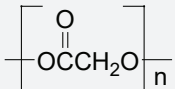
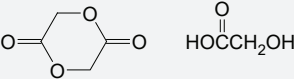


PGA poly(glycolic acid)

| PARAMETER | UNIT | VALUE | REFERENCES |
|--|--------------------|--|---|
| GENERAL | | | |
| Common name | - | poly(glycolic acid) | |
| IUPAC name | - | poly[ox(1-oxo-1,2-ethanediyl)] | |
| CAS name | - | acetic acid, 2-hydroxy-, homopolymer | |
| