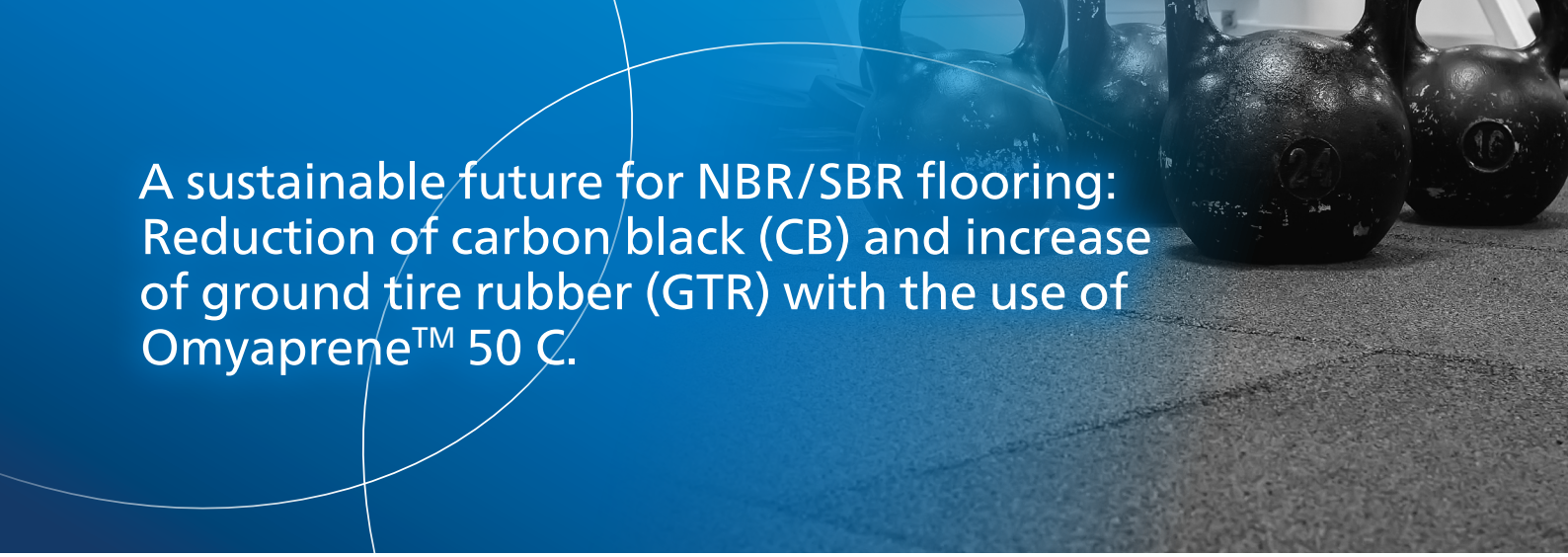


A sustainable future for NBR/SBR flooring: Reduction of carbon black (CB) and increase of ground tire rubber (GTR) with the use of Omyaprene™ 50 C.

Abstract

NBR/SBR flooring applications have a broad range of end uses, from commercial office surfaces, high-impact gym floors to durable rail-crossing panels and resilient animal-stable mats. The flooring applications are under growing pressure to be more cost-effective and use sustainable materials. Traditional formulations relying heavily on fossil-based fillers such as carbon black (CB). Carbon black becomes increasingly more expensive, is exposed to geopolitical tensions implying an uncertain supply chain and has about 2.400 kg CO_2-eq. per ton. These points are driving the industry to seek alternative solutions. A key pathway toward cost reduction and CO_2 minimization is the incorporation of ground tire rubber (GTR) and partial substitution of carbon black (CB), which enables manufacturers to lower raw-material costs while increasing recycled content.

By partially substituting virgin rubber and carbon black with GTR and functional minerals, NBR/SBR flooring systems maintain robust mechanical performance while significantly reducing their carbon footprint. This shift supports the broader transition to circular materials, helping flooring producers balance performance, affordability, and environmental responsibility in applications that demand long service life and high durability.

