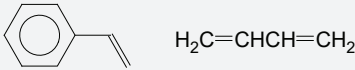


# SBC styrene-butadiene block copolymer

PARAMETER	UNIT	VALUE	REFERENCES
<b>GENERAL</b>			
Common name	-	styrene-butadiene block copolymer	
Acronym	-	SBC, S-TPE	
CAS number	-	9003-55-8	
<b>HISTORY</b>			
Person to discover	-	Hoeg, D F; Goldberg, E P; Pendleton, J F	Hoeg, D F; Goldberg, E P; Pendleton, J F, US Patent 3,598,886, Borg-Warner, Aug. 10, 1971.
Date	-	1971	
<b>SYNTHESIS</b>			
Monomer(s) structure	-		
Monomer(s) CAS number(s)	-	100-42-5; 106-99-0	
Monomer(s) molecular weight(s)	dalton, g/mol, amu	104.15; 54.09	
Styrene content	%	60-82.6	
Method of synthesis	-	styrene, cyclohexane, and initiator are polymerized then butadiene is added and polymerized	Xiong, X; Eckelt, J; Wolf, B A; Zhang, Z; Zhang, L, J. Chromat., A1110, 53-60, 2006.
Temperature of polymerization	°C	50	
Time of polymerization	h	5	
Pressure of polymerization	Pa	nitrogen atmosphere	
Number average molecular weight, $M_n$	dalton, g/mol, amu	87,000-109,000	
Mass average molecular weight, $M_w$	dalton, g/mol, amu	70,000-270,000	Nestle, N; Heckmann, W; Staining, H; Knoll, K, Anal. Chim. Acta, 604, 54-61, 2007.
Polydispersity, $M_w/M_n$	-	1.1-1.74	
<b>STRUCTURE</b>			
Cell dimensions	nm	a:b:c=0.885:0.908:0.479	Sakurai, K; Shrikawa, Y; Kashiwagi, T; Takahashi, T, Polymer, 35, 4238-9, 1994.
Unit cell angles	degree	$\beta=113$	Sakurai, K; Shrikawa, Y; Kashiwagi, T; Takahashi, T, Polymer, 35, 4238-9, 1994.
Tacticity	%	86 ( <i>trans</i> in butadiene portion)	Sakurai, K; Shrikawa, Y; Kashiwagi, T; Takahashi, T, Polymer, 35, 4238-9, 1994.
Cis content	mol%	97 (butadiene units)	Zhu, H; Wu, Y-X; Zhao, J-W; Guo, Q-L; Huang, Q-g; Wu, G-Y, J. Appl. Polym. Sci., 106, 1, 103-9, 2007.
Lamellae thickness	nm	19	Balta-Calleja, F J; Cagiao, M E; Adhikari, R; Michler, G H, Polymer, 45, 247-54, 2004.
<b>COMMERCIAL POLYMERS</b>			
Some manufacturers	-	BASF; Chevron Phillips	
Trade names	-	Styroflex, Styrolux; K-Resin	

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PARAMETER	UNIT	VALUE	REFERENCES
<b>PHYSICAL PROPERTIES</b>			
Density at 20°C	g cm <sup>-3</sup>	1.0-1.02; 0.91 (melt)	
Bulk density at 20°C	g cm <sup>-3</sup>	0.55-0.65	
Color	-	colorless, clear to opaque	
Transmittance	%	90-92	
Haze	%	0.2-1.4	
Odor	-	faint, specific	
Softening point	°C	>35 to >90	
Decomposition temperature	°C	300	
Thermal expansion coefficient, 23-80°C	10 <sup>-4</sup> °C <sup>-1</sup>	0.75E-4	
Thermal conductivity, melt	W m <sup>-1</sup> K <sup>-1</sup>	0.16	
Specific heat capacity	J K <sup>-1</sup> kg <sup>-1</sup>	2,300 (melt)	
Heat deflection temperature at 0.45 MPa	°C	62-75	
Heat deflection temperature at 1.8 MPa	°C	47-65	
Vicat temperature	°C	35-85	
Relative permittivity at 100 Hz	-	2.5	
Relative permittivity at 1 MHz	-	2.5	
Dissipation factor at 100 Hz	E-4	3	
Dissipation factor at 1 MHz	E-4	8	
Volume resistivity	ohm-m	>1E13	
Surface resistivity	ohm	1E15	
Comparative tracking index	-	600	
Permeability to oxygen, 23°C	cm <sup>3</sup> m <sup>-2</sup> d <sup>-1</sup> bar <sup>-1</sup>	27.2	
Permeability to water vapor, 23°C	g m <sup>-2</sup> d <sup>-1</sup>	0.27	
<b>MECHANICAL &amp; RHEOLOGICAL PROPERTIES</b>			
Tensile modulus	MPa	120 (Styroflex); 900-1800 (Styrolux)	
Tensile stress at yield	MPa	4 (Styroflex); 15-35 (Styrolux); 15-35 (K-Resin)	
Tensile creep modulus, 1000 h, elongation 0.5 max	MPa	490-1,050	
Elongation	%	20-360	
Tensile yield strain	%	2-5	
Flexural strength	MPa	24-37	
Flexural modulus	MPa	850-1,800	
Young's modulus	MPa	1,200	
Elmendorf tear resistance	N	650 (parallel); 800 (normal)	
Charpy impact strength, unnotched, 23°C	kJ m <sup>-2</sup>	no break; 25 (Styrolux)	
Charpy impact strength, unnotched, -30°C	kJ m <sup>-2</sup>	no break	
Charpy impact strength, notched, 23°C	kJ m <sup>-2</sup>	no break; 2-85 (Styrolux)	

