

Low Cis Polybutadiene Rubber

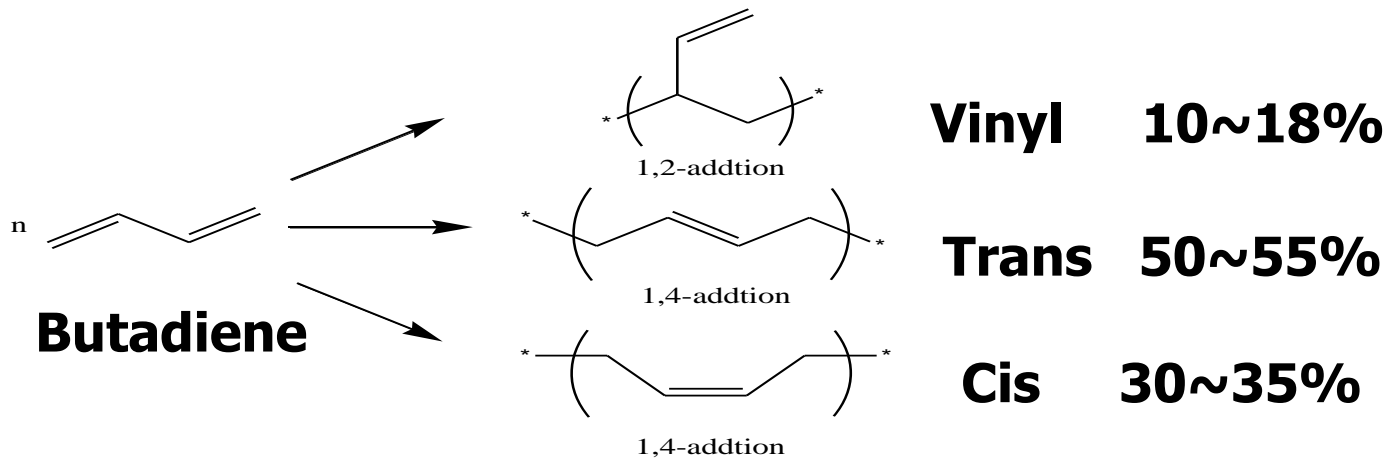
Application: Resin modification for HIPS and Mass ABS

Control of High Cis BR Structure by:

- Catalyst System (Butyl Lithium)
- Molecular Weight (Mn, Mw, PDI)
- Molecular Weight Distribution (Broad, Medium, Narrow)
- Branching (Linear, Medium)
- Microstructure (Cis, Trans, Vinyl)
- Block/Bound Styrene Content

For:

- Higher grafting and cross-linking copolymerization reactivity for HIPS
- Increase Processability
- Rubber Particle Size
- High Gloss/Super High Gloss HIPS
- High Solution Viscosity



Low Cis Polybutadiene Rubber (LBR)

Properties	ASTM Method	Condition	Unit	LBR		
				PR-245	PR-235	PR-255
Mooney	D-1646	—	MU	45 ± 3	40 ± 5	52 ± 5
BD/SM	D-1416	—	%	100/0	100/0	100/0
Volatile Matter	D-1416	—	%	≤ 0.75	≤ 0.75	≤ 0.75
Ash Content	D-1416	—	%	≤ 0.1	≤ 0.1	≤ 0.1
Solution Viscosity	D-445	5% Styrene solution	cps	35	100	164
Gel Content	CMD-D1-3310	—	Rating degree	≤ 3	≤ 3	≤ 3
Specific Gravity	D-792	23°C	—	0.91	0.91	0.91
APHA Color	D-1209	—	APHA	< 10	< 10	< 10
Cis Content	—	—	%	35	35	35
Vinyl Content	—	—	%	12~15	8.5~10.5	8.5~10.5
Package	—	—	Kg	35	35	35
Wrapping Film	—	—	Type	PS	PS	PS
Application				High Gloss HIPS	HIPS	General HIPS