Introduction

Globally in 2012 about 13.5 million tonnes of tires were scraped worldwide. Based on recent developments and market analysis from 2020, 30.0 million tonnes of tires scrapped worldwide. The number of scrapped tires globally increases with a compound annual growth rate (CAGR) of about 4.0%. On average a passenger car tire weight about 10 kg and consists of 10 wt.% textile, 15 wt.% steel and 75 wt.% rubber compounds (rubber, filler, curatives, etc.). Based on a rough estimation 22.5 million tonnes of rubber compound can be retrieved from end-of-life tires. According to market studies for the non-tire industry in 2024, 12.5 million tonnes of rubber is used in technical rubber goods. These 12.5 million tonnes consist of about 9.0 million tonnes synthetic rubber and 3.5 million tonnes natural rubber. When these figures are placed in perspective, it becomes evident that the newly made rubber for non-tire applications is almost 2 times smaller than the available rubber compound (rubber and additives) in the market coming from the recycling of tires. Increasingly, the recycled rubber compounds from end-of-life tires are finding valuable applications in the rubber and plastics industry, offering sustainable and versatile solutions across a variety of sectors. In this white paper, the evolving formulation strategy for NBR/SBR flooring compounds is examined. Focusing on how the flooring industry can simultaneously reduce

cost and environmental impact while maintaining mechanical performance. The investigation focuses on the substitution of neat NBR/SBR rubber and the partial replacement of carbon black – two fossil-based raw materials whose reduced use directly supports both economic and sustainability target. The benefits of combining these reductions to redesigning compounds with a more efficient and circular filler system are evaluated. A key part of this transformation is the introduction of Omya's new functional mineral, Omyaprene™ 50 C, which enables lower CB loading while enhancing compound functionality. Additionally, the use of GENAN's MESH 40 ground tire rubber (GTR) is highlighted. This GRT not only increases the recycled content and decreases the neat rubber within the formulation, but also lowers the overall CO_2 footprint by re-integrating secondary raw materials into high-volume flooring systems. Together, these elements outline a modern, more sustainable approach to NBR/SBR flooring compounds built on material efficiency, circularity, cost optimization and performance improvement.

Typical formulations and material characteristics

In the **Table 1** the investigated recipes are presented. The study evaluates five NBR/SBR flooring compound formulations designed to progressively reduce fossil-based inputs while increasing the share of functional minerals and recycled rubber. Any modification is the formulations assumes that GTR consists of 50% rubber. This leads to a 100 phr of rubber in each formulation. The **Reference** formulation contains a traditional ratio of 60 phr NBR, 40 phr SBR, and a loading of 60 phr carbon black (N550) without any recycled content.

Sample 1 begins the transition by lowering NBR to 55 phr and introducing 10 phr of 40-mesh ground tire rubber (GTR) while maintaining the same carbon black level. **Sample 2** further reduces neat polymer, with NBR at 55 phr and SBR at 35 phr, representing a total polymer reduction of 10 phr. In addition, 20 phr of 40-mesh GTR is incorporated. **Sample 3** continues with 55 phr NBR but replaces part of the carbon black, reducing it from 60 to 50 phr, and compensates with 10 phr of Omyapren™ 50 C together with 10 phr GTR, demonstrating a hybrid filler system. **Sample 4** advances this development by combining the lowest polymer and carbon black levels to this point: NBR at 55 phr, SBR at 35 phr (again a 10 phr polymer reduction), with carbon black reduced to 40 phr and replaced by 20 phr Omyapren™ 50 C plus 20 phr GTR. Finally, **Sample 5** presents the most challenging and ambitious formulation, still maintaining the 10 phr polymer reduction, while significantly lowering carbon black to 35 phr and compensating with 10 phr Omyapren™ 50 C and 20 phr GTR, resulting in high recycled load and the lowest carbon black content.

