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Effect of PbO percent on mechanical properties of Rubber Compound (SBR)

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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), (PbO) 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 shows that the hardness, Fatigue, Compression, wear, increases with the loading level of (PbO). But the Tensile and Elongation that increase with excited ratio of (PbO) and decrease in another Value at 100% .

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 crosslinking 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 crosslinked 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. 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. (PbO) 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 (TiO2, PbO) [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 1ooºC = 50 , specific gravity 0.94 (gm/cm), ash content 1 %. There are two types of E-SBR in the market.

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One of them is the hot rubber which is product at 150 ºC, 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 5ºC and the chain modifier is applied to control the molecular weight [8,9]

$(CH_2 - CH == CH - CH_2 - CH_2 - CH) n$

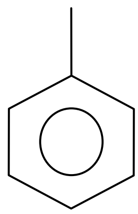

Figure (1) the chemical formula of SBR

* **Titanium Dioxide (TiO2)** is found in abundance in nature as the minerals lmenite (FeTiO3), rulite (TiO2) ,and sphere (CaSiTiO5) among other. The theoretical density of (TiO2) ranges from 3895 Kg/m3 for anatase to 4250 Kg/m3 for rutile. The molecular weight is 79.865, melting point 1843ºC, Four naturally occurring titanium dioxide polymorphs exist : rutile ,anatase, brookite and titanium dioxide. Anatase and rutile are tetragonal boorkite is orthormbic 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 equi dimensional 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 diameter of about 6 nm and inner of about 3 nm. Non-scrolled nanofibers have also been produced from (TiO2) "anatse" and (TiO2) with diameter of 20-100 nm and length of (10-100 µm) [12,13].

* **Lead Oxide (PbO)** semiconductor nanoparticles were prepared by Chemical synthesis method The molecular weight is 223.2, melting point 888 °C Lead Oxide (PbO) semiconductor nanoparticles were prepared by Chemical synthesis method. 60 ml of 1.0 M Pb (C2H3O2)2.3 H2O (lead (II) acetate) aqueous solution was prepared using de-ionized water and heated upto 90^0 C. This solution was added to an aqueous solution of 50 ml of 19M NaOH in a beaker and stirred vigorously. Upon adding the lead (II) acetate, the solution initially became cloudy, and then turned a peach color, 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 oC. 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- phynel-P-phenlenediamine]: specific gravity 1.0 (gm/cm3) [15].
- Sulfur: Pale yellow powder of sulfur element, purity 99.0%, melting point 112ºC, specific gravity 2.04-2.06 (gm/cm) [16].
- Zinc Oxide: fine powder, purity 99% , specific gravity 5.6 (gm/cm3).
- Steric acid: melting point 67-69 ºC, specific gravity 0.838 (gm/cm3) [17].

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 [18], flexibility, and toughness. Beyond these common characteristics, each rubber has its own unique properties, often requiring additives to achieve the appropriate behaviors [19]. Rubber compounding ingredients can be categorized as: vulcanizing or crosslinking agents, processing aids, fillers, anti-degradients, 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).

Table (1) A general rubber formulation[20]

	Parts per hundred parts of rubber
rubber (SBR)	100
TiO2	60
PbO	variable
Antioxidant	1
Stearic acid	1.5
Zinc oxide	3
Accelerator	0.6
Sulfur	2

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 (Hamed and Park, 1999). The properties of fillers such as size, shape, surface area and surface activity control the effectiveness of the reinforcement (Lee, 2007). 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 composite materials by adding the reinforcing filler (TiO2) at constant ratio 60%, (PbO) at different loading level in addition (20,40,60,80,100), other materials like (ZnO, Steric Acid, Rubber SBR….etc) to Elastomer Styrene Butadine rubber SBR and show the Effect of (PbO) loading in pphr of SBR.

Results and Discussion

Many tests are 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 (2).in addition to Rubber Compound Distinguishing that having (tiO2) at ratio (60% pphr) that best compound because have best properties of Tensile, Elasticity Modulus and Elongation, (PbO) adding to compound and from figure that show simple increasing from Tensile in simple ratio of (PbO) but cross linking increase between (PbO,TiO2) and cross linking between (Pbo,TiO**2**) and Rubber Chain ,but after (80% pphr) from (PbO) notice tensile decrease When Rubber chain can not having Filler practice.

