

CPE chlorinated polyethylene

PARAMETER	UNIT	VALUE	REFERENCES
GENERAL			
Common name	-	polyethylene, chlorinated	
ACS name	-	chlorinated polyethylene rubber	
Acronym	-	CPE	
CAS number	-	63231-66-3	
HISTORY			
Person to discover	-	Fawcett, E W; Gibson, R O; Perrin, M W	Fawcett, E W; Gibson, R O; Perrin, M W, US Patent 2,153,553, ICI, 1939.
Date	-	1939	
Details	-	chlorination in solution at elevated temperature	
SYNTHESIS			
Monomer(s) structure	-	polyethylene; chlorine	
Monomer(s) CAS number(s)	-	9002-88-4; 7782-50-5	
Monomer(s) molecular weight(s)	dalton, g/mol, amu	variable; 35.453	
Chlorine content	%	10-48	Varma, A J; Deshpande, S V; Kondapalli, P, Polym. Deg. Stab., 63, 1-3, 1999.
Method of synthesis	-	chlorination in solution or powder form	Steenbakkens-Menting, H N A M, Chlorination of Ultrahigh Molecular eight Polyethylene, Diss. Techn. Uni. Eindhoven, 1995.
Temperature of polymerization	°C	20-130	
Time of polymerization	h	2-4	
Mass average molecular weight, M_w	dalton, g/mol, amu	96,500-120,000	
Polydispersity, M_w/M_n	-	4.6-5.0	
STRUCTURE			
Crystallinity	%	2-5 (non-crystalline); 20-50 (semi-crystalline); 13.0-58.5 (CPE films having different chlorine content); 25% (25% Cl); 2% (36-42 Cl%); crystalline up to 30 wt% Cl if chlorination in solution and up to 50% if chlorination in powder form (blocky placement of chlorine atoms)	Stoeva, S, J. Appl. Polym. Sci., 101, 2602-13, 2006; Whiteley, M J; Pan, W-P, Thermochim. Acta., 166, 27-39, 1990; Steenbakkens-Menting, H N A M, Chlorination of Ultrahigh Molecular eight Polyethylene, Diss. Techn. Uni. Eindhoven, 1995.
Crystallite size	nm	7-16 (thickness)	
Lamellae thickness	nm	6.5-14.5	Steenbakkens-Menting, H N A M, Chlorination of Ultrahigh Molecular eight Polyethylene, Diss. Techn. Uni. Eindhoven, 1995.
COMMERCIAL POLYMERS			
Some manufacturers	-	Showa Denko, Dow	
Trade names	-	Elaslen, Tyrin	
PHYSICAL PROPERTIES			
Density at 25°C	g cm ⁻³	1.12-1.20	
Bulk density at 20°C	g cm ⁻³	0.39-0.55	

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PARAMETER	UNIT	VALUE	REFERENCES
Color	-	off-white	
Odor	-	odorless	
Melting temperature, DSC	°C	108.9-123.3	Stoeva, S, J. Appl. Polym. Sci., 101, 2602-13, 2006.
Decomposition temperature	°C	215-239	Varma, A J; Deshpande, S V; Kondapalli, P, Polym. Deg. Stab., 63, 1-3, 1999.
Glass transition temperature	°C	-10 to 55	Stoeva, S, J. Appl. Polym. Sci., 101, 2602-13, 2006.
Heat of fusion	J g ⁻¹	2	
Vicat temperature VST/A/50	°C	49.9-71.7	
Hildebrand solubility parameter	MPa ^{0.5}	19.2 (44% Cl)	
MECHANICAL & RHEOLOGICAL PROPERTIES			
Tensile strength	MPa	6.0-16.8; 3.1	Guo, Z; Ran, S; Fang, Z, Compos. Sci. Technol., 86, 157-63, 2013.
Elongation	%	550-1,000	
Elastic modulus	MPa	1.5	Guo, Z; Ran, S; Fang, Z, Compos. Sci. Technol., 86, 157-63, 2013.
Shore A hardness	-	47-70	
Shore D hardness	-	46-48	
Brittleness temperature (ASTM D746)	°C	-55 to <-70	
Mooney viscosity	-	64-115	
Melt viscosity, shear rate=1000 s ⁻¹	Pa s	800-2,900	
Melt index, 180°C/21.6 kg	g/10 min	0.1-25	
CHEMICAL RESISTANCE			
Alcohols	-	good	
Aromatic hydrocarbons	-	poor	
Esters	-	good	
Halogenated hydrocarbons	-	poor	
Ketones	-	good	
Good solvent	-	chlorobenzene, cyclohexanone, tetrachloroethylene, toluene, xylene	
Non-solvent	-	ketones, alcohols, esters	
FLAMMABILITY			
Limiting oxygen index	% O ₂	29-33	
Volatile products of combustion	-	HCl, H ₂ , CH ₄ , CO ₂ , H ₂ O	Whiteley, M J; Pan, W-P, Thermo- chim. Acta., 166, 27-39, 1990.
TOXICITY			
Carcinogenic effect	-	not listed by ACGIH, NIOSH, NTP	
Oral rat, LD ₅₀	mg kg ⁻¹	>8,000; 920	
PROCESSING			
Typical processing methods	-	extrusion, mixing, molding, peroxide vulcanization	

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PARAMETER	UNIT	VALUE	REFERENCES
Preprocess drying: temperature/time/residual moisture	°C/h/%	80-85/4/-	
Processing temperature	°C	145-165	
Additives used in final products	-	Fillers: calcium carbonate, carbon black, clay, silica, magnesium oxide (used as thermal stabilizer; typically 5-10 phr), titanium dioxide; Antistatics: polymers of ethylene oxide and epihalohydrin	
Applications	-	autoignition wire, automotive air ducts and hoses, car axle boots, fiber optic cable, impact modification for PVC in pipe, power steering hose, roofing membranes, technical hoses, transmission oil cooler hose, vinyl siding, window profiles and FR ABS, wire and cable	
Outstanding properties	-	fire resistance, impact resistance, solvent resistance	
BLENDS			
Suitable polymers	-	ABS, ASA, ENR, EVAC, PMMA, PVC	Zhang, Z; Zhu, W; Zhang, J; Tian, T, Polym. Testing., 44, 23-9, 2015.
Compatibilizers	-	ENR	
ANALYSIS			
FTIR (wavenumber-assignment)	cm ⁻¹ /-	C-Cl – 660, 609; CH ₂ – 1263, 1469	O'Keefe, J F, Rubber World, June 2004, 27-37.