Mechanical Properties of Rice Husk /Carbon Black Hybrid Natural Rubber Composite

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Abstract
The mechanical and end use properties of natural rubber reinforced rice-husk/Carbon Black hybrid filler, was investigated. Hybrid filler were used to prepare a natural rubber vulcanizate in order to determine testing data for the mechanical properties of the compound. In the sample preparation, six levels of filler loading were designed, which include variation in carbon black volume content. Tensile strengths, compression set, abrasion resistance, and Hardness, of the vulcanizate shows improvement with increase in carbon black content, while elongation at break shows decrease with increase in carbon black content. The flex fatigue shows great improvement. Thus rice-husk/Carbon Black Hybrid filler can be utilized as reinforcing filler in the rubber industry, where specific end-use property of a rubber product is required.
Keywords: Hybrid, Filler, Natural rubber, Rice husk, Carbon black

1. Introduction

In an agrarian economy, especially in developing countries like Nigeria, harvests seasons are often accompanied with tones of residues that constitute, in mist case environmental menace and some cases hazards. Many of these wastes are fibrous in natural; this class of materials could be utilized in the design and development of new polymeric composite materials as filler. These natural fillers when used as reinforcing fillers is not only inexpensive but also able to minimize the environmental pollution caused by the characteristic biodegradability (Premalal *et al* 2002, Han-Seung Yang *et al* 2004)

In the compounding of rubber products, fillers are major additives. Incorporation of such additives into the rubber matrix enhances properties such as tensile strength, modulus, tear strength, abrasion resistance, stiffness and possibility. The cost of the manufactured rubber product is also significantly reduced (Okieimen and Imanah 2003). In the vulcanization of rubber, carbon black is the main filler in use, However, because of the origin of carbon black from petroleum, carbon black causes pollution, and gives the rubber a black colour. The filler is also costly (Isaac and Augustina 2011)

Different materials have been used to reinforce natural and synthetic rubber such as clay (Kim *et al* 2006),organo clay (Arroyo *et al* 2003), coal shale-based fillers (Zhao and Xiang 2004), synthetic precipitated amorphous white silica nanofiller.(Ansarifar *et al* 2006), recycled rubber powder (Ismail *et al* 2002), graphite (Yang *et al* 2006). Agricultural by-products as fillers has also been investigated, this included banana peel, rice husk, spent mango, bean seed skin and groundnut shell (Adeosun 2002), cocoa pod and rubber seed shell (Okieimen and Imanah 2003), and short pine apple leaf fiber (Lopattananon *et al* 2006), ash rice husk (Ismail *et al* 2001). In addition, the processing of these composite materials is flexible, economical, and ecological and it is possible to use the same machinery employed with other traditional fillers.

In this present work the use of rice husk and carbon black N330 grade as reinforcement in natural rubber is reported, the objective, is to investigate the effect of rice husk/ carbon black (N330) hybrid filler on the mechanical properties of natural rubber composite.

2. Materials and Methods

Rice husk (RH) was obtain from a local rice mill in south western Nigeria, natural rubber (TSR 5) was obtain from NR processing factory Utagbo-Nno Delta state Nigeria, while Carbon black (CB) (N330 grade) was obtain from Warri Refinery And Petrochemical Company, Warri Nigeria. Compounding ingredients were of commercial grade and were used as obtained

2.1. Composite Preparation

Rice husk (RH) was washed and dried at 105°C for 24hr to adjust its moisture content and then stored over desiccant in sealed containers, the sample was grinded into powder with the use of an electric blender. The grinded powder was later sieved with BS/ISO 3310 into particle size of 38 μm. The natural rubber (NR) was masticated with other compounding ingredients in a laboratory two-roll mixer, as showed in table 1. Filler content was maintain at 50pph, six different test samples were prepared, the volumetric relation between rice husk and carbon black was modified according to the following composition

a) 100% carbon black and 0% Rice husk

b) 90% carbon black and 10% Rice husk
c) 80% carbon black and 20% Rice husk
d) 60% carbon black and 40% Rice husk
e) 50% carbon black and 50% Rice husk
f) 0% carbon black and 100% Rice husk

2.2. Determination of Vulcanizate Properties

The curing of test pieces was done by compression molding. The curing was carried out at 140 °C, the Tensile strength modulus and elongation was done as describe in ASTM D412-87 (Method A), using the Instron universal testing machine model 4301. Abrasion resistance was done using test method for Abrasion resistance DIN to ISO 4649 Akron to BS 903 part 49 (Method C), using croydon Akron-Wallace Abrada with serial no 0840251. Compression set was done as described in. ASTM D395, using a Wallace compression test equipment with serial no 0840522. Hardness test was done as specified in ASTM 1415 using the Wallace hardness tester model C8007/25. The measurement of Flex fatigue was done as describe in ASTM D430, using the Wallace De-Mattia flex machine.

