

ERJ - TOP 10 - ELASTOMERS FOR SUSTAINABILITY

1. Personal Details

Name of person completing form: Marjolein Groeneweg, Sr Marketing & Communications Leader, Synthos

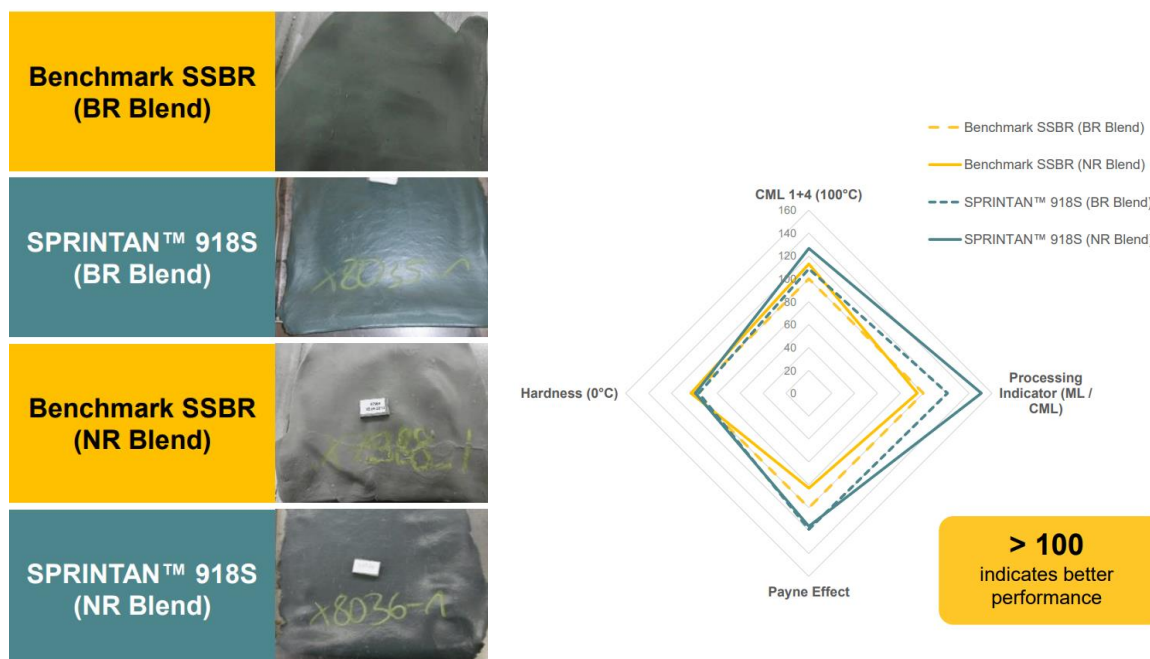
2. Title of product or project

Extending the magic triangle with multi-functionalized SPRINTAN[®] 918S SSBR for improved wet braking and dry braking performance, enhanced abrasion resistance and lower rolling resistance of EV tires.

3. Main materials technologies involved

- Unique, proprietary, functionalization technology specifically developed for high-molecular weight oil-extended SSBR, combining outstanding elasticity at low frequency (correlated to rolling resistance) with exceptional wet grip performance and wear resistance, while providing processing characteristics comparable to a non-functionalized SSBR.
- The unique microstructure (level of styrene and vinyl groups) has been optimized with the aim of achieving excellent wet braking performance at a comparatively low glass transition temperature, which in turn optimizes wear performance.

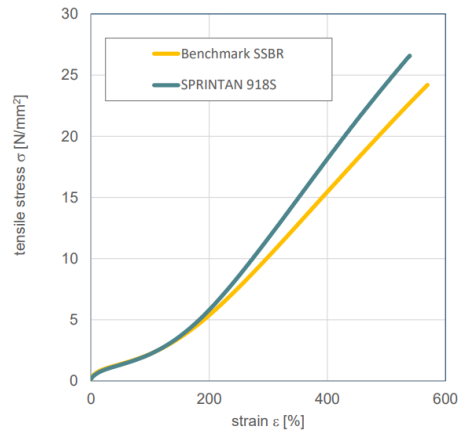
Processing of Silica filled Rubber Formulation



SPRINTAN[®] 918S provides processing comparable to benchmark.

