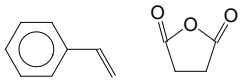
SMA poly(styrene-co-maleic anhydride)

PARAMETER	UNIT	VALUE	REFERENCES
GENERAL			
Common name	-	poly(styrene-co-maleic anhydride)	
IUPAC name	-	poly(styrene-co-maleic anhydride)	
ACS name	-	2,5-furandione, polymer with ethenylbenzene	
Acronym	-	SMA	
CAS number	-	9011-13-6	
RTECS number	-	ON4240000	
HISTORY			
Person to discover	-	Wagner-Juaregg, T	Wagner-Juaregg, T, Chem. Ber., 63, 3213, 1930.
Date	-	1930	
SYNTHESIS			
Monomer(s) structure	-		
Monomer(s) CAS number(s)	-	100-42-5; 108-31-6	
Monomer(s) molecular weight(s)	dalton, g/mol, amu	104.15; 96.06	
Maleic anhydride content	%	8-35	
Method of synthesis	-	precipitation polymerization	
Temperature of polymerization	°C	60	
Time of polymerization	h	12	
Number average molecular weight, M_n	dalton, g/mol, amu	28,000-46,000	
Mass average molecular weight, M_w	dalton, g/mol, amu	5,000-224,000	
Polydispersity, M_w/M_n	-	2.5	
Polymerization degree (number of monomer units)	-	322-495	
Radius of gyration	nm	21	Krueger, S; Krahl, F; Arndt, K-F, Eur. Polym. J., 46, 1040-48, 2010.
STRUCTURE			
Entanglement molecular weight	dalton, g/mol, amu	calc.=14,522, 16,462,17,750	
Free volume	$cm^3\ g^{-1}$	0.0668-0.0744	Kilburn, D; Dlubek, G; Pionteck, J; Bamford, D; Alam, M A, Polymer, 46, 869-76, 2005.
Hole size	$nm^3\ K^{-1}$	0.075-0.102	Kilburn, D; Dlubek, G; Pionteck, J; Bamford, D; Alam, M A, Polymer, 46, 869-76, 2005.
COMMERCIAL POLYMERS			
Some manufacturers	-	Ineos; Polyscope	
Trade names	-	Lustran; Xiran	
PHYSICAL PROPERTIES			
Density at 20°C	$g\ cm^{-3}$	1.05-1.08	

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Bulk density at 20°C	g cm^{-3}	0.55	
Color	-	translucent, off-white	
Refractive index, 20°C	-	1.5640-1.577	
Transmittance	%	91	
Haze	%	2-2.5	
Odor	-	slight	
Melting temperature, DSC	°C	115	
Thermal expansion coefficient, 23-80°C	10^{-4} $°C^{-1}$	1	
Glass transition temperature	°C	118-176	
Heat deflection temperature at 0.45 MPa	°C	93-106	
Heat deflection temperature at 1.8 MPa	°C	80-92	
Vicat temperature VST/A/50	°C	104-129	
Dielectric constant at 100 Hz/1 MHz	-	2.65/2.73	
Dissipation factor at 100 Hz	E-4	62	
Dissipation factor at 1 MHz	E-4	38	
Volume resistivity	ohm-m	1.5E14	
Surface resistivity	ohm	4.3E14	
Electric strength K20/P50, d=0.60.8 mm	kV mm^{-1}	14	
MECHANICAL & RHEOLOGICAL PROPERTIES			
Tensile strength	MPa	29-43	
Tensile modulus	MPa	2,000-2,300	
Tensile stress at yield	MPa	30-44	
Elongation	%	3-10	
Flexural strength	MPa	57-72	
Flexural modulus	MPa	2,000-2,300	
Charpy impact strength, unnotched, 23°C	kJ m^{-2}	30 to NB	
Charpy impact strength, unnotched, -40°C	kJ m^{-2}	30-84	
Charpy impact strength, notched, 23°C	kJ m^{-2}	9-13	
Charpy impact strength, notched, -40°C	kJ m^{-2}	5-17	
Izod impact strength, notched, 23°C	J m^{-1}	180-210	
Izod impact strength, notched, -30°C	J m^{-1}	80-96	
Rockwell hardness	-	R98-100	
Shrinkage	%	0.028-0.6	
Melt index, 220°C/10 kg	g/10 min	6-7	
Moisture absorption, equilibrium 23°C/50% RH	%	0.2	

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PARAMETER	UNIT	VALUE	REFERENCES
CHEMICAL RESISTANCE			
Acid dilute/concentrated	-	very good	
Alcohols	-	very good	
Alkalis	-	poor	
Aliphatic hydrocarbons	-	good	
Aromatic hydrocarbons	-	poor	
Esters	-	poor	
Halogenated hydrocarbons	-	poor	
Ketones	-	poor	
Good solvent	-	toluene	
FLAMMABILITY			
Flammability according to UL-94 standard; thickness 1.6/0.8 mm	class	HB	
Ignition temperature	°C	343	
Autoignition temperature	°C	487	
WEATHER STABILITY			
Spectral sensitivity	nm	260, 300, 320	Holland, K A; Griesser, H J; Hawthorne, D G; Hodgkin, J H, Polym. Deg. Stab., 31, 269-89, 1991.
TOXICITY			
NFPA: Health, Flammability, Reactivity rating	-	1/1/0	
Carcinogenic effect	-	not listed by ACGIH, NIOSH, NTP	
TLV, ACGIH	mg m^{-3}	3 (respirable), 10 (total)	
OSHA	mg m^{-3}	5 (respirable), 15 (total)	
Oral rat, LD_{50}	mg kg^{-1}	21,000	
PROCESSING			
Typical processing methods	-	electrospinning, injection molding	
Preprocess drying: temperature/ time/residual moisture	°C/h/%	82-93/2-3/<0.1	
Processing temperature	°C	240-265	
Processing pressure	MPa	0.17-0.35 (back)	
Applications	-	adhesion promoter, compatibilizer, fiber, ink additive, paper sizing, pigment binding, viscosity modifier	
Outstanding properties	-	heat resistance, impact resistance	
BLENDS			
Suitable polymers	-	ABS, CA, epoxy, PA6, PCL, PET, PMMA, PS, PTMG, PVC, PVDF	
ANALYSIS			
FTIR (wavenumber-assignment)	cm^{-1}/-	C-H – 3100-3000 (aromatic) 2922, 2850 (aliphatic); C=C – 1601; aromatic ring – 1493	Ignatova, M; Stoilova, O; Manolova, N; Mita, D G; Diano, N; Nicolucci, C; Rashkov, I, Eur. Polym. J., 45, 2494-2504, 2009.

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NMR (chemical shifts)	ppm	H NMR: CH_3 – 3.69; $COOCH_3$ – 7.13-7.22	Ignatova, M; Stoilova, O; Manolova, N; Mita, D G; Diano, N; Nicolucci, C; Rashkov, I, Eur. Polym. J., 45, 2494-2504, 2009.