Investigated NBR/SBR formulations for flooring applications. Assuming that GTR consists of 50% polymer. This leads to a 100 phr of rubber in each formulation.

Raw material	Reference	1	2	3	4	5
NBR 3345	60	55	55	55	55	55
SBR 1502	40	40	35	40	35	35
CB N 550	60	60	60	50	40	35
Omyaprene™ 50 C				10.0	20.0	10.0
GTR 40 Mesh V3		10.0	20.0	10.0	20.0	20.0
Stearic acid			1.5			
Rubatan 184-TMQ			1.5			
Santoflex 13-6PPD			1.5			
Zinc oxide			4.9			
Antilux 654			1.0			
CBS GR			1.5			
Sulfur 99%			1.8			

Table 1

Figures 1-8, together with their legends, illustrate how this sustainable formulation strategy succeeds in maintaining ISO 7619-1 compliant performance while reducing carbon black, increasing recycled content, and enhancing specific mechanical characteristics that are important for durable and reliable flooring applications. Specifically, the hardness results **(Figure 1)** show an initial increase in stiffness for **Samples 1** and **2** before gradually softening in **Samples 3-5**, as carbon black is replaced by mineral and GTR. The compression set **(Figure 2)** performance remains great for the **Reference** and **Sample 2**, but it increases as the GTR content exceeds the 10 phr. Tensile strength **(Figure 4)** remains well above specification for all compounds, while elongation at break **(Figure 3)** improves in **Samples 3–5**, demonstrating enhanced flexibility as carbon black is reduced. Modulus values **(Figure 5)** illustrate a clear transition from highly reinforced networks in the early samples to softer, more compliant ones in the later formulations. Tear resistance **(Figure 6)** is improved with moderate GTR levels, since it acts as crack-deflector, particularly in **Sample 5**. Curing profiles **(Figures 7 and 8)** remain consistent and industrially manageable despite changes in filler type and loading. These results outline how each formulation balances performance, elasticity, reinforcement, cost and sustainability. The following figures with their legends provide a detailed explanation of these behaviors.

Hardness shore-A

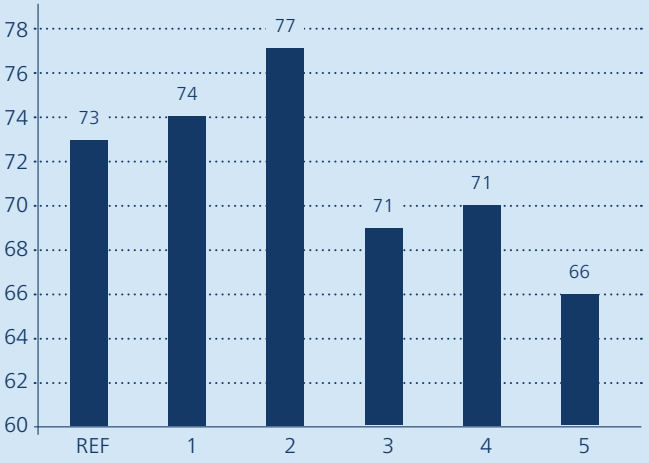


Figure 1

Hardness shore-A of NBR/SBR flooring compounds is showing the effect of neat polymer reduction, carbon black replacement, and incorporation of Omyaprene™ 50 C and GTR. Absolute values demonstrate the softening trend as carbon black decreases and GTR increases, with **Samples 4** and **5** falling fully within the ISO 7619-1 specification range (65 ± 5).

Compression set (%) measured after 24 h at 70 °C, illustrating the influence of reduced neat polymer content, carbon black substitution, and increasing levels of GTR. The **Reference** and **Sample 2** (10 phr GTR) show the best elastic recovery, while higher than 10% GTR and lower CB levels **(Samples 3–5)** increase permanent deformation. All the values are well below the 25% ISO 7619-1 specification.

