

Technical Insight of KURARAY LIQUID RUBBER

Silane modified LBR for SBR / Silica formulation

Elastomer R&D Department
Elastomer Division

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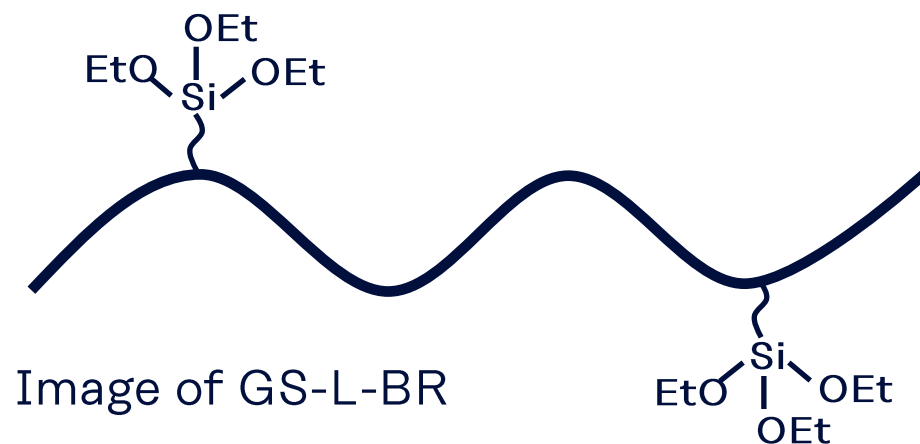
Agenda

Our silane-modified LBR; GS-L-BR is the latest development of KURARAY LIQUID RUBBER grades.

- 1) Silane modified LBR (GS-L-BR)
- 2) Evaluation in SBR / Silica formulation

Silane modified LBR (GS-L-BR)

Grade Name [Development Code]	Structure	Functional Group	Mw	Tg (°C)	Number of functional group / chain	Viscosity at 38°C (Pa • s)
GS-L-BR-188 [SB-006]	Polybutadiene /Graft silane	Triethoxysilane	38,000	-88	4	124
[SB-009]	Polybutadiene /Graft silane	Triethoxysilane	33,000	No data	2	No data



- High reactivity with silica
- Improve dispersibility of silica
- Crosslinkable with base rubber

Formulation & Mixing Conditions

	Control	Formulation
f-SSBR	80	80
BR	20	20
Silica	100	100
SCA	8	8
TDAE	28	28
LBR		12
Chemicals	ZnO 3.0, Stearic acid 2.5 6PPD 2.5, Wax 2.0	
Sulfur	S 1.5	
Accelerator	DPG 0.5, CBS 0.35, TBTD 1.5	

Mixing Conditions		
NP1	sec	Banbury-type mixer*
	0	Solid rubber (60°C)
	20	Silica, SCA, TDAE, LR, Chemicals
	180	Sweep
	360	Dump out (150-160°C)
NP2		Banbury-type mixer*
	0	1 st mixed compound (90°C)
	240	Dump out (150-160°C)
FM		Banbury-type mixer*
	0	Compound, Sulfur, Accelerators (50°C)
	75	Dump out (90-100°C)

