Resinonance and hardness is invers relation, from Figure (8) show the Resilience decrease when (Satiric acid) percent increase, because the cross linking between rubber chain that absorb energy and transford it to heat among the rubber chain.

REFERENCES

- [1] Oday Hattem Rhemh.Al-Bodairy, Mohammad H.Al-Maamori, Nehad A.Saleh; Effect of TiO_2 Percent on Transmission Properties for (X-Ray) of Rubber Compound (SBR), J. of enhanced research in science technology & engineering, **2(2319-7463)**, (2013).
- [2] Oday Hattem Rhemh.Al-Bodairy, Mohammad H.Al-Maamori, Nehad A.Saleh; Effect of tungsten percent on transmissionproperties for (x-ray) of rubber compound (SBR), J. of Academic Research International, **4(3)**, (2013).
- [3] L.Mathew; Development of Electrometric Hybrid Composite Based on Synthesized Nano Silica and short Nylon Fiber, Ph.D.Thesis, Cochin University of Science and Technology, (2009).
- [4] C.X.Viet; Curing Characteristics Mechanical prorteries Morphology of Surface Modification montmorilonite Filled Natural rubber Nano Composites, M.sc.thesis, Sains Malaysia Unvesity, (2008).
- [5] Oday Hattem Rhemh.Al-Bodairy, Mohammad H.Al-Maamori, Nehad A.Saleh; Effect of

Full Paper

- chlorophyll percent on transmission Properties for (X-RAY) OF rubber compound (SBR), J. of Academic Research International, **4(4)**, (2013).
- [6] M.Al – Maamory, Z.J.Al-asadee; Effect of NBR Perecent on the Resistance of CR/NBR Blend Rubber, J. of Polymers, **14(2)**, (2010).
- [7] M.S.Sobhy, D.E.Elnashan, N.A.Maziad; Cure Characteristic and Physicommechanical Propertise of Calcium Carbonate Reinforcement Rubber Composites, J.of Polymer.Sci, **26(2)**, (2003).
- [8] S.E.Gwaily, H.H.Hassn, M.M.Badawy; NaturalRubber Composites Thermal Neutron Radiation Shieldes II- H_3BO_4 /NR Composites, www.elesrier.com Polytest, (2002).
- [9] J.K.Olewi, M.S.Hamza; A study of The Effect of Black Carbon Powder on the physical properties of SBR / NR Blend Used In Tire Tetrad, J. of Eng & Tech, **29(5)**, (2011).
- [10] Oday Hattem Rhemh.Al-Bodairy, Mohammad H.Al-Maamori, Nehad A.Saleh; Effect of TiO2 percent on Mechanical Properties to Rubber Compound (SBR), J. of Iraqi j, of Polymers, **15(1)**, (2012).
- [11] S.Goyanes, C.C.Lopez, G.H.Rubiolo, F.Quasso, A.J.Marzocca; Thermal Properties in Cured Natural rubber/ Styrene Butadiene Rubber Blend, J. of European Polymer, **44(152)**, (2008).
- [12] M.Tian, L.Cheng, W.Liang, L.Shags; Overall Properties of Fibrillar Silicate /Styrene –Butadiene Rubber Nan Composites, J.of applied Polymer Science, **101(273)**, (2006).
- [13] S.Gnanam, V.Rajendran; Optical Properties of Capping Agents Mediatited Lead Oxide Nano Particales via facile hydrothermal Process, J. of Nanomterial and Biostructures, **1(12)**, (2004).
- [14] T.Alasaarele; Atomic Layer Deposited Titanium Dioxide in Optical Waveguiding Applications, School of electrical Engineering, (2011).
- [15] Oday Hattem Rhemh.Al-Bodairy, Mohammad H.Al-Maamori, Nehad A.Saleh; Effect of PbO percent on mechanical properties of Rubber Compound (SBR), J. Of enhanced research in science technology & engineering, **2(2319-7463)**, (2013).
- [16] J.Karger, J.Gremmels, Kaiserslautern, A.Mousa; Application of hygrothermally Decoposed polyurethane in Rubber Recipes, J. of Kautschuk Gummi kunsts toffee, **53(9)**, (2009).
- [17] J.Lee; Microstructure and Properties of Zinc Oxide Nano- Crystalline Thin Films And Composite, Ph.D. Thesis,Anckland University, (2006).
- [18] L.Kantiyong; Magnetic and Mechanical Properties of Barium Ferrite Natural Rubber Composites, M.Sc.Thesis, Kasetsart University, (2009).
- [19] M.Madani, M.M.Badawy; Influence of Electron Beam Irradiation and Step – Crossling Process Solvent Penetration and Thermal Properties of Natural Rubber Vulcanizattes, J. of Solids, **27(21)**, (2004).
- [20] Oday Hattem Rhemh.Al-Bodairy, Mohammad H.Al-Maamori, Nehad A.Saleh; Effect of pbo with rubber composite on transmission of (X-Ray), J. of Natural and Applied Sciences, **3(3)**, (2012).
- [21] J.Karger, J.Gremmels, Kaiserslautern, A.Mousa; Application of hygrothermally Decoposed polyurethane in Rubber Recipes, J. of Kautschuk Gummi kunsts toffee, **53(9)**, (2009).