Compression set at 70°C, 24h [%]

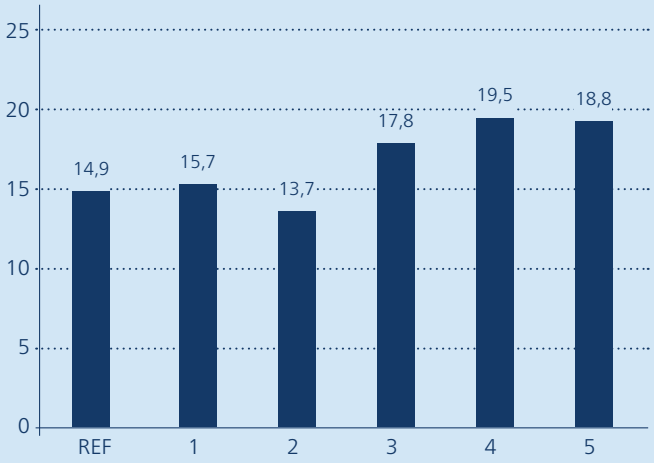


Figure 2



Elongation at break [%]

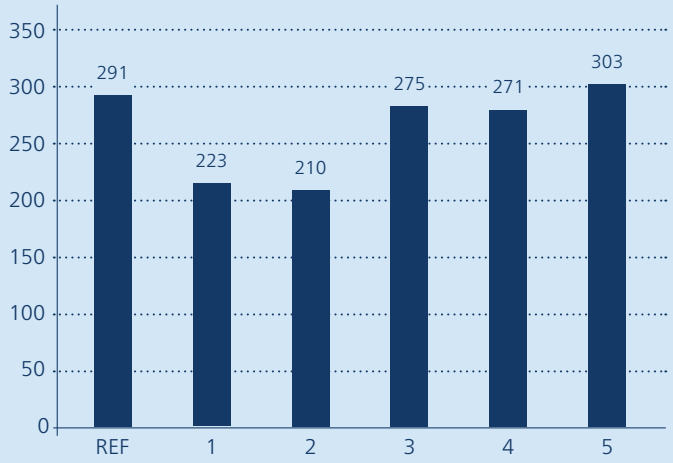


Figure 3

Elongation at break demonstrating the transition from stiffer, highly reinforced systems **(Samples 1–2)** to more extensible compounds **(Samples 3–5)**. **Samples 3, 4,** and **5** meet and exceed the ISO 7619-1 requirement of ≥ 250%, with **Sample 5** showing the highest elasticity due to reduced CB and increased GTR.

Tensile strength results for all formulations. Despite reductions in neat polymer and reinforcing carbon black, all samples exceed the minimum requirement of 7 MPa according to ISO 7619-1. Strength decreases gradually with higher GTR and lower filler reinforcement yet remains fully compliant with flooring applications.

Tensile strength [MPa]

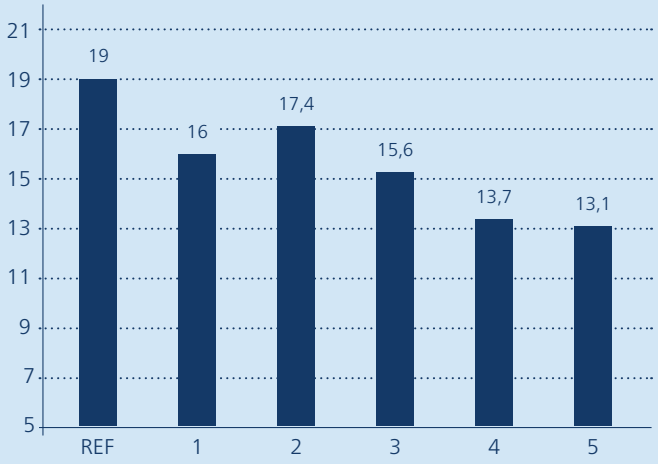


Figure 4



100% Module [MPa]