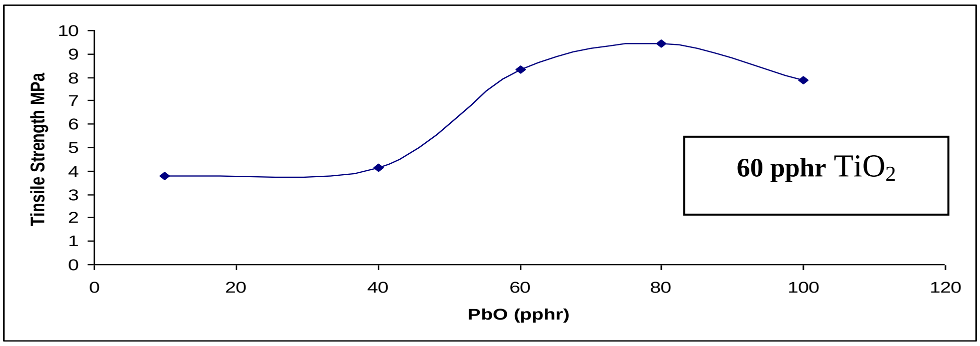

Figure (2) Effect of (PbO) on the SBR Tensile

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 (3).in addition to Rubber Compound Distinguishing that having (TiO2) at ratio (60% pphr) that best compound because have best properties of Tensile , Elasticity Modulus and Elongation , (PbO) adding to compound and from figure that show simple increasing from Tensile in simple ratio of (PbO) but cross linking increase between (PbO,TiO2) and cross linking between (Pbo,TiO2) and Rubber Chain ,but after (80% pphr) from (PbO) notice tensile decrease when Rubber chain can not have Filler practice.

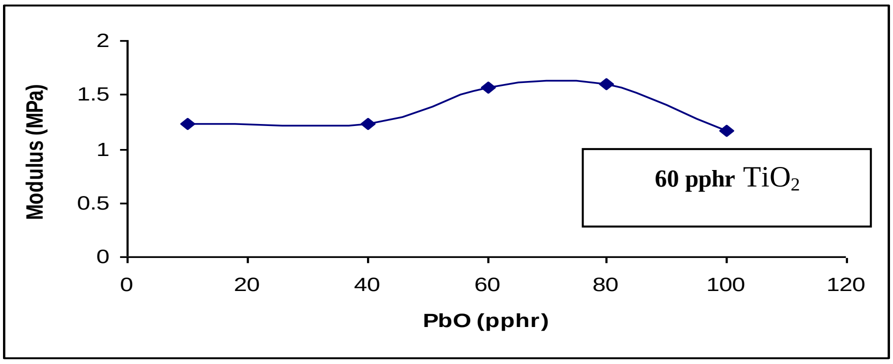

Figure (3) Effect of (PbO) on the SBR Elasticity

Elongation

The test result for Elongation are shown in Figure (4) it is seen Elongation increase with percent of (PbO) at second tow value and become decrease because Physical interaction between (PbO) and Rubber chain , When the grain size of filler resistance Elongation .

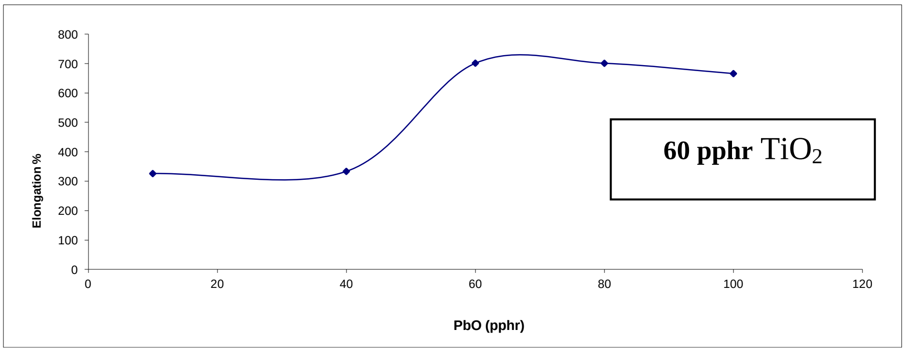

Figure (4) Effect of (PbO) on the SBR Elongation

Hardness

Figure (5) shows the shore hardness is plotted against the loading level of reinforcing filler (PbO) for SBR respectively. From this figure it can be seen that rubber hardness shows signification increment with the increasing loading level of reinforcing of (PbO).
Titanium dioxide reinforcing filler have fine grain size , this mean that (PbO) 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.

