Crimson Publishers
Wings to the Research

Mini Review

# Effect of Sustainable Recycled Black on Mechanical and Barrier Property of Butyl Based Tyre Inner Liner and Tube Compound

**Arnab Dutta, Hirak Satpathi*, Tirthankar Bhandary, Sanjit Kumar Das, Saikat Dasgupta and Rabindra Mukhopadhyay**

Hari Shankar Singhania Elastomer and Tyre Research Institute, India

**Abstract**

Partial incorporation of sustainable recycled black into the butyl-based rubber-Carbon Black (CB) system can improve the barrier & mechanical properties of the rubber composite. Bromo Butyl Rubber (BIIR), Butyl Rubber (IIR) and natural rubber-based tyre inner liner and tube compounds were prepared by melt mixing technique. Effects of various grades of sustainable Austin Black and ASTM grade N660 black were studied. Decreasing trend in gas permeability values for both inner liner as well as tube compounds indicate better gas impermeability for recycled Austin Black formulations when compared to those without Austin Black. The curing characteristics of the recycled Austin black composite has shown improvement of process safety and set properties as well.

**Keywords:** Carbon black; Bromo butyl rubber (BIIR); Elastomer; Gas permeability; Formulations

**ISSN: 2770-6613**


***Corresponding author:** Hirak Satpathi, Hari Shankar Singhania Elastomer and Tyre Research Institute, Hebbal Industrial Area, Mysore-570016, Karnataka, India

**Submission:** February 03, 2022

**Published:** April 06, 2022

Volume 3 - Issue 2

**How to cite this article:** Arnab Dutta, Hirak Satpathi, Tirthankar Bhandary, Sanjit Kumar Das, Saikat Dasgupta, Rabindra Mukhopadhyay. Effect of Sustainable Recycled Black on Mechanical and Barrier Property of Butyl Based Tyre Inner Liner and Tube Compound. Polymer Sci peer Rev J. 3(3). PSPRJ. 000561. 2022.
DOI: 10.31031/PSPRJ.2022.03.000561



## Introduction

Carbon blacks find their use mainly as reinforcing fillers in tires and other rubber products. The reinforcement effect is influenced by the interaction between the elastomer molecules, amongst the carbon black particles as well as between the carbon black particles and the elastomer matrix. Factors affecting degree of reinforcement include the primary particle size (specific BET surface area), surface activity, degree of carbon black dispersion, carbon black loading and structure. Austin black is manufactured from high quality, low volatile bituminous coal. It is a dry, finely divided powder, having platy structure and a pH value of 7.0. It has enhanced chemical, ultraviolet resistance and low moisture absorption properties. As it does not absorb moisture, thus improves air retention and moisture impermeation properties in rubber compounds.

In this study, three different grades of Austin black were used to replace ASTM grade carbon black N660 partially in tire tube and inner liner compound to achieve desired property of air and gas impermeability [1]. Normal blacks are mostly fossil based (CBFS). We tried to change it to coal based addressing the sustainability approach. Morphological study was conducted to analyze the structure of the black. Further, detailed investigation was done to determine how well it could reinforce and/or otherwise affect the mechanical properties of butyl/halo butyl composites in tire tube and inner liner compounds.

## Key Results and Discussion

The inner linear & tube of a pneumatic tire assembly must fulfil several performance requirements like retention of air pressure during the tire and inner tube service life (i.e., low air permeability), durability (from oxidation, ozonolysis, heat, and aging), tear resistance, low growth (i.e., low tension set) during service and non-stickiness of the inner tube to the tire casing during service (heat resistance & retention of physical properties). Some of these properties have been evaluated and discussed in this study. For each inner liner and tube compound three different formulations were mixed with 35phr of recycled Austin Black along with 25phr of N660, whereas control was mixed without any Austin Black and with 42phr of N660. Tensile strength exhibited a decreasing trend when going from control to Austin black formulations, both for inner liner as well as tube compounds. The deterioration of tensile properties for Austin black formulations can be explained by the non-reinforcing nature of this black. Tear strength for inner liner compounds was obtained to be comparable but for tube compounds tear strength increased 2 to 3 units from 24.8MPa for Control to Austin black containing mixes. Improved tear strength for tube compounds implies less tearing which in turn relates to decreased magnitude of punctures and puncture size. This results in minimized repair work. Tension set @105 °C & 120 °C for inner liner Austin formulations indicates higher set properties ~10-15% when compared to inner liner control. Similarly, tension set @105 °C & 120 °C for tube Austin formulations indicates higher set properties ~5-10% when compared to tube control. For inner liner gas permeability values decreased 0.4 to 0.7 units as compared to control which has a value of 3.95E-17$m^2$/Pa.s. On a similar trend gas permeability of tube reduced even up to 7.04E-17$m^2$/Pa.s for Austin black formulations as compared to control which shows a relatively higher value of 1.03E-16$m^2$/Pa.s. This indicates better gas impermeability for sustainable recycled black formulations when compared to control ASTM grade ones [2].

As part of investigation involving effect of oxidative (aerobic) thermal aging on stress–strain properties, ageing experiments were also conducted. Results of the same have been depicted as retention percentage. Austin black formulations for both inner liner as well as tube compounds exhibited better retention in modulus whereas poor retention was observed for tensile strength and elongation at break. Moduli and hardness for all the compounds increased after ageing. This could be attributed to higher degree of reinforcement with Austin Black. Also, elongation at break for all the compounds dropped after ageing. This can be explained by the loss of flexibility in the compounds due to conversion of poly-sulfidic crosslinks into mono and di-sulfidic linkages. So, from the above observation it can be concluded that partial replacement of ASTM grade black with sustainable recycled black in case of tyre and tube product line not only brings sustainability through materials aspect but also have a positive impact on air impermeability and other physical properties.

## References

1. Fillers for polymer applications; Carbon black as a polymer filler. In: Spahr ME, Rothon R (Eds.), Part of the polymers and polymeric composites: A reference series book series (POPOC), pp. 261-291.
2. Adventures in Carbon Black by Frank Karl.