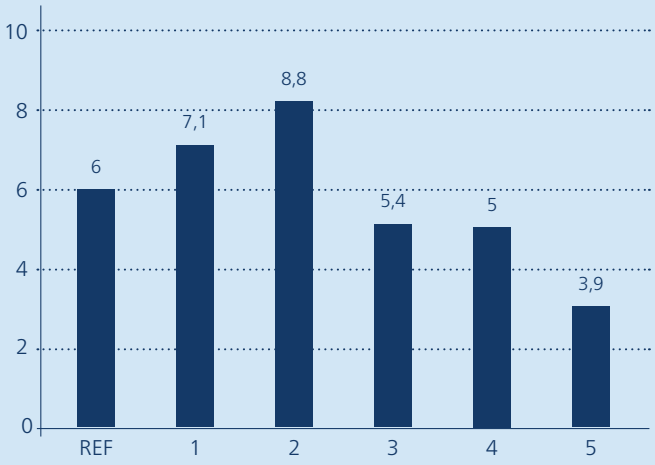


Figure 5

100% Modulus values reflect the compound stiffness at low strain. S1–S2 show increased modulus due to polymer reduction under constant reinforcement and GR content, while S3–S5 show a slight decrease as carbon black is replaced with Omyaprene™ 50 C and GTR, resulting in softer, more flexible materials.

Tear growth resistance highlights the ability of each compound to withstand crack propagation. 10 to 25 phr of GTR (S2 and S5) show improved tear resistance due to crack-deflection effects, while formulations with lower CB (S4) show slightly reduced but still acceptable performance.

Tear growth resistance [N/mm]

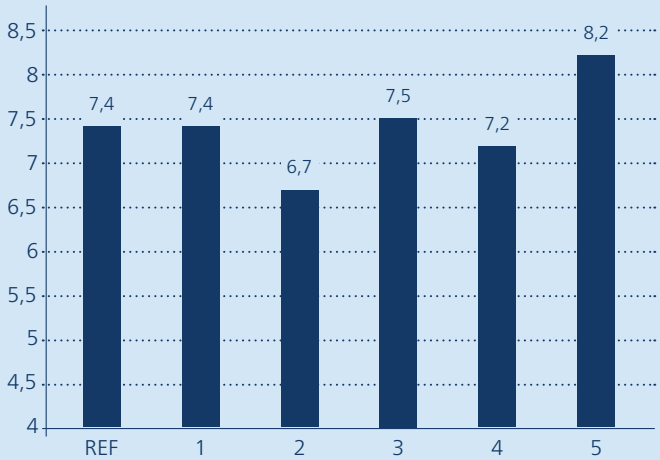


Figure 6

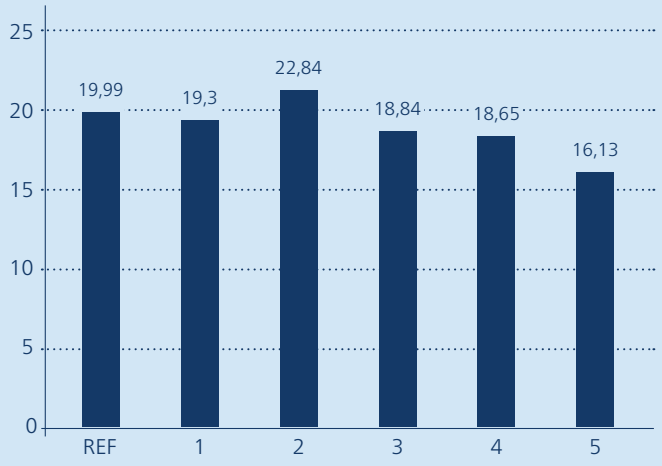


Figure 7

Maximum torque from rheometric curves showing crosslink density evolution. **Sample 2** exhibits the highest torque due to reduced polymer and high CB reinforcement, while **Samples 3–5** show progressively lower, even though similar to **Reference**, torque as carbon black is replaced by Omyaprene™ 50 C and GTR.





Curing times (min:sec)

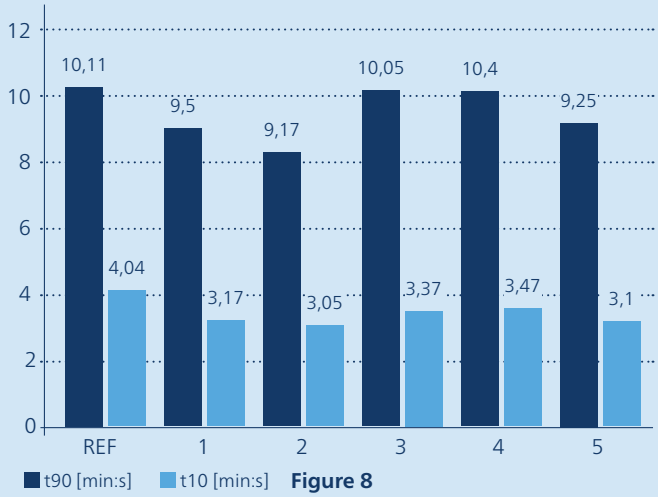


Figure 8

Curing profile comparing scorch time (t10) and optimum cure time (t90). All formulations show stable scorch safety, while t90 slightly varies, depending on reinforcement level and dilution of the polymer matrix. Omyaprene™ 50 C and GTR introduce slight retardation in **Samples 3–5**, but curing remains well within industrial processing windows.

The above presented results clearly demonstrate that significant cost optimization and sustainability gains can be achieved in NBR/SBR flooring compounds without compromising mechanical performance. As carbon black is progressively reduced and partially replaced by Omyaprene™ 50 C, the formulations show a controlled softening, improved elasticity, maintained tensile properties within the required performance range, and a direct contribution to both cost reduction and CO_2 footprint minimization. The introduction and gradual increase of ground tire rubber (GTR) further enhance the recycled content of the compounds while simultaneously improving key properties such as elongation at break and tear resistance. Notably, samples enriched with GTR exhibit greater flexibility and energy-absorption capability, properties highly desirable in flooring materials. The combined use of Omyaprene™ 50 C and GTR not only reduces reliance on fossil-derived fillers and polymers but also supports a circular-materials approach with measurable mechanical benefits.

Conclusion

In conclusion, the combination of the new functional mineral Omyaprene™ 50 C and the ground tire rubber (GTR) offers several key advantages for the rubber flooring industry, including:

- ✔ All sustainable formulations met or exceeded ISO 7619-1 mechanical requirements, with **Samples 4** and **5** fully complying with hardness, tensile strength, and elongation criteria.
- ✔ Carbon black reduction through Omyaprene™ 50 C proved technically successful, enabling softer, more flexible compounds while keeping tensile strength and tear resistance in acceptable level.
- ✔ Ground tire rubber (GTR) significantly improved elongation and tear resistance, demonstrating that recycled content can reinforce specific performance attributes rather than weaken them. Compression set, on the other hand, is a property that needs careful formulation, see **Sample 2** and **5**.
- ✔ **Sample 5** delivered the highest sustainability benefit, with the largest carbon-black reduction and the highest GTR content (25 phr), while still surpassing ISO 7619-1 requirements and providing excellent elasticity and tear resistance.
- ✔ Curing behaviour remained industrially stable across all samples, demonstrating that the introduction of Omyaprene™ 50 C and GTR does not introduce processing risks.
- ✔ Overall, the study confirms the technical feasibility of transitioning toward low-CB, low-polymer, high-recycled flooring compounds without sacrificing mechanical integrity.



This article was written in collaboration of Omya International AG with Genan S.A.

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