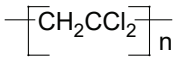
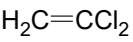
PVDC poly(vinylidene chloride)

PARAMETER	UNIT	VALUE	REFERENCES
GENERAL			
Common name	-	poly(vinylidene chloride)	
IUPAC name	-	poly(1,1-dichloroethene)	
Acronym	-	PVDC	
CAS number	-	9002-85-1	
Formula			
HISTORY			
Person to discover	-	Henri Vicror Regnault; Ralph Wiley, Dow Chemical	
Date	-	1830; 1933; 1940; 1953	
Details	-	Regnault synthesized monomer and polymerized it by heating; Wiley discovered polymer by accident; produced in DOW in 2000 gal reactor; commercialized as Saran	Mounts, M L, Antec, 3849-53, 2003.
SYNTHESIS			
Monomer(s) structure	-		
Monomer(s) CAS number(s)	-	75-35-4	
Monomer(s) molecular weight(s)	dalton, g/mol, amu	96.94	
Monomer ratio	-	100%	
Formulation example	-	vinylidene chloride, water, methyl hydroxypropyl cellulose, lauroyl peroxide	
Method of synthesis	-	free radical polymerization	
Temperature of polymerization	°C	60	
Time of polymerization	h	30-60	
Yield	%	85-98	
Heat of polymerization	J g^{-1}	836-1104	Lebedev, B V; Kulagina, T G; Smirnova, N N, Vyssomol. Soed., A, 37, 1896, 1995.
Mass average molecular weight, M_w	dalton, g/mol, amu	105,000-125,000	
Polydispersity, M_w/M_n	-	1.5-2.0	
Molar volume at 298K	cm^3 mol^{-1}	49.7 (crystalline)	
Van der Waals volume	cm^3 mol^{-1}	38.0 (crystalline)	
CRYSTALLINE STRUCTURE			
Crystallinity	%	4-6	
Cell type (lattice)	-	monoclinic	
Cell dimensions	nm	a:b:c=0.672:1.252:0.468	
Unit cell angles	degree	γ=123	
Rapid crystallization temperature	°C	140-150	
COMMERCIAL POLYMERS			
Some manufacturers	-	Dow	
Trade names	-	Saran	

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PHYSICAL PROPERTIES			
Density at 20°C	g cm^{-3}	1.70; 1.775 (amorphous); 1.97 (crystalline)	
Bulk density at 20°C	g cm^{-3}	0.8	
Refractive index, 20°C	-	1.60-1.63	
Odor	-	odorless	
Melting temperature, DSC	°C	158-205	
Softening point	°C	100-150	
Decomposition temperature	°C	120	
Glass transition temperature	°C	calc=-19; -17 to -20	
Heat of fusion	kJ mol^{-1}	5.62	
Hansen solubility parameters, δ_D, δ_P, δ_H	$MPa^{0.5}$	19.0, 9.6, 9.0	
Interaction radius		5.8	
Hildebrand solubility parameter	$MPa^{0.5}$	25.0; 23.1	
Surface tension	mN m^{-1}	calc.=45.4	Wu, S, J. Adhesion, 5, 39, 1973.
Permeability to nitrogen, 25°C	cm^3 cm cm^{-2} s^{-1} Pa^{-1} x 10^{12}	0.0000706	
Permeability to oxygen, 25°C	cm^3 cm cm^{-2} s^{-1} Pa^{-1} x 10^{12}	0.000383	
Permeability to water vapor, 25°C	cm^3 cm cm^{-2} s^{-1} Pa^{-1} x 10^{12}	0.7	
Contact angle of water, 20°C	degree	80	
Surface free energy	mJ m^{-2}	31.5	
MECHANICAL & RHEOLOGICAL PROPERTIES			
Tensile strength	MPa	24-69; 207-414 (oriented)	
Tensile stress at yield	MPa	19-26	
Elongation	%	10-20; 15-40 (oriented)	
Flexural strength	MPa	40	
Flexural modulus	MPa	500	
Compressive strength	MPa	55	
Rockwell hardness	-	R55	
Shrinkage	%	0.5-2.5	
Brittleness temperature (ASTM D746)	°C	-10 to 10	
Melt viscosity, shear rate=1000 s^{-1}	Pa s	750	
CHEMICAL RESISTANCE			
Acid dilute/concentrated	-	very good	
Alcohols	-	very good	

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PARAMETER	UNIT	VALUE	REFERENCES
Alkalis	-	good-poor	
Aliphatic hydrocarbons	-	good	
Aromatic hydrocarbons	-	fair-poor	
Esters	-	good-fair	
Greases & oils	-	good	
Halogenated hydrocarbons	-	fair-poor	
Ketones	-	fair	
Good solvent	-	benzonitrile, butyl acetate, cyclohexanone, 1,2-dichlorobenzene, dioxane, DMA, DMF, NMP, tetrahydrofurfuryl alcohol, tetralin (hot), THF (hot), trichloroethane	
Non-solvent	-	concentrated acids and alkalis (except ammonia), alcohols, carbon disulfide, chloroform, cyclohexanone, dioxane, hydrocarbons, phenols, THF	
FLAMMABILITY			
Ignition temperature	°C	>530	
Autoignition temperature	°C	>530	
Limiting oxygen index	% O_2	60	
UL 94 rating	-	V-0	
WEATHER STABILITY			
Important initiators and accelerators	-	Pd/AC (oxidation catalyst)	
PROCESSING			
Typical processing methods	-	coating, extrusion, fiber spinning, molding	
Additives used in final products	-	Plasticizers: acetyl tri-n-butyl citrate, epoxidized soybean oil, polymeric condensation product of azelic acid and 1,3-butanediol, polymeric plasticizer of adipic acid and propylene glycol, Antistatics: ionic polymer, imidazoline/metal salt	
Applications	-	cling wrap (recently changed to LDPE), coatings, fiber, film layer reducing permeability of oxygen and flavors, filters, membranes, monofilaments, screens, shower curtains, stuffed animals, tape	
BLENDS			
Suitable polymers	-	PBA, PBM	