Fabrication and Testing of Composite Materials From Rubber

Maan Abd-Alameer Salih
Physics Department,College of Science, Babylon University, P.O.BOX4 , Iraq
E-mail: facemoon862@yahoo.com

Abstract

Recently, there has been considerable interest in forming Filler as a means to improve several properties of Elastomers. For this purpose layered (CaCO3 and Stiric Acid "S.A") are now widely being used. These layered are a class of inorganic materials that are naturally layered in structure , 8 different rubber compound were prepared by using (SBR 1502) type of Styrene Butadiene rubber in level and each recipe reinforced with carbonate calcium (CaCO3) at constant ratio (60) pphr (part per hundred), Stearic Acid (S.A) at variable ratio (1,2,3,4,5,6,7 and 8) 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 %.

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. (Satiric 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 ($CaCO_3$, 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

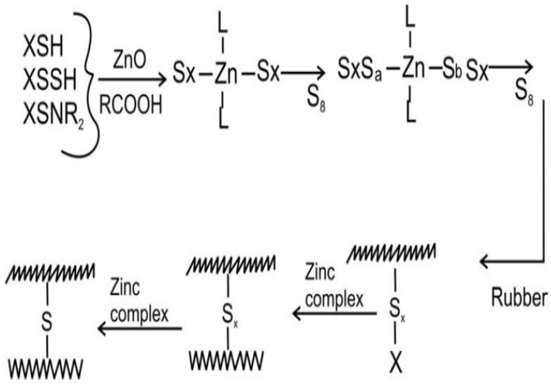
- Styrene-butadiene rubber (SBR) . with styrene content 23.5 % , Moony viscosity at 1ooºC = 50 , specific gravity 0.94 (gm/cm), ash content 1 % . there are two types of E-SBR in the market . One of them is the hot rubber which is product at 150 ºC , Whereby the molecular weight is high and depolymerization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

* CaCO3 particles are generally supplied as agglomerates and during processing they are broken and dispersed into primary particles. Large particleparticle interactions result in inhomogeneous distribution of the filler, processing problems, poor appearance, and inferior properties. This fact may emphasize the importance of homogeneity where the increasing amount of aggregates leads to a decrease of tensile properties of the rubber composites [10-12]. It is well known that the overall performance of composites is achieved by the addition of a low molecular weight organic compound, such as stearic acid [13], resulting in a better dispersion of the particles in the rubber matrix. Finally, aging behavior is taken here as deterioration due to the prolonged action of high-energy radiation [2], where several changes in the chemical network structure can occur. Evaluation of aging behavior isn't only estimated from the changes in tensile properties but also to include liquid absorption measurements This article deals with the effect of CaCO3 addition to rubber (SNR) or nitrile rubber (SBR) on the cure characteristics and physicomechanical properties. [10,11] .

In all four polymorphs , titanium is coordinated octahedral by oxygen , but the position of octahedral differs between polymorphs 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 (*CaCO3*) "anatse" and (*CaCO3*) with diameter of 20-100 nm and length of (10-100 µm) [12,13]

* Satiric Acid (A.s) semiconductor nanoparticles were prepared by Chemical synthesis method The molecular weight is 223.2 , melting point 888 °C Satiric Acid (A.s) semiconductor nanoparticles were prepared by Chemical synthesis method. 60 ml of 1.0 M (C2H3O2)2.3 H2O ((II) acetate) aqueous solution was prepared using de-ionized water and heated upto 90 oC. 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 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).



((Rle of ZnO and fatty acid in accelerated sulfur Vulcanization where X=Accelerator residue , L= ligand))

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, 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. Ageneral 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 (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 materias by adding the reinforcing filler ($CaCO_3$) at constant ratio 60 % , (Satiric acid) at different loading level in addition (20,40,60,80,100), other materials like (ZnO , Rubber SBR ….etc) to Elastomer Styrene Butadine rubber SBR and show the Effect of (S.A) 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 (S.A) 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 ($CaCO_3$) 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, $CaCO_3$) and cross linking between (Satiric acid, $CaCO_3$) and Rubber Chain ,but after (80% pphr) from (Satiric acid) notice tensile decrease When Rubber chain can not 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 (3).in addition to Rubber Compound Distinguishing that having ($CaCO_3$) 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, $CaCO_3$) and cross linking between (Satiric acid, $CaCO_3$ and Rubber Chain .

Elongation

The test result for Elongation are shown in Figure (4) 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 (5) 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 decrement with the increasing loading level of reinforcing of (Satiric acid) .
Satiric acid reinforcing filler have fine graen 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 but soft approach led degradation the chain

Resilience

The relation between Resinonance and hardness is invers relation , from figure (6) 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 . value of resinonance decrease when hardness or cross linking increase

Compression

This test is caeeied on according to ASTM D-471-57T specification . The test result for Compression are shown in Figure (7).
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 with out Buckling .

