

## Model formula for tire innerliner 80/20 Exxon™ bromobutyl 2222 natural rubber blend

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Exxon™ bromobutyl is readily blended with other materials to improve processability or take advantage of material properties from other types of rubber.

Material	Units	Amount
Exxon bromobutyl 2222	PHR <sup>(1)</sup>	80.00
Natural rubber (technical specified rubber, TSR20)	PHR	20.00
Carbon black N660	PHR	60.00
Naphthenic oil	PHR	8.00
Aromatic and aliphatic hydrocarbon resin blend	PHR	7.00
Phenolic tackifying resin	PHR	4.00
Magnesium oxide	PHR	0.15
Stearic acid	PHR	2.00
Zinc oxide	PHR	1.00
Sulfur	PHR	0.50
Mercaptobenzothiazyl disulfide (MBTS)	PHR	1.20
<b>Total (PHR)</b>		<b>183.85</b>

Properties	Test method based on	Units and conditions	Typical values <sup>(2)</sup>
Mooney viscosity ML (1+4) at 100°C	ASTM D1646	MU, 100°C	50.0
<b>Mooney scorch (tested at 125°C)</b>	ASTM D1646		
Minimum viscosity	ASTM D1646	MU	22.0
Time to 5pt rise	ASTM D1646	minutes	25.0
<b>MDR rheometer</b>	ASTM D5289	160°C; 30 minutes; 0.5 deg. arc	
M <sub>l</sub> (minimum torque)	ASTM D5289	dNm	1.3
M <sub>h</sub> (maximum torque)	ASTM D5289	dNm	5.1
M <sub>h</sub> - M <sub>l</sub> (delta torque)	ASTM D5289	dNm	3.8
Tc <sub>10</sub> (time to 10% torque increase)	ASTM D5289	minutes	2.5
Tc <sub>50</sub> (time to 50% torque increase)	ASTM D5289	minutes	7.7
Tc <sub>90</sub> (time to 90% torque increase)	ASTM D5289	minutes	14.6
Cure rate (peak rate)	ASTM D5289	dNm/min	0.4

**Model formula for automobile tire innerliner**  
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Properties	Test method based on	Units and conditions <sup>(2)</sup>	Typical values <sup>(3)</sup>
<b>MDR rheometer</b>	ASTM D5289	180°C; 30 minutes; 0.5 deg. arc	
M <sub>l</sub> (minimum torque)	ASTM D5289	dNm	1.0
M <sub>h</sub> (maximum torque)	ASTM D5289	dNm	4.8
M <sub>h</sub> - M <sub>l</sub> (delta torque)	ASTM D5289	dNm	3.8
Tc <sub>10</sub> (time to 10% torque increase)	ASTM D5289	minutes	1.1
Tc <sub>50</sub> (time to 50% torque increase)	ASTM D5289	minutes	2.5
Tc <sub>90</sub> (time to 90% torque increase)	ASTM D5289	minutes	4.2
Cure rate (rate at tc 50)	ASTM D5289	dNm/min	1.5
<b>Stress strain properties</b>		cure time <sup>3</sup> 25 minutes at 160°C	
Tensile strength	ASTM D412	MPa	10.4
Elongation at break		%	745
Modulus 100%		MPa	1.1
Modulus 200%		MPa	2.4
Modulus 300%		MPa	3.9
Energy to break		joules	10.3
Tear strength (die B) peak load	ASTM D624	N	92.2
Tear strength (die B) mean		KN/m	54.2
Hardness	ASTM D2240	shore A	47.1
Rebound	DIN 53512	%, 23 °C	12.2
Fatigue to failure (cycles)	ASTM 4482	cycles at 136% strain	205765
Mocon oxygen permeability coefficient	ExxonMobil method	cc*mm (m <sup>2</sup> -day-mmHg) at 60° C	0.92
ARES dynamic properties at 0 °C	ExxonMobil method	1% strain, 10.0 Hz.	
G'		MPa	6.74
G''		MPa	3.51
Tan_delta			0.52
ARES dynamic properties at 60 °C		1% strain, 10.0 Hz.	
G'		MPa	2.30
G''		MPa	0.43
Tan_delta			0.19

1. Parts per hundred rubber.

2. Values given are typical and should not be interpreted as a specification.

3. Samples cured Tc 90 + 2 at 160°C.

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