3. Results and Discussions

Result of mechanical properties of the composite figure 1-4, reviles that increase in carbon black content yield an increase in tensile strength, modulus, abrasion resistance and hardness, this can be attributed to increase interaction between filler and rubber matrix, filler dispersion, and high surface area of N330 carbon black . It is well known that natural rubber forms a strong adsorptive bond with carbon black (Ismail et al 2001).

Figure 5 shows, effect of carbon black content on Elongation at break [EB]. Generally, the addition of fillers into natural rubber leads to decreases in EB of rubber vulcanizate, irrespective of whether the filler is reinforcing or inert, this trend, decreases in EB with increasing carbon black filler content may be due to the non-stiffening of the rubber chains, and hence, non-resistance to stretch when strain is applied.

Analyzing the result in figure 6, decrease in flex fatigue has been explained in terms of adherence of the filler to the polymer phase leading to the stiffening of the polymer chain and hence resistance to stretch when strain is applied. (Lopattananon et al 2006), in this case, as carbon black content increases there is reduce stiffening of polymer chain and resistance to stretching and thus an improve fatigue resistance.

4. Conclusion

Mechanical properties of rice husk/Carbon Black Hybrid filler reinforced natural rubber compounds has been studied. An increased in N330 Carbon Black content in the hybrid fillers has yield an increased in tensile strength, modulus hardness and abrasion resistance of the compounds. Elongation at break shows decrease, while the fatigue resistance of the compound shows considerable improvement. Thus rice husk/carbon black hybrid filler can be used as reinforcement in natural rubber compound, were specific end use properties are require.

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Table 1: Compounding recipe.

Ingredients	pphr
Natural Rubber	100
Sulphur	2.5
Zinc Oxide	5
CBS	2
TMQ	1
Stearic Acid	2
Processing oil	2.5
Filler	50