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Table (1) A general rubber formulation[20]

rubber (SBR)	Parts per hundred parts of rubber 100
$CaCO_3$	60
Satiric acid	variable
Antioxidant	1
Zinc oxide	3
Accelerator	0.6
Sulfur	2

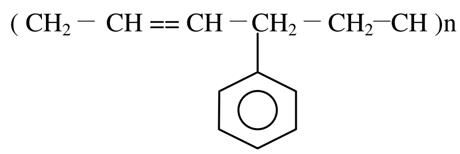

Figure (1) the chemical formula of SBR

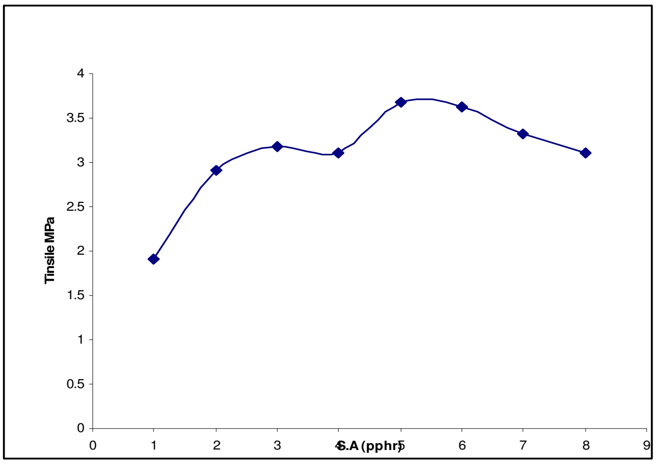

Figure (2) Effect of (Satiric acid) **on the SBR Tensile**

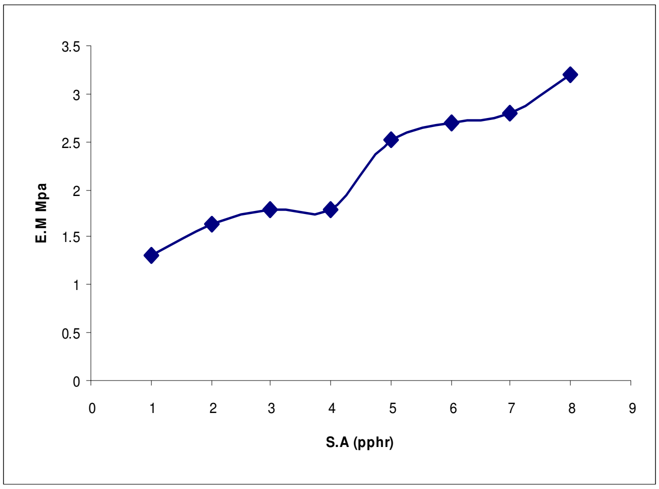

Figure (3) Effect of (Satiric acid) on the SBR Elasticity

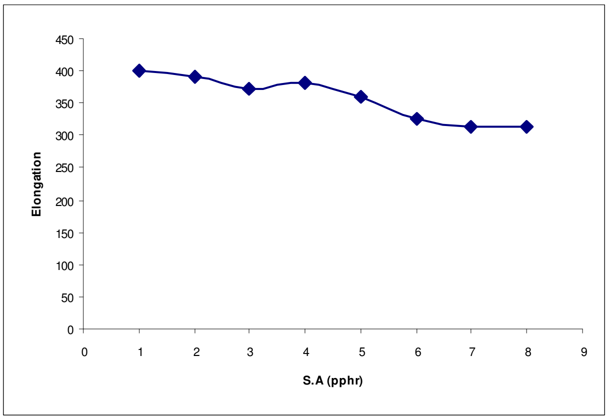

Figure (4) Effect of (Satiric acid) on the SBR Elongation

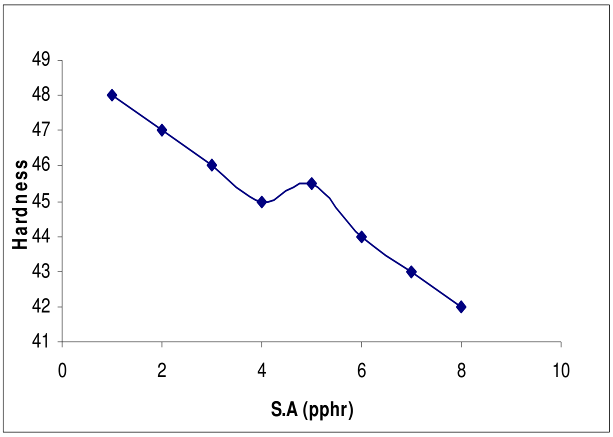

Figure (5) Effect of (Satiric acid) on the SBR Hardness

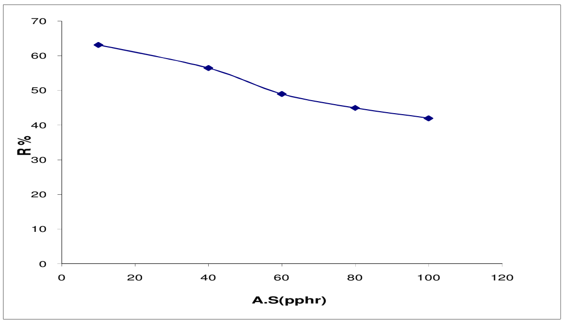

Figure (6) Effect of (Satiric acid) on the SBR Resilience

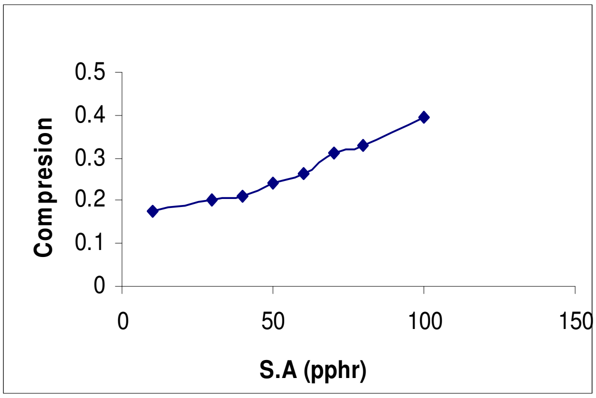

Figure (7) Effect of (Satiric acid) on the SBR Compression