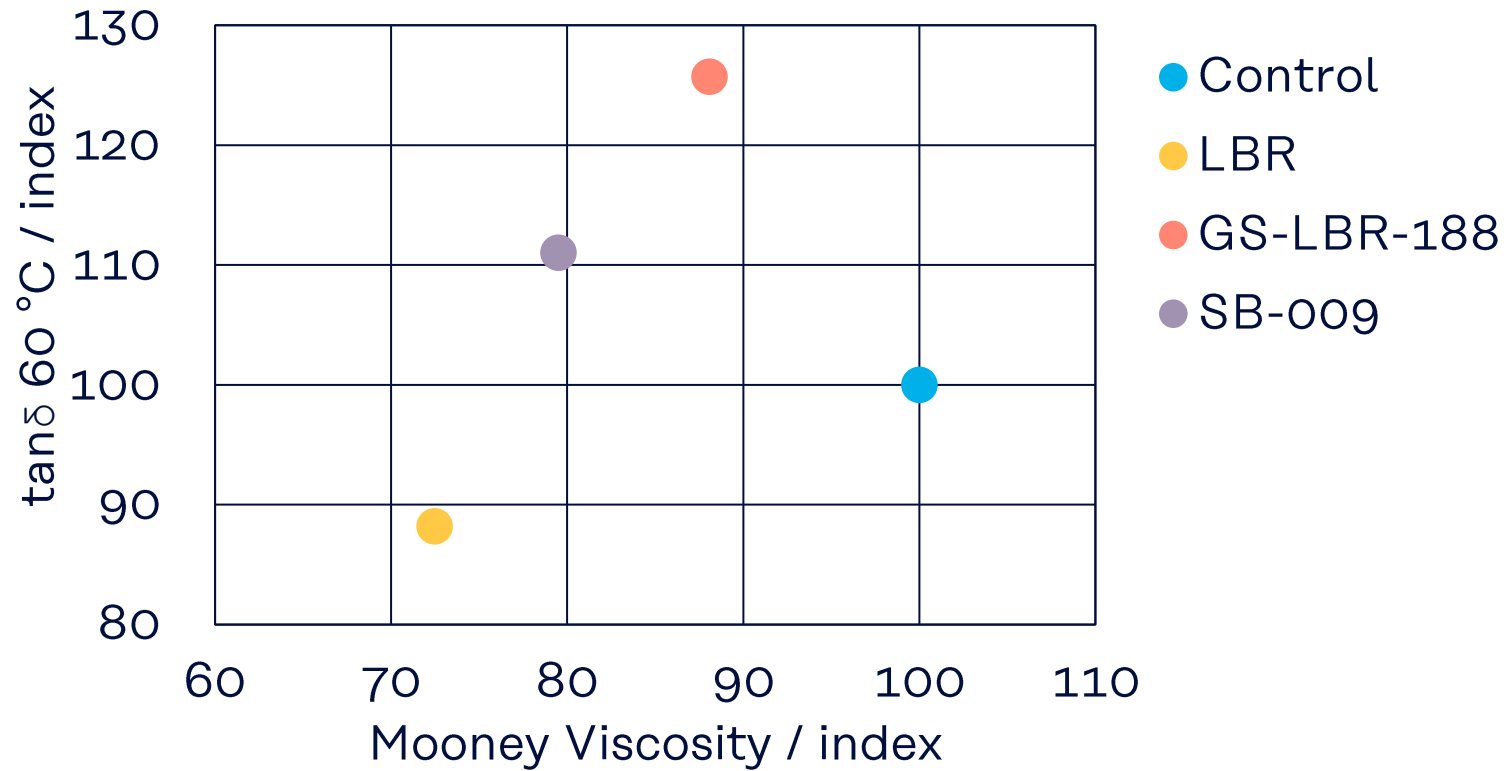
*MIXTRON® BB Mixer (by Kobe Steel, Ltd.)

Summary of properties

			Control	LBR*	GS-L-BR-188	SB-009
Mooney Viscosity (ML1+4, @130°C)			51.2	37.1	45.1	40.7
Mechanical Properties						
Hardness	Type A		69	61	63	64
EB	(%)		430	500	365	380
TB	(MPa)		23.0	21.0	19.6	19.4
M100	(MPa)		2.7	2.0	3.0	2.7
M300	(MPa)		14.7	10.3	14.8	13.7
DMA (Dynamic Mechanical Analysis)						
E'	0°C	(MPa)	14.8	10.4	9.1	9.5
	25°C	(MPa)	7.9	5.7	5.8	6.0
	60°C	(MPa)	5.6	4.0	4.5	4.4
tanδ	0°C	(-)	0.673	0.576	0.450	0.464
	25°C	(-)	0.346	0.327	0.226	0.253
	60°C	(-)	0.182	0.206	0.145	0.164
Payne effect (0.5%E'-5.0%E')	index		100	58	38	47

