EAA poly(ethylene-co-acrylic acid)

PARAMETER	UNIT	VALUE	REFERENCES
GENERAL			
Common name	-	poly(ethylene-co-acrylic acid)	
ACS name	-	2-propenoic acid, polymer with ethene	
Acronym	-	EAA	
CAS number	-	9010-77-9	
SYNTHESIS			
Monomer(s) structure	-	$H_2C{=}CH_2$ $H_2C{=}CHC(=O)OH$	
Monomer(s) CAS number(s)	-	74-85-1; 79-10-7	
Monomer(s) molecular weight(s)	dalton, g/mol, amu	28.05; 72.06	
Acrylic acid content	%	5-38	
Aromacity	%	0-10 of aromatic protons	
Temperature of polymerization	°C	240-300	
Pressure of polymerization	MPa	200-300	
Number average molecular weight, M_n	dalton, g/mol, amu	280-160,000	Wiggins, K M; Bielawski, C W, Polym. Chem., 4, 2239-45, 2013.
Mass average molecular weight, M_w	dalton, g/mol, amu	450-86,000	
Polydispersity, M_w/M_n	-	1.1-3.97	McAlduff, M; Reven, L, Macromolecules, 38, 3745-53, 2005.
STRUCTURE	-		
Crystallinity	%	8-37	Zhang, J; Chen, S; Su, J; Shi, X; Jin, J; Wang, X; Xu, Z, J. Therm. Anal. Calorim., 97, 959-67, 2009.
Peak crystallization temperature	°C	85-90	
Avrami constants, k/n	-	-/3-4	Zhang, J; Chen, S; Su, J; Shi, X; Jin, J; Wang, X; Xu, Z, J. Therm. Anal. Calorim., 97, 959-67, 2009.
COMMERCIAL POLYMERS			
Some manufacturers	-	Dow; DuPont	
Trade names	-	Primacor; Nucrel	
PHYSICAL PROPERTIES			
Density at 20°C	g cm^{-3}	0.92-0.96	
Bulk density at 20°C	g cm^{-3}	0.5-0.6	
Color	-	clear to white to off-white to yellow	
Haze	%	3.7-4	
Gloss, 60°, Gardner (ASTM D523)	%	74-76	
Odor	-	acidic	
Melting temperature, DSC	°C	75-112	
Softening point	°C	92-140	
Thermal degradation	°C	325	
Glass transition temperature	°C	-28 to 86	
Vicat temperature VST/A/50	°C	40-90	

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PARAMETER	UNIT	VALUE	REFERENCES
pKa		4.25	Laney, K A, Elastic Modulus of Poly(ethylene-co-acrylic acid) Copolymers and Ionomers, Diss., Princeton, May 2010.
Coefficient of friction	-	0.3; 0.15-0.18 (with slip)	Luo, N; Janorkar, A V; Hirt, D E; Husson, S M; Schwark, D W, J. Appl. Polym. Sci., 97, 2242-48, 2005.
Permeability to oxygen, 25°C	cm^3 mm m^{-2} day^{-1} atm^{-1}	180-550	
Permeability to water vapor, 25°C	g mm m^{-2} atm^{-1} 24 h^{-1}	0.0.37-0.44	
MECHANICAL & RHEOLOGICAL PROPERTIES			
Tensile strength	MPa	5.8-24	Li, D; Sur, G S, J. Ind. Eng. Chem., 20, 3122-7, 2014.
Tensile modulus	MPa	22-130	
Tensile stress at yield	MPa	7.2-10	
Elongation	%	390-640	
Flexural modulus	MPa	110	
Young's modulus	MPa	65-115	Valenza, A; Visco, A M; Acierno, D, Polym. Test., 21, 101-9, 2002.
Dart drop impact	g	410	
Elmendorf tear strength	g	270-730	
Shore D hardness	-	50-51	
Melt viscosity, shear rate=1000 s^{-1}	Pa s	0.93-7	
Melt index, 190°C/2.16 kg	g/10 min	1.5-1300	
CHEMICAL RESISTANCE			
Alkalis	-	good	
Aliphatic hydrocarbons	-	poor	
Aromatic hydrocarbons	-	poor	
FLAMMABILITY			
Ignition temperature	°C	>250 to 340	
WEATHER STABILITY			
Stabilizers	-	silica coated ZnO particles shield polymer for UV radiation	Ramasamy, M; Kim, Y J; Gao, H; Yi, D K; An, J H, Mater. Res. Bull., 51, 85-91, 2014.
BIODEGRADATION			
Stabilizers	-	benzoyl chloride	Matche, R S; Kulkarni, G; Raj B, J. Appl. Polym. Sci., 100, 3063-68, 2006.
TOXICITY			
NFPA: Health, Flammability, Reactivity rating	-	1/1/0; 1/0/0 (HMIS)	

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PARAMETER	UNIT	VALUE	REFERENCES
Carcinogenic effect	-	not listed by ACGIH, NIOSH, NTP	
TLV, ACGIH	ppm	2 (acrylic acid)	
OSHA	ppm	10 (acrylic acid)	
Oral rat, LD_{50}	mg kg^{-1}	>2,350; >5,000	
Skin rabbit, LD_{50}	mg kg^{-1}	>2,000	
PROCESSING			
Typical processing methods	-	cast film, extrusion blown film, extrusion coating, lamination	
Processing temperature	°C	193-288 (extrusion); 305-325 (blown film)	
Additives used in final products	-	Slip: erucamide, grafted 12-aminododecamide	Luo, N; Janorkar, A V; Hirt, D E; Husson, S M; Schwark, D W, J. Appl. Polym. Sci., 97, 2242-48, 2005.
Applications	-	packaging multilayer films, resins for hot-melt adhesives, resins for pressure-sensitive adhesives; products: hot-melt packaging, curtain coating, bookbinding, glue stick, masking tapes, carpet tape, mounting tape, paper, strapping tapes, thermoplastic road marking	
Outstanding properties	-	adhesion, environmental stress cracking resistance, optical properties, strength	
BLENDS			
Suitable polymers	-	cellulose, PA6, PE, PP, starch	
ANALYSIS			
FTIR (wavenumber-assignment)	cm^{-1}/-	OH – 3500; C-H – 2925, 2850, 1450, 1465, 1375; C=O – 1710, 1230-1320; C-C – 940	Valenza, A; Visco, A M; Acierno, D, Polym. Test., 21, 101-9, 2002.