Low Cis Polybutadiene Rubber

Grade Name		Styrene Content (%)	Solution Viscosity* 1) (mPa·S)	Mooney Viscosity (ML ₁₊₄ , 100° C)	Applications
BR	ASADENE™ 35AE	0	85	33	General HIPS
	ASADENE™ 55AE	0	170	55	General HIPS
	ASAPRENE™ 700A	0	44	37	High Gloss HIPS
	ASAPRENE™ 720AX	0	25	40	High Gloss HIPS, Mass ABS
	ASAPRENE™ 730AX	0	35	47	High Gloss HIPS
SBR	ASAPRENE™ 610A	15	10	---	Mass ABS
	ASAPRENE™ 625A	35	22	---	Transparent HIPS, Mass ABS
	ASAPRENE™ 670A	38	34	---	Transparent HIPS, Ultra High Gloss HIPS



High Cis Polybutadiene Rubber

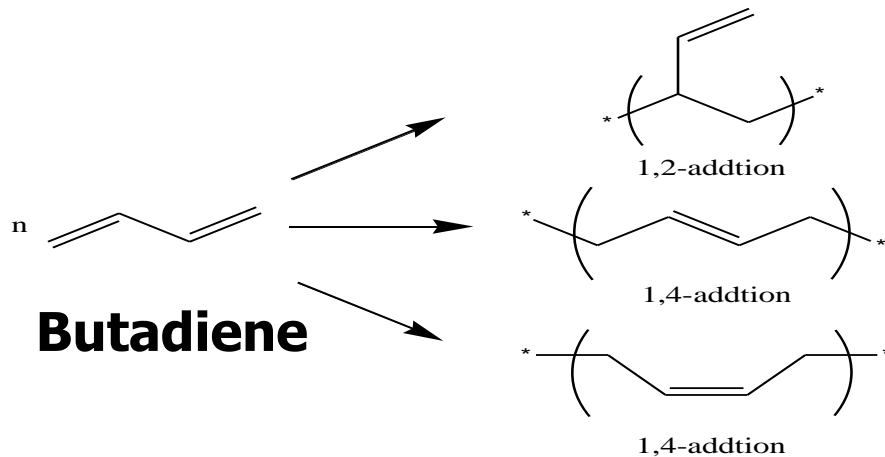
Application: Tires, Conveyor Belts, Footwear, Resin Modification for HIPS

Control of High Cis BR Structure by:

- Catalyst System (Neodymium, Cobalt, Nickel, etc.)
- Molecular Weight (Mn, Mw, PDI)
- Molecular Weight Distribution (Broad, Medium, Narrow)
- Branching (Linear, Medium)
- Microstructure (Cis, Trans, Vinyl)
- Block/Bound Styrene Content

For:

- Higher Cis Content
- Narrower Molecular Weight Distribution
- High Linearity
- Increase Processability- Roll Processing
- Abrasion Resistance
- Resiliency
- S-SBR Low hysteresis loss resulting in lower rolling resistance (improved fuel economy)



Vinyl ~ 1%

Trans ~ 1%

Cis ~ 98%



High Cis Polybutadiene Rubber (BR)