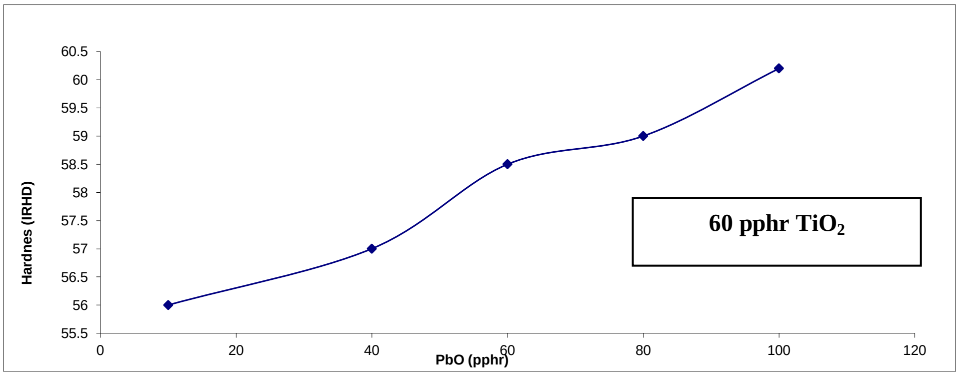

Figure (5) Effect of (PbO) on the SBR Hardness

Resilience

The relation between Resinonance and hardness is inverse relation, from figure (6) show the Resilience decrease when (PbO) percent increase , because the cross linking between rubber chain that absorb energy and transform it to heat among the rubber chain. Value of resinonance decrease when hardness or cross linking increases.

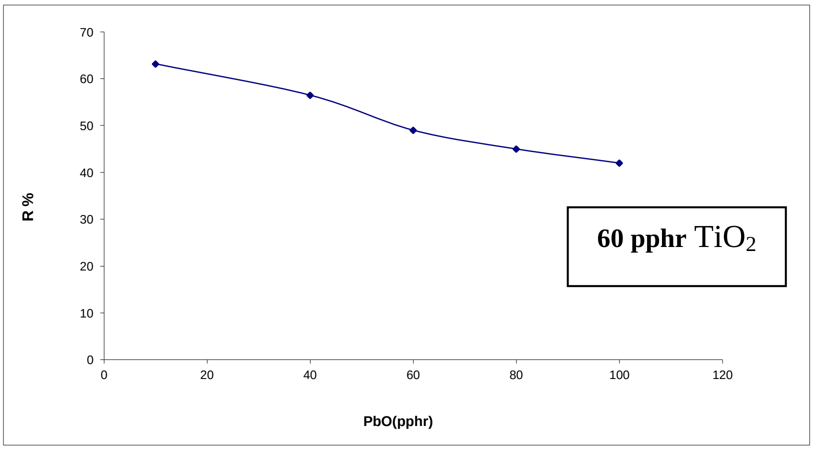

Figure (6) Effect of (PbO) on the SBR Resilience

Compression

This test is carried on according to ASTM D-471-57T specification. The test result for Compression are shown in Fig (7). Because interaction between filler (PbO) and rubber (SBR) that lead to increasing of cross linking at 3-dim (PbO) 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 .

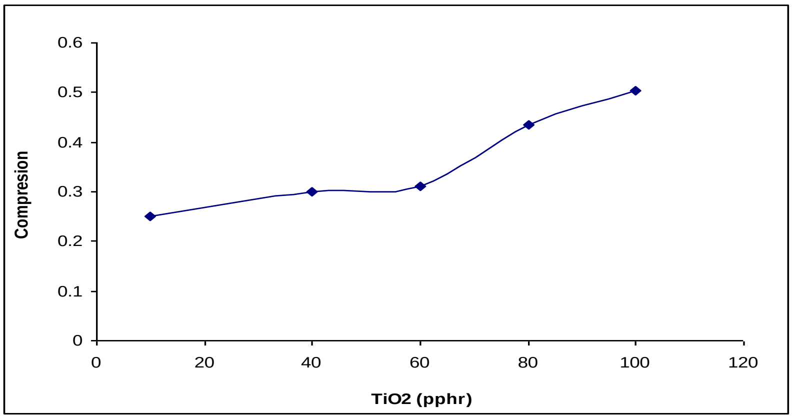

Figure (7) Effect of (PbO) on the SBR Compression

Conclusions

- The present work reveals that this composite materials have the best properties such as Tensile, Elasticity Modulus and Elongation at some value of (PbO) but having badly properties at high value of filler.
- The best value of Adhesion at (20 % pphr of PbO) perhaps using to protective clothing.
- Hardness Value in Aging increase with time exposure that refer heat is doing as helping factor to increase cross linking between rubber chain.

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