CY cyanoacrylate

PARAMETER	UNIT	VALUE	REFERENCES
GENERAL			
Common name	-	cyanoacrylate (super glue)	
ACS name	-	2-propenoic acid, 2-cyano-, ethyl ester, homopolymer	
Acronym	-	CY	
CAS number	-	123-31-9 (methyl); 7085-85-0 (ethyl); 25067-30-5 (2-propenoic); 6606-65-1 (butyl); 6701-17-3 (octyl)	
EC number	-	230-391-5 (ethyl)	
HISTORY			
Person to discover	-	Harry Coover and Fred Joyner	
Date	-	1942	
Details	-	discovered that after determination of refractive index of monomer the prisms of refractometer could not any longer be separated	
SYNTHESIS			
Monomer(s) structure	-	CH_2=C(CN)C(O)OCH_3; CH_2=C(CN)C(O)OCH_2CH_3; CH_2=C(CN)C(O)$O(CH_2)_3CH_3$	
Monomer(s) CAS number(s)	-	137-05-3; 7085-85-0; 6606-65-1	
Monomer(s) molecular weight(s)	dalton, g/mol, amu	111.1; 125.13; 153.18	
Method of synthesis	-	reaction of cyanoacrylic acid with formaldehyde in aqueous solution in the presence of basic condensation catalyst; polymerization is conducted in the presence of initiator (e.g., N,N'-dimethyl-p-toluidine), the reaction is spontaneous	
Initiation rate constant	s^{-1}	1E10	Zhou, Y; Bei, F; Ji, H; Yang, X; Lu, L; Wang, X, J. Molecular Structure, 737, 117-23, 2005.
Propagation rate constant	s^{-1}	100-500	Zhou, Y; Bei, F; Ji, H; Yang, X; Lu, L; Wang, X, J. Molecular Structure, 737, 117-23, 2005.
Number average molecular weight, M_n	dalton, g/mol, amu	852,000-1,112,000	Han, M G; Kim, S; Liu, S X, Polym. Deg. Stab., 93, 1243-51, 2008.
Mass average molecular weight, M_w	dalton, g/mol, amu	954,000-1,440,000	Han, M G; Kim, S; Liu, S X, Polym. Deg. Stab., 93, 1243-51, 2008.
Polydispersity, M_w/M_n	-	1.09-1.35	Han, M G; Kim, S; Liu, S X, Polym. Deg. Stab., 93, 1243-51, 2008.
STRUCTURE			
Crystallinity	%	amorphous	
COMMERCIAL POLYMERS			
Some manufacturers	-	Cyberbond; Elmer; Permabond	
Trade names	-	Apollo; Alpha; Permabond	
PHYSICAL PROPERTIES			
Density at 20°C	g cm^{-3}	1.05-1.08	
Refractive index, 20°C	-	1.483 (ethyl CY); 1.479 (butyl); 1.482 (hexyl)	Shankland, K; Whateley, T L, J. Colloid Interface Sci., 154, 1, 160-6, 1992.
Transmittance	%	80	
Softening point	°C	150	

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Decomposition temperature	°C	160; 300 (completely degraded)	Han, M G; Kim, S; Liu, S X, Polym. Deg. Stab., 93, 1243-51, 2008.
Activation energy of thermal degradation	kJ mol^{-1}	8.92	Han, M G; Kim, S; Liu, S X, Polym. Deg. Stab., 93, 1243-51, 2008.
Thermal expansion coefficient, 23-80°C	10^{-4} $°C^{-1}$	1.6	
Thermal conductivity, melt	W m^{-1} K^{-1}	0.1	
Glass transition temperature	°C	50-120; 74 (butyl cyanoacrylate)	
Maximum service temperature	°C	80-120 (typical for adhesives)	
Long term service temperature	°C	-55 to 250; -55 to 80 (typical)	
Dielectric constant at 100 Hz/1 MHz	-	3.3	
Electric strength K20/P50, d=0.60.8 mm	kV mm^{-1}	24.6	
Permeability to water vapor, 25°C	g m^{-2} day^{-1}	1,800-2,100 (octyl, medical)	Zhang, S; Ruiz, R, World Patent 2010/008822, Adhezion Biomedical, 2010.
MECHANICAL & RHEOLOGICAL PROPERTIES			
Tensile strength	MPa	22.8-42.0	
Shear strength	MPa	10-42; 10.3-22.1 (ethyl); 24.8 (methyl)	
Adhesive bond strength	MPa	25	
Melt viscosity, shear rate=1000 s^{-1}	mPa s	1-25,000	
CHEMICAL RESISTANCE			
Acid dilute/concentrated	-	poor	
Alcohols	-	good	
Alkalis	-	poor	
Aliphatic hydrocarbons	-	good	
Aromatic hydrocarbons	-	good	
Greases & oils	-	good	
Halogenated hydrocarbons	-	good	
FLAMMABILITY			
Ignition temperature	°C	77-93	
Autoignition temperature	°C	485	
Volatile products of combustion	-	CO, H_2O, CO_2	
BIODEGRADATION			
Typical biodegradants	-	hydrolase	Williams, D F; Zhong, S P, Int. Biodet. Biodeg., 95-130, 1994.
TOXICITY			
Carcinogenic effect	-	not listed by ACGIH, NIOSH, NTP	
Cytotoxicity		linear relationship with formation of formaldehyde (higher alkyl homologues, e.g., octyl, less toxic)	Park, D H; Kim, S B; Ahn, K-D; Kim, E Y; Kim, Y J; Han, D K, J. Appl. Polym. Sci., 89, 3272-78, 2003.

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PARAMETER	UNIT	VALUE	REFERENCES
TLV, ACGIH	ppm	0.2 (methyl, ethyl)	
Oral rat, LD_{50}	mg kg^{-1}	>5,000; 30,000 (octyl)	
Skin rabbit, LD_{50}	mg kg^{-1}	>2,000	
PROCESSING			
Typical processing methods	-	compounding	
Additives used in final products	-	Plasticizers: acetyl tributyl citrate, dioctyl phthalate; Release: flujoroaliphatic polymer, silicone oil; Slip: cetyl palmitate, polydimethylsiloxane-trifluoropropylsiloxane; Inhibitor of degradation - acids	
Applications	-	drug delivery applications, fast curing glues (most frequently ethyl for general purpose glues); medical glue (most frequently butyl and octyl), endovascular use, tissue adhesive	Loffroy, R, Diagnostic Interventianal Imaging, in press, 2015.
Outstanding properties	-	fast cure, one component, low viscosity, modified with PLCL gives bioglue	Lim, J I; Kim, J H, Colloids Surf. B: Biointerfaces, 133, 19-23, 2015.
ANALYSIS			
FTIR (wavenumber-assignment)	cm^{-1}/-	CH_2 – 2991; C=O – 1750; C-O – 1254; CN – 2249	Zhou, Y; Bei, F; Ji, H; Yang, X; Lu, L; Wang, X, J. Molecular Structure, 737, 117-23, 2005.