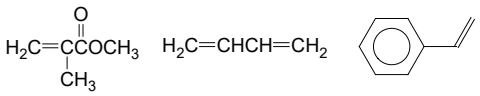
MBS poly(styrene-co-butadiene-co-methyl methacrylate)

PARAMETER	UNIT	VALUE	REFERENCES
GENERAL			
Common name	-	poly(styrene-co-butadiene-co-methyl methacrylate)	
IUPAC name	-	buta-1,3-diene; methyl 2-methylprop-2-enoate; styrene	
CAS name	-	2-propenoic acid, 2-methyl-methyl ester, polymer with 1,3-butadiene and ethenyl-benzene	
Acronym	-	MBS	
CAS number	-	25053-09-2	
HISTORY			
Person to discover	-	D'Alello, G F	
Date	-	1947	
Details	-	polymerization patented	
SYNTHESIS			
Monomer(s) structure	-		
Monomer(s) CAS number(s)	-	80-62-6; 106-99-0; 100-42-5	
Monomer(s) molecular weight(s)	dalton, g/mol, amu	100.12; 54.09; 104.15	
Methyl methacrylate content	%	40-55	
Styrene content	%	25-40	
Butadiene content	%	15-25	
Method of synthesis	-	MBS consists of an elastomeric core and a glass shell. The elastomeric core is polybutadiene or styrene–butadiene rubber (SBR), and the shell is poly(methyl methacrylate) and poly-styrene. The MBS copolymers are synthesized by emulsion polymerization method. In the preparation process PB polymer or SBR have to be synthesized first and then St and MMA are polymerized on rubber particles.	Zhou, C; Chen, M; Tan, Z Y; Sun, S L; Ao, Y H; Zhang, M Y; Yang, H D; Zhang, H X, Eur. Polym. J., 42, 1811-18, 2006.
Mass average molecular weight, M_w	dalton, g/mol, amu	100,000-150,000	
COMMERCIAL POLYMERS			
Some manufacturers	-	Arkema; Dow; Evonik; Shin-A	
Trade names	-	Clearstrength; Paraloid; Cyrolite; Claradex	
PHYSICAL PROPERTIES			
Density at 20°C	g cm^{-3}	1.05-1.11	
Bulk density at 20°C	g cm^{-3}	0.20-0.45	
Color	-	white	
Refractive index, 20°C	-	1.52-1.57	
Transmittance	%	84-91	
Haze	%	2.5-2.7	
Odor		pungent, sweet odor	
Melting temperature, DSC	°C	132-149	
Decomposition temperature	°C	>250	
Storage temperature	°C	<50	

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PARAMETER	UNIT	VALUE	REFERENCES
Thermal expansion coefficient, 23-80°C	10^{-4} °C^{-1}	0.9	
Glass transition temperature	°C	-77 to -30	Zhou, C; Chen, M; Tan, Z Y; Sun, S L; Ao, Y H; Zhang, M Y; Yang, H D; Zhang, H X, Eur. Polym. J., 42, 1811-18, 2006.
Heat deflection temperature at 0.45 MPa	°C	83	
Heat deflection temperature at 1.8 MPa	°C	72-85	
Vicat temperature VST/B/50	°C	95	
Surface resistivity	ohm	1E13	
Electric strength K20/P50, d=0.60.8 mm	kV mm^{-1}	1E13	
MECHANICAL & RHEOLOGICAL PROPERTIES			
Tensile strength	MPa	34-42	
Tensile modulus	MPa	2,300	
Tensile stress at yield	MPa	44-59	
Elongation	%	11-70	
Tensile yield strain	%	3.4-25	
Flexural strength	MPa	59-88	
Flexural modulus	MPa	1,800-2,200	
Charpy impact strength, unnotched, 23°C	kJ m^{-2}	NB	
Charpy impact strength, notched, 23°C	kJ m^{-2}	9-12	
Izod impact strength, unnotched, 23°C	J m^{-1}	1,000	
Izod impact strength, notched, 23°C	J m^{-1}	39-130	
Rockwell hardness	-	M29-40; R76-85	
Melt index, 200°C/5 kg	g/10 min	0.5-6.2	
Water absorption, equilibrium in water at 23°C	%	0.3	
FLAMMABILITY			
Flammability according to UL-94 standard; thickness 1.6/0.8 mm	class	HB	
Ignition temperature	°C	400	
Autoignition temperature	°C	470	
Limiting oxygen index	% O_2	18	
Volatile products of combustion	-	CO, CO_2, acrylates, hazardous organic products	
WEATHER STABILITY			
Products of degradation	-	depolymerization of PMMA chain in presence of PVC	Chen, Q; Wang, J; Shen, J, Polym. Deg. Stab., 87, 527-533, 2005.
TOXICITY			
NFPA: Health, Flammability, Reactivity rating	-	2/0/0; 2/0/0 (HMIS)	

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PARAMETER	UNIT	VALUE	REFERENCES
Carcinogenic effect	-	not listed by ACGIH, NIOSH, NTP	
TLV, ACGIH	mg m^{-3}/ ppm	not established	
OSHA	mg m^{-3}	5 (respirable), 15 (total dust)	
Oral rat, LD_{50}	mg kg^{-1}	>5,000	
Skin rabbit, LD_{50}	mg kg^{-1}	>5,000	
ENVIRONMENTAL IMPACT			
Aquatic toxicity, *Daphnia magna*, LC_{50}, 48 h	mg l^{-1}	>100	
Aquatic toxicity, *Bluegill sunfish*, LC_{50}, 48 h	mg l^{-1}	>100	
Aquatic toxicity, *Rainbow trout*, LC_{50}, 48 h	mg l^{-1}	>100	
PROCESSING			
Typical processing methods	-	extrusion, film extrusion, injection molding, profile extrusion, thermoforming	
Preprocess drying: temperature/ time/residual moisture	°C/h/%	71-79/2-3/	
Processing temperature	°C	218-260	
Processing pressure	MPa	69-103 (injection); 0.17-0.69 (back)	
Additives used in final products	-	epoxidized soybean oil	
Applications	-	core-shell impact modifier (automotive parts, housings for electronic components, thermoset adhesives), electrical parts, sheet	
Outstanding properties	-	high impact efficiency, part rigidity, part surface finish	
BLENDS			
Suitable polymers	-	ABS, PBT, PC, PET, PVC, SAN	