*pphr-part per hundred rubber

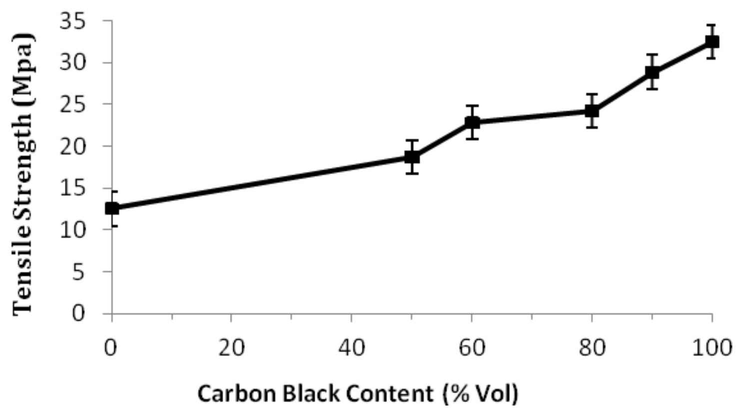

Figure 1. Tensile strength of the composite in relation to Carbon Black Content

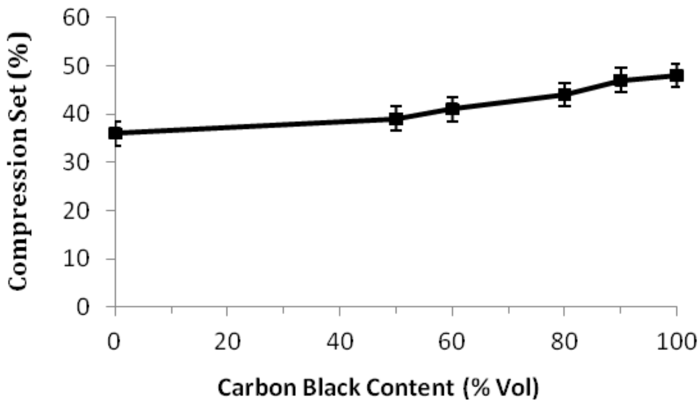

Figure 2. Compression set of the composite in relation to Carbon Black Content

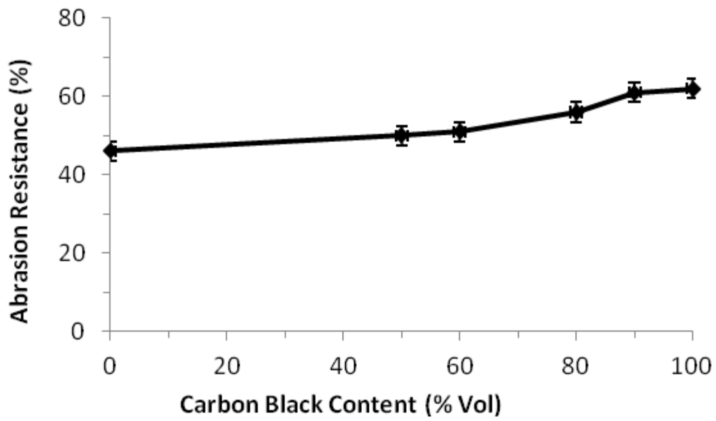

Figure 3. Compression set of the composite in relation to Carbon Black Content

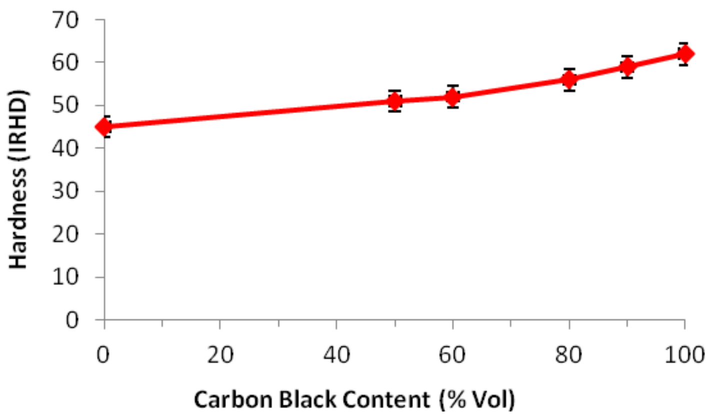

Figure 4. Hardness of the composite in relation to Carbon Black Content

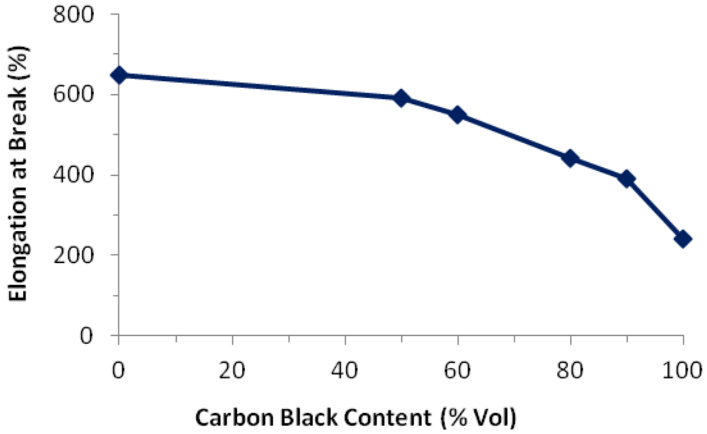

Figure 5. Elongation at Break of the composite in relation to Carbon Black Content

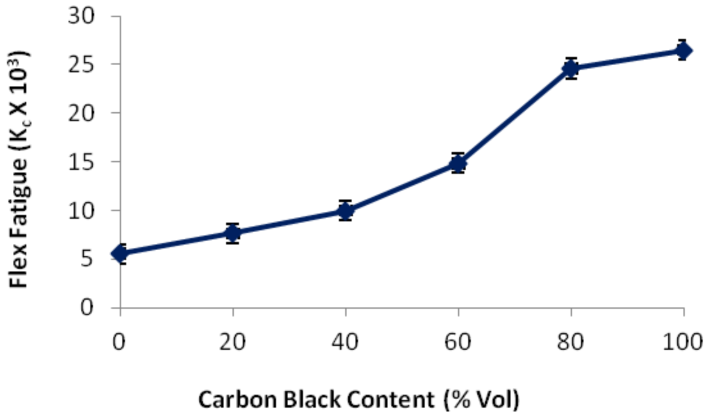

Figure 6. Flex Fatigue of the composite in relation to Carbon Black Content

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