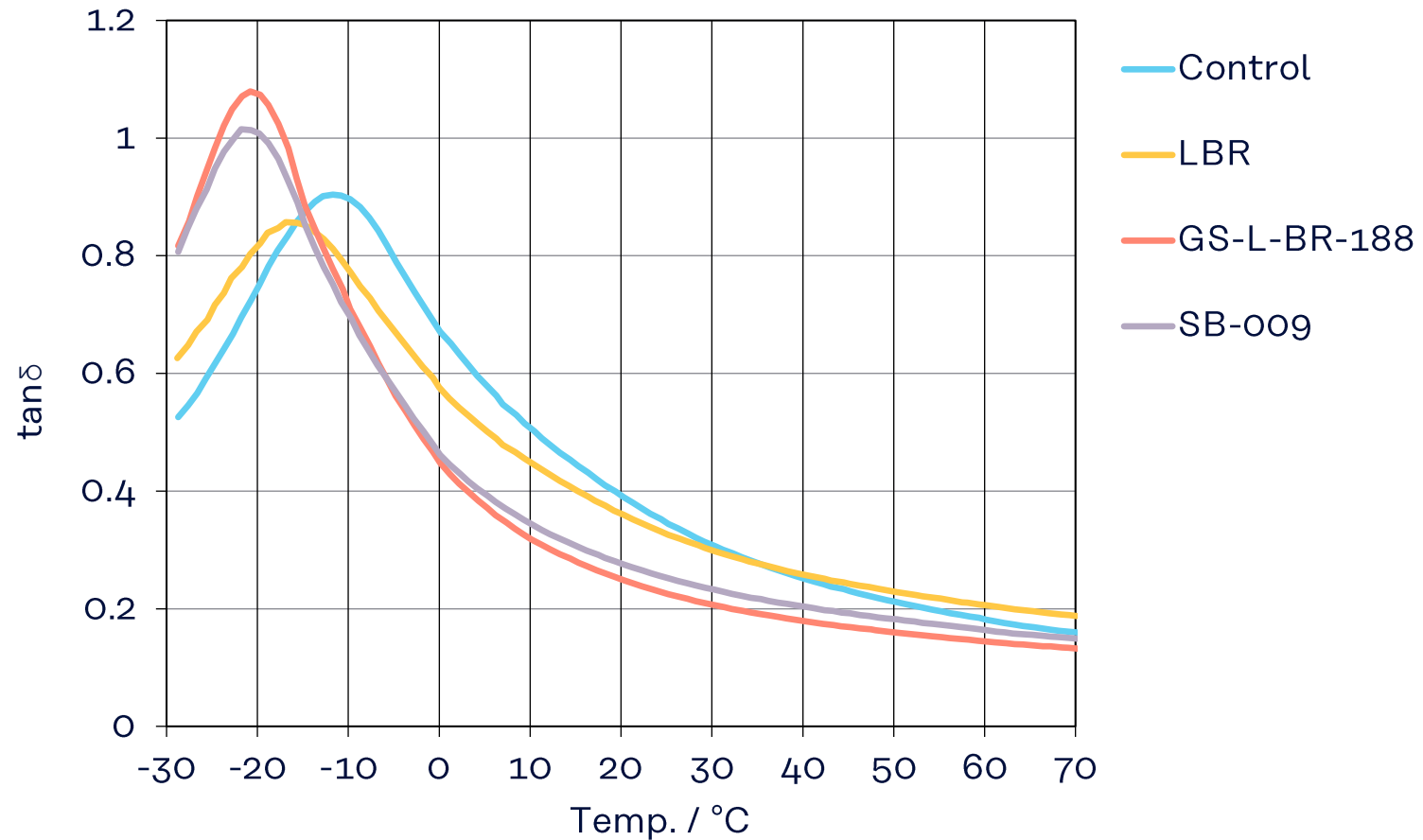
*Precursor of GS-L-BR-188 and SB-009

Mooney viscosity and $\tan\delta$ at 60°C



- Mooney viscosity and $\tan\delta$ at 60 °C showed trade off relationship.

DMA (Dynamic Mechanical Analysis)



- GS-L-BR-188 and SB-009 improve silica dispersion from the result of sharp $\tan \delta$.

Summary

- SB-009 was compared with GS-L-BR-188
 - Similar Hardness
 - Lower Mooney viscosity but higher $\tan\delta$ at 60°C

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Precautions should be taken in handling and storage. Please refer to the appropriate Safety Data Sheet for further safety information. In using KURARAY LIQUID RUBBER, please confirm related laws and regulations, and examine its safety and suitability for the application.

For medical, health care and food contact applications, please contact your Kuraray representative for specific recommendations. Even so, users must conduct their own assessment, revisions, registrations as well rely in their own technical and legal judgment to establish the safety and efficacy of their compound and/or end product with KURARAY LIQUID RUBBER for any application. KURARAY LIQUID RUBBER should not be used in any devices or materials intended for implantation in the human body. Nothing contained herein constitutes a license to practice under any patent and it should not be construed as an inducement to infringe any patent and the user is advised to take appropriate steps to be sure that any proposed use of the product will not result in patent infringement.

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Raw material

Material	Product Name	Manufacturer	Note
Styrene-butadiene rubber	JSR HPR355	JSR Corporation	Styrene content: 27% Mooney Vis. @100°C: 44 Tg: -24°C
Butadiene Rubber	JSR BR01	JSR Corporation	Cis content: 95% Mooney Vis. @100°C: 45
Silica	ULTRASIL® 7000GR	Evonik Industries AG	Specific surface area (N2) 175 m ² /g
Silane Coupling Agent	Si 75®	Evonik Industries AG	
TDAE	VIVATEC 500	H&R GmbH Co. KGaA	