Rubber Grade	Unit	Chimei PR-040	NdBR-G	NdBR-I	NdBR-K	CoBR-T	NiBR-C
Mooney	ML	45.2	46.0	44.3	38.9	43.2	45
Mw		715421	684780	923007	821024	681792	683905
Mn		319386	317426	292220	272233	280226	193285
Q(PDI)		2.3	2.2	3.2	3.0	2.4	3.5
V.M	%	0.4	0.1	0.2	0.1	0.4	0.3
Ash	%	0.2	0.1	0.3	0.2	0.1	0.04
Compounding Character : Mooney 2000 Temp.=100°C							
Comped Mooney	ML	65.0	65.9	70.3	56.3	65.1	55.1
Curing Character MDR-2000 condition=160°C x 45min							
M(L)	lb-in	3.9	3.8	4.2	3.5	3.5	3.2
M(H)	lb-in	24.6	27.9	23.2	23.3	22.8	19.4
T(10)	min	4.3	5.6	4.4	4.5	4.5	5.0
T(90)	min	12.5	14.6	12.6	11.7	12.2	14.2
ts2	min	4.2	5.3	4.6	4.5	4.6	5.6
Cured Rubber Physical Property : Curing Temp. = 145°C, Time = 35 min							
T _{sb}	Kg/cm ²	185	170	181	172	150	150
300% M	Kg/cm ²	110	109	93	96	113	74
EL _b	%	430	456	443	421	365	481
Tear St.	Kg/cm ²	140	131	141	132	121	109
Abra. Loss(DIN)	loss c.c.	0.010	0.013	0.011	0.012	0.014	0.014
Density	gr/cm ³	1.11	1.11	1.11	1.11	1.11	1.11
Flex-Cracking	cycles	9000	10000	9000	9000	8000	7000
Comp. Set 100/22	%	40	42	38	35	41	43
Hardness	Shore A	61	63	61	61	59	61
Rebound	%	55	55	54	55	53	55

*Based on ASTM D-3189



High Cis Polybutadiene Rubber (BR)

Grade	Mooney Viscosity (ML ₁₊₄ , 100 °C)	Cis 1,4 Content (wt%)	Characteristics
BR150	43	98	<ul style="list-style-type: none"> Standard grade Well-balanced between processability and physical properties
BR150B	40	97	<ul style="list-style-type: none"> High chain branched type of BR150 Easy compounding Good open roll mill processability under high loading recipe
BR130B	29	96	<ul style="list-style-type: none"> Lower Mooney viscosity type of BR150B More excellent processability than BR150B Most suitable for high loading of carbon black
BR150L	43	98	<ul style="list-style-type: none"> High chain linearity type of BR150 Good physical properties, Excellent abrasion resistance, High rebound, Lower heat build up
BR360L	51	98	<ul style="list-style-type: none"> Higher Mooney viscosity polymer of BR150L Most superior abrasion resistance, rebound, and heat built up properties among BR grades
BR230	38	98	<ul style="list-style-type: none"> Broader molecular weight distribution type of BR150 Easy compounding and well balanced between open roll mill processability and physical properties
BR700	37	98	<ul style="list-style-type: none"> Broader molecular weight distribution type of BR150L Well balanced between good processability and high abrasion resistance
BR133P	35	98	<ul style="list-style-type: none"> Oil extended type The grade contains an environmentally-friendly, non-staining paraffinic oil
VCR412	45	*98	<ul style="list-style-type: none"> Standard grade of VCR Superior processability such as extrusion and mill behavior High hardness and modulus, and superior cut growth property
VCR617	62	*98	<ul style="list-style-type: none"> Special grade of VCR Superior processability compared to VCR412 Higher hardness and modulus compared to VCR412
VCR450	39	*98	<ul style="list-style-type: none"> Broad molecular weight distribution of matrix BR Well-balanced characteristics between processability such as extrusion and mill behavior, and physical properties
VCR800	40	*98	<ul style="list-style-type: none"> Broad molecular weight distribution of matrix BR Superior processability compared to VCR450



*Microstructure of Matrix Polymer



High Cis Polybutadiene Rubber for HIPS

Grade	Mooney Viscosity (ML ₁₊₄ , 100 °C)	5 wt. % Solution Viscosity in Styrene	Characteristics
BR15HB	40	60	<ul style="list-style-type: none"> ▪ Standard grade UBEPOL-BR for HIPS ▪ Low solution viscosity
BR15H	43	92	<ul style="list-style-type: none"> ▪ In between linearity and solution viscosity of BR15HB and BR15HL
BR15HL	43	135	<ul style="list-style-type: none"> ▪ High solution viscosity ▪ Good balance between gloss and impact resistance
BR13HB	30	41	<ul style="list-style-type: none"> ▪ Lowest solution viscosity ▪ Excellent gloss for HIPS
BR14H	33	58	<ul style="list-style-type: none"> ▪ Improved solubility of rubber in styrene ▪ Short dissolving time in styrene monomer ▪ Easy to control rubber particle size in HIPS
BR23H	38	155	<ul style="list-style-type: none"> ▪ Designed to have broad molecular weight distribution ▪ Best impact resistance
BR22H	41	202	<ul style="list-style-type: none"> ▪ Designed to have the same broad molecular weight distribution as that of BR23H ▪ Higher solution viscosity than BR23H



High Cis Polybutadiene Rubber for HIPS

Grade		BR15HB	BR15H	BR15HL	BR13HB	BR14H	BR23H	BR22H
Mooney Viscosity (ML1+4, 100°C)		40	43	43	30	33	38	41
Volatile Matter (wt.%)		0.5	0.5	0.5	0.5	0.5	0.50	0.5
Ash Content (wt.%)		0.05	0.05	0.05	0.05	0.05	0.05	0.05
Micro Structure (%)	Cis	97	98	98	96	97	98	98
	Trans	2	1	1	2	2	1	1
	Vinyl	1	1	1	2	1	1	1
Molecular Weight and Distribution	M _w (x10 ⁴)	56	58	57	49	50	61	70
	M _n (x10 ⁴)	15	19	23	13	15	15	15
	M _w /M _n	3.7	3.1	2.5	3.8	3.3	4.1	4.7
Linearity of Molecular Chain		Less	Medium	More	Less	Medium	Medium	Medium
5wt.% Solution in Styrene	Solution Viscosity (cps)	60	92	135	41	58	155	202
	Styrene Insolubles (wt. %)	0.003	0.003	0.003	0.003	0.003	0.003	0.003
	APHA Color	10	10	10	10	10	10	10
Remarks		Branching Type (Standard Grade)		Linear Type	Good Gloss	Good Balance Between Gloss and Impact Strength	Superior Impact Strength	



High Cis Polybutadiene Rubber for HIPS (Physical Properties)

Grade		BR15HB	BR15H	BR15HL	BR13HB	BR14H	BR23H	BR22H
Swelling Index		10.9	10.7	10.6	11.2	10.8	11.5	11.3
MEK/Acetone Insolubles (wt. %)		23.0	23.3	23.5	22.1	23.1	23.0	23.1
Rubber Particle Size (μm)		2.1	2.5	2.7	1.6	1.9	2.4	2.6
Tensile Strength (MPa)	At Yield	30	29	29	31	30	28	27
	At Break	29	29	30	30	29	28	28
Elongation (%)		22	23	25	20	22	30	30
Izod Impact Strength		76	75	75	72	78	83	79
Gloss		59	56	51	68	66	56	54
Vicat Softening Point (°C)		101	101	101	101	101	101	101
Melt Flow Index (g/10min.)		3.6	3.5	3.6	3.6	3.6	3.5	3.5



High Cis Polybutadiene Rubber for HIPS (Metallocene Technology)

Sample Name		MBR500	MBR Z604	Low Cis BR
Physical properties of HIPS				
Molecular Weight of Matrix PS	M_w ($\times 10^4$)	22.1	22.9	21.8
	M_n ($\times 10^4$)	7.7	6.8	6.7
	M_w/M_n	2.9	3.3	3.3
Volume % RPS (μm)		2.6	2.1	3.2
Izod Impact Strength (kgf · cm/cm)		9.1	10.4	8.3
Dupont Impact Strength (kgf · cm)		31.5	28.5	22.3
Tensile Strength	at Yield (MPa)	28.6	26.3	26.6
	at Break (MPa)	27.3	26.7	27.0
Elongation (%)		34	32	32
MEK/Acetone Insoluble (wt%)		26.5	25.7	27.6
Grafting Ratio (%)		231	221	245
Toluene Insoluble (wt%)		27.0	26.1	27.0
Swelling Index		12.1	12.4	12.0

