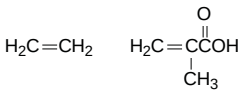
PEM poly(ethylene-co-methacrylic acid)

PARAMETER	UNIT	VALUE	REFERENCES
GENERAL			
Common name	-	poly(ethylene-co-methacrylic acid)	
CAS name	-	2-propenoic acid, 2-methyl-, polymer with ethene	
Acronym	-	PEM	
CAS number	-	25053-53-6	
HISTORY			
Person to discover	-	DuPont	
Date	-	1960s	
SYNTHESIS			
Monomer(s) structure	-		
Monomer(s) CAS number(s)	-	74-85-1; 79-41-4	
Monomer(s) molecular weight(s)	dalton, g/mol, amu	28.05; 86.06	
Methacrylic acid content	wt%	4-20 (Nucrel, Surlyn)	
Sodium cations content	% of COOH groups	30-60	
Number average molecular weight, M_n	dalton, g/mol, amu	13,900-16,600	
Mass average molecular weight, M_w	dalton, g/mol, amu	69,000-103,700	
Polydispersity, M_w/M_n	-	5.0-6.4	
STRUCTURE			
Crystallinity	%	32.7-36.5	
Avrami constants, k/n	-	n=3.54-3.9	Huang, J-W; Wen, Y-L; Kang, C-C; Yeh, M-Y; Wen, S-B, Thermochim. Acta, 465, 48-58, 2007.
COMMERCIAL POLYMERS			
Some manufacturers	-	DuPont	
Trade names	-	Conpol, Nucrel, Surlyn (ionomer)	
PHYSICAL PROPERTIES			
Density at 20°C	g cm^{-3}	0.93-0.95	
Color	-	white	
Odor	-	mild methacrylic acid	
Melting temperature, DSC	°C	76-105	
Softening point	°C	62	
Decomposition temperature	°C	>325	
Glass transition temperature	°C	45.8	Cai, X; Riedl, B; Ait-Kadi, A; Composites: Part A, 34, 1075-84, 2003.
Maximum processing temperature	°C	235-310	
Vicat temperature VST/A/50	°C	60-95	

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MECHANICAL & RHEOLOGICAL PROPERTIES			
Tensile strength	MPa	1.3-530.8	Kraemer, R H; Raza, M A; Gedde, U W, Polym. Deg. Stab., 92, 1795-1802, 2007.
Tensile stress at yield	MPa	17.9-21.2	
Elongation	%	630-1,180	
Flexural modulus	MPa	400	
Young's modulus	MPa	276	Cai, X; Riedl, B; Ait-Kadi, A; Composites: Part A, 34, 1075-84, 2003.
Izod impact strength, notched, 23°C	J m^{-1}	370 to NB	
Shore D hardness	-	46	
Melt index, 190°C/2.16 kg	g/10 min	7.5-60	
FLAMMABILITY			
Ignition temperature	°C	335-365	
Volatile products of combustion	-	CO, organic acids, aldehydes, alcohols, other hydrocarbon oxidation products	
BIODEGRADATION			
Typical biodegradants	-	Aspergillus, Penicillium	Weng, Y-M; Chen, M-J; Chen, W, Lebensm.-Wiss. u-Technol., 32, 191-5, 1999.
Stabilizers	-	benzoic and sorbic acids	
TOXICITY			
Carcinogenic effect	-	not listed by ACGIH, NIOSH, NTP	
OSHA	mg m^{-3}	5 (respirable dust), 15 (total dust)	
PROCESSING			
Typical processing methods	-	extrusion, injection molding	
Processing temperature	°C	135-235	
Additives used in final products	-	slip agent, antifog agent, antiblocking agent	
Applications	-	adhesives, footwear, glass coating, metal coating, modification of surface properties of films and coatings; refrigerated food packaging, wire and cable; ionomer (Surlyn): golf ball covers, hockey helmets, ski boots	
Outstanding properties	-	inherently flexible, self-healing following ballistic puncture	
BLENDS			
Compatible polymers	-	ionomer (Surlyn), ethylene-methacrylic acid-acrylate terpolymer (Nucrel), PBT, PE, PEO, PET	
Compatibilizers	-	compatibilizer of PET/LLDPE blends	
ANALYSIS			
FTIR (wavenumber-assignment)	cm^{-1}/-	C=O – 1756, 1750, 1743, 1727; calcium carbonate – 1580-1300, CH_2 – 1435, CH_3 – 1365; C-O – 1255	Kraemer, R H; Raza, M A; Gedde, U W, Polym. Deg. Stab., 92, 1795-1802, 2007.
WAXD	2θ	21.5	Huang, J-W; Wen, Y-L; Kang, C-C; Yeh, M-Y; Wen, S-B, Thermochim. Acta, 465, 48-58, 2007.