# SBC styrene-butadiene block copolymer

PARAMETER	UNIT	VALUE	REFERENCES
Charpy impact strength, notched, -30°C	kJ m <sup>-2</sup>	2	
Shore D hardness	-	56-63	
Melt volume flow rate (ISO 1133, procedure B), 200°C/5 kg	cm <sup>3</sup> /10 min	11-16	
Melt index, 230°C/3.8 kg	g/10 min	7.5-15	
Water absorption, equilibrium in water at 23°C	%	0.07	
Moisture absorption, equilibrium 23°C/50% RH	%	0.07-0.09	
<b>CHEMICAL RESISTANCE</b>			
Acid dilute/concentrated	-	poor	
Alcohols	-	good	
Alkalis	-	very good	
Aliphatic hydrocarbons	-	not resistant	
Aromatic hydrocarbons	-	not resistant	
Esters	-	not resistant	
Greases & oils	-	not resistant	
Halogenated hydrocarbons	-	not resistant	
Ketones	-	not resistant	
<b>FLAMMABILITY</b>			
Flammability according to UL-94 standard; thickness 1.6/0.8 mm	class	HB	
Ignition temperature	°C	>288	
Autoignition temperature	°C	>400	
Volatile products of combustion	-	CO, CO <sub>2</sub> , hydrocarbons	
<b>WEATHER STABILITY</b>			
Stabilizers	-	Antioxidant: p-phenylenediamine	Cibulkova, Z; Simon, P; Lehocky, P; Kosar, K; Chochulova, A, J. Therm. Anal. Calorim., 97, , 535-40, 2009.
<b>TOXICITY</b>			
HMIS: Health, Flammability, Reactivity rating	-	0-1/1/0-1	
<b>ENVIRONMENTAL IMPACT</b>			
Aquatic toxicity, <i>Bluegill sunfish</i> , LC <sub>50</sub> * 48 h	mg l <sup>-1</sup>	>100	
<b>PROCESSING</b>			
Typical processing methods	-	extrusion, injection molding, mixing	
Preprocess drying: temperature/time/residual moisture	°C/h/%	60/1 (usually do not require drying)	
Processing temperature	°C	190-220 (Styroflex, injection molding); 170-190 (Styroflex, film extrusion); 170-240 (Styroflex, flat film extrusion); 180-250 (Styrolux, injection molding); 190-230 (Styrolux, extrusion)	

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PARAMETER	UNIT	VALUE	REFERENCES
<b>Processing pressure</b>	MPa	30-40 (clamping force)	
<b>Additives used in final products</b>	-	antiblock; slip; thermal stabilizer	
<b>Applications</b>	-	appliance housings, blister packs, bottles, boxes, containers, cups, deli-trays, drink cups, flexible tubing, foam, hangers, lids, medical, modification of styrenic polymers (improves toughness and stress cracking resistance), packaging fresh meat, toys	
<b>Outstanding properties</b>	-	thermoplastic elastomer, transparency (sparkling clarity), surface gloss, impact strength, and toughness	
<b>BLENDS</b>			
<b>Suitable polymers</b>	-	PS	
<b>ANALYSIS</b>			
<b>FTIR (wavenumber-assignment)</b>	cm <sup>-1</sup> /-	C=O – 1775, 1739, 1735, 1730, 1715, 1695, 1685, 1639	Allen, N S; Barcelona, A; Edge, M; Wilkinson, A; Merchan, C G; Sant Quiteria, V R, Polym. Deg. Stab., 86, 11-23, 2004.