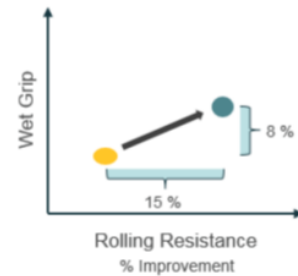
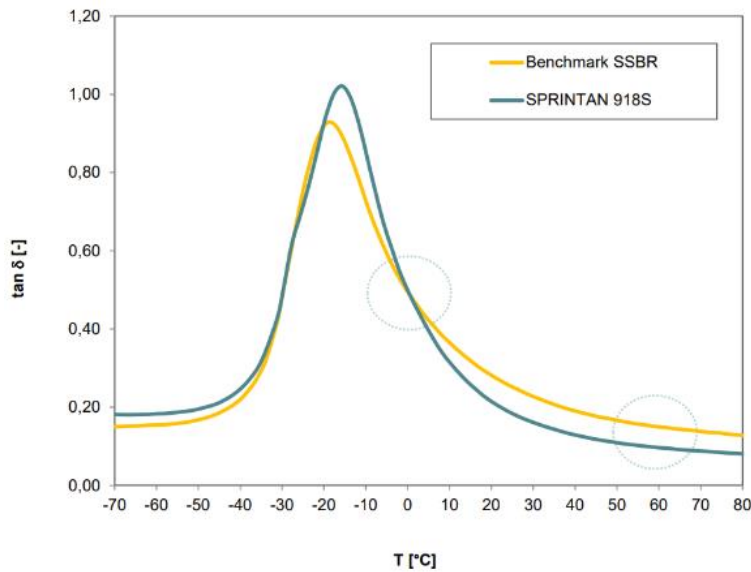
Mechanical Performance of Cured Rubber Formulation

	Benchmark SSBR	SPRINTAN™ 918S
Tensile Strength [MPa]	24.2	26.6
Elongation @ break [%]	571	540
Modulus 100 [MPa]	2.2	2.2
Modulus 300 [MPa]	10.2	11.6
Shore A hardness @ RT	64.1	58.1
Rebound resilience @ RT [%]	34.3	36.2
Rebound resilience @ 60°C [%]	59.2	64.3



SPRINTAN® 918S provides excellent mechanical property profile.

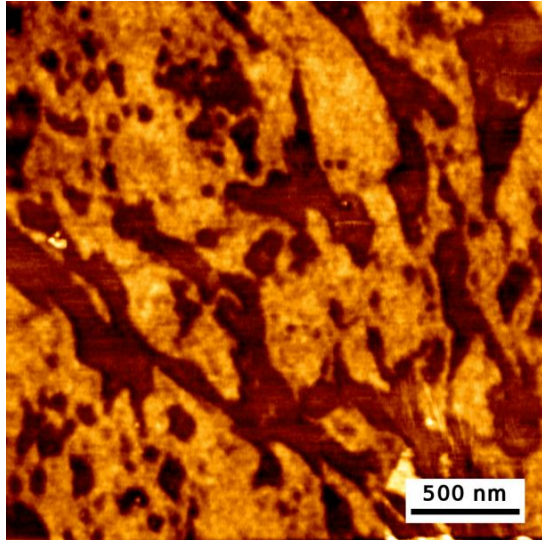
Dynamic Lab Predictors for Tire Performance



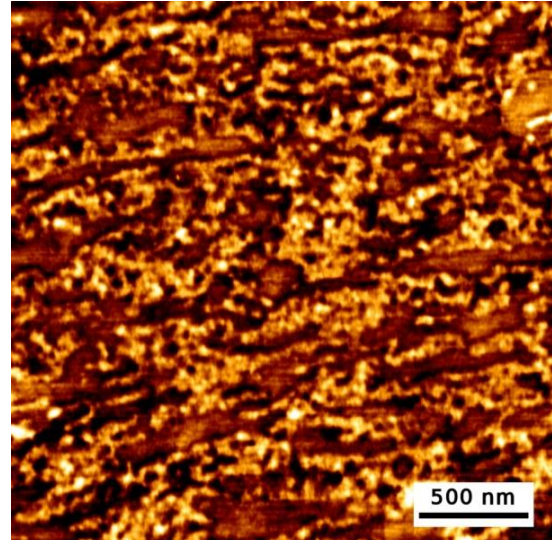
SPRINTAN® 918S provides 15% improved rolling resistance at 8% higher wet grip level for high surface silica-based rubber formulation.

Morphology of Cured Silica filled Rubber Composite

Benchmark SSBR



SPRINTAN® 918S



SPRINTAN® 918S refines the blend morphology.

Electric vehicles, with their high curb weight and ample torque, are putting tires under severe levels of stress and strain. At the same time, the lowest possible rolling resistance of the tires is a must to extend the EV 's range as much as possible. And for this combination of seemingly contradictory properties, SPRINTAN® 918S meets all requirements and its unique performance balance makes it the ideal choice for all summer-, winter- and all-season (U)UHP tire treads and especially for EV tires.

4. Main goal or objective of the development project

Synthos has a strong track record in developing functionalized SSBR for improved rolling resistance in tire applications, and SPRINTAN® 918S is another excellent example.

Prior to the development of SPRINTAN® 918S, high grip SSBR typically had high glass transition temperatures and their use was essentially limited to UHP or UUHP summer treads. Because these polymers were traditionally optimized for wet grip, they did not contribute significantly to improving the rolling resistance of tire treads. However, today's requirements are becoming more stringent towards CO₂ emission reduction and require products that enable more efficient e-mobility.

SPRINTAN® 918S was developed precisely with these requirements in mind yet promises excellent grip performance and improved wear resistance.

5. Technical challenges addressed by the project team

The main challenges in the development of medium-T_G functionalized SSBR SPRINTAN® 918S lay in achieving the required high wet grip performance at a comparatively low polymer glass transition temperature. Careful fine-tuning of the micro- and macrostructure, in combination with the functionalization technology was

carried out to ensure that low-temperature performance as well as wear resistance could still benefit from high main chain flexibility. To maximize the fuel efficiency potential, strong polymer-filler interaction through reactive functional elements was designed into SPRINTAN® 918S, while still maintaining adequate processing of the compounds during mixing and extrusion in tire production.

Efficient silica-active functionalization of SSBR often has the disadvantage of difficult processing characteristics, including high compound viscosity, poor green strength, or deteriorated extrusion behavior. However, the new SSBR offers a functional SSBR design that essentially retains the processing properties of a comparable non-functionalized SSBR grade. Accordingly, SPRINTAN® 918S can be used in state-of-the-art compounding and extrusion processes without compromising tire production rates.

6. What is the commercial status of the technology or product?

Due to current demand, Synthos is now producing SPRINTAN® 918S on a regular basis. While already with commercially attractive volumes, a further boost in SPRINTAN® 918S demand is anticipated soon, as other tire manufacturers use this new SSBR grade in tire developments for a wide range of tire applications. One tire manufacturer reports a 7% improvement in wet braking performance, a 2% improvement in dry braking performance and a 3% improvement in abrasion resistance, without any deterioration in fuel efficiency. Our customers' experience shows that these results should be considered as an extension of the magic triangle.

Finally, SPRINTAN® 918S is now also available as bio/circular-attributed SSBR under ISCC certification. SPRINTAN® 918S ISCC Certified has the same product properties as its conventional variant, meets the same specifications, and can therefore be considered interchangeable and the same.

All Synthos synthetic rubber products are expected to be ISCC Plus certified from June 2022.

7. Please describe the contribution of the technology or product to sustainability

The use of SPRINTAN® 918S in tire tread allows a reduction of the tire rolling resistance, which reduces the amount of energy required to travel a given distance. This consequently reduces fuel consumption or extends the range of electrical vehicles.

90% of energy consumption over the life cycle of a tire is attributed to the tire use-phase, in the form of the fuel or electric energy consumption of the vehicle. Therefore, developing new polymers and compounding concepts to improve rolling resistance of the tire and therewith fuel efficiency of the car, addresses the core element how the environmental impact of tires can be reduced.

Based on lab indicator data confirmed by tire customers, SPRINTAN® 918S (compared to non-functionalized high grip SSBR) improves fuel efficiency of the whole car by approx. 1.5%. Considering in Europe alone, 18 million vehicles are sold, the benefit of this increased

fuel efficiency would translate in approx. 540.000 tons less fuel consumed or a reduction of CO₂ emissions by 1.3 million tons. *¹ When it comes to electric mobility, SPRINTAN[®] 918S, as a grip component in the tire tread, is an important step towards extended range in high-torque electric vehicles. To further support the move from internal combustion engines towards more sustainable forms of propulsion, Synthos is actively collaborating with key customers to continuously improve tire performance for this growing segment.

8. Scope for further enhancements to the technology or product

Synthos is already actively developing the next generation of multi-functionalized SSBR with further enhanced interaction between the polymer and surrounding filler particles. The next generation SSBR will enable continuous improvements in rolling resistance and greater wear performance, and therefore will positively impact environmental footprint.

9. Any further comments to further highlight the contribution of this development project to environmental sustainability?

Looking at the contribution tires can bring to sustainable, individual mobility, it is not enough to focus only on rolling resistance and wet grip potential but also on tire wear. Indeed, tire weight can be lowered further, reducing rolling resistance and in turn reducing particulate emissions during the tire use phase.

SPRINTAN[®] 918S, with its unique composition and proprietary, effective functionalization technology addresses all these key requirements, and is thus supporting the global decarbonization initiatives of the transportation sector, so vital in the fight against accelerating global warming and for the preservation of primary raw materials.

In line with Synthos strong commitment to moving in the green direction, SPRINTAN[®] 918S is now also available as bio/circular-attributed SSBR under ISCC Plus certification.

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<https://www.iea.org/reports/tracking-transport-2019/fuel-economy-of-cars-and-vans>
https://www.spritmonitor.de/de/berechnung_co2_ausstoss.html

¹Based on 2020 European average fuel economy of new cars of 7.5l/100 km, combined with an average annual travel distance of 40,000 km.