

CAP cellulose acetate propionate

PARAMETER	UNIT	VALUE	REFERENCES
GENERAL			
Common name	-	cellulose acetate propionate	
CAS name	-	cellulose, acetate propanoate	
Acronym	-	CAP	
CAS number	-	9004-39-1	
HISTORY			
Date	-	1924; 1931	
Details	-	introduced into the photographic film industry in 1924; in 1931 Celanese developed commercial product	Schilling, M; Bouchard, M; Khanjian, H; Learner, T; Phenix, A; Rivenc, R, Accounts Chem. Res., 43, 6, 888-96, 2010.
SYNTHESIS			
Monomer(s) structure	-	cellulose; propionic acid; acetic acid	
Monomer(s) CAS number(s)	-	9004-34-6; 79-09-4; 64-19-7	
Monomer(s) molecular weight(s)	dalton, g/mol, amu	typical for raw materials: 74.08; 60.05	
Acetyl content	%	0.6-2.5	
Propionyl content	%	42.5-89.7	
Hydroxyl content	%	1.7-10.0	
Method of synthesis	-	similar to other acetates, it is made with the addition of propionic acid in place of acetic anhydride	
Number average molecular weight, M_n	dalton, g/mol, amu	17,000-75,000	
Mass average molecular weight, M_w	dalton, g/mol, amu	25,000-247,000	
Polydispersity, M_w/M_n	-	3.07-3.31	
STRUCTURE			
Crystallinity	%	0, amorphous	
COMMERCIAL POLYMERS			
Some manufacturers	-	Eastman; Rotuba	
Trade names	-	Cellulose Acetate Propionate, Tenite; Auracel	
PHYSICAL PROPERTIES			
Density at 20°C	g cm ⁻³	1.17-1.25	
Bulk density at 20°C	g cm ⁻³	0.40	
Color	-	white	
Refractive index, 20°C	-	1.46-1.475	
Birefringence	-	5-8E-4	Yamaguchi, M; Masuzawa, K, Eur. Polym. J., 43, 3277-82, 2007.
Transmittance	%	90	
Haze	%	8.5	
Odor	-	none	
Melting temperature, DSC	°C	184-210	
Thermal expansion coefficient, 23-80°C	10 ⁻⁴ °C ⁻¹	1.2-1.8	

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Thermal conductivity, melt	W m ⁻¹ K ⁻¹	0.16-0.36	
Glass transition temperature	°C	128-159; 117.5	Schilling, M; Bouchard, M; Khanjian, H; Learner, T; Phenix, A; Rivenc, R, Accounts Chem. Res., 43, 6, 888-96, 2010.
Specific heat capacity	J K ⁻¹ kg ⁻¹	1,200-1,900	
Maximum service temperature	°C	60	
Heat deflection temperature at 0.45 MPa	°C	76-96	
Heat deflection temperature at 1.8 MPa	°C	67-90	
Vicat temperature VST/A/50	°C	87-96	
Vicat temperature VST/B/50	°C	94	
Dielectric constant at 100 Hz/1 MHz	-	3.55-4/3.3-3.8	
Dissipation factor at 1 MHz	E-4	80	
Volume resistivity	ohm-m	1E10	
Electric strength K20/P50, d=0.60.8 mm	kV mm ⁻¹	11-19	
Contact angle of water, 20°C	degree	66	Amim, J; Kosaka, P M; Petri, D F S; Maia, F C B; Miranda, P B, J. Colloid Interface Sci., 332, 477-83, 2009.
MECHANICAL & RHEOLOGICAL PROPERTIES			
Tensile strength	MPa	22-66	
Tensile modulus	MPa	1,000-2,200	
Tensile stress at yield	MPa	22-32	
Elongation	%	3-45	
Tensile yield strain	%	4	
Flexural strength	MPa	29-58	
Flexural modulus	MPa	1,100-1,750	
Compressive strength	MPa	58	
Izod impact strength, notched, 23°C	J m ⁻¹	130-520	
Izod impact strength, notched, -40°C	J m ⁻¹	85-120	
Abrasion resistance (ASTM D1044)	mg/1000 cycles	65	
Rockwell hardness	-	R40-96	
Shrinkage	%	0.2-0.6	
Water absorption, equilibrium in water at 23°C	%	1.8-2; 1.5 (24 h)	
Moisture absorption, equilibrium 23°C/50% RH	%	1.0	
CHEMICAL RESISTANCE			
Acid dilute/concentrated	-	good-fair	
Alcohols	-	poor	
Alkalis	-	good	

PARAMETER	UNIT	VALUE	REFERENCES
Aliphatic hydrocarbons	-	good	
Aromatic hydrocarbons	-	poor	
Esters	-	poor	
Greases & oils	-	good	
Halogenated hydrocarbons	-	poor	
Ketones	-	poor	
Good solvent	-	acetone, butyl acetate, cellosolve acetate, ethyl acetate, methyl alcohol, methyl ethyl ketone	
Non-solvent	-	ethylene glycol, heptane, turpentine, water	
FLAMMABILITY			
Autoignition temperature	°C	432	
Limiting oxygen index	% O ₂	17-19	
Volatile products of combustion	-	CO, CO ₂	
UL 94 rating	-	HB	
TOXICITY			
NFPA: Health, Flammability, Reactivity rating	-	1/1/0; 0/0/0 (HMIS)	
Carcinogenic effect	-	not listed by ACGIH, NIOSH, NTP	
Oral rat, LD ₅₀	mg kg ⁻¹	>6,400	
Skin rabbit, LD ₅₀	mg kg ⁻¹	>5,000	
PROCESSING			
Typical processing methods	-	mixing, injection molding	
Preprocess drying: temperature/time/residual moisture	°C/h/%	65-70/2	
Processing temperature	°C	168--195	
Processing pressure	MPa	8-10 (injection)	
Process time	s	8-12 (cycle time)	
Additives used in final products	-	Plasticizers: poly(1,3-butylene glycol adipate) (Drapex 429), polyester sebacate (Paraplex G-25), octyl adipate; Antistatic: hydroxyethyl cellulose; Antiblocking: silica; Release: fluorochemical, microcrystalline wax, polyethylene wax, silicone; Slip: alumina, magnesium stearate, polyethylene wax, silica	
Applications	-	films, housewares, medical, membranes, nail care, ophthalmic, printing inks	
Outstanding properties	-	fast solvent release, high melting point, solubility in ink solvents	
BLENDS			
Suitable polymers	-	acrylics, alkyds, amino resins, isocyanate resins, PHB	
ANALYSIS			
FTIR (wavenumber-assignment)	cm ⁻¹ /-	major bands: C=O stretch of ester group 1746; asymmetric stretching of C-C-O of ester group 1234; asymmetric stretching of O-C-C bond attached to carbonyl	Schilling, M; Bouchard, M; Khanjian, H; Learner, T; Phenix, A; Rivenc, R, Accounts Chem. Res., 43, 6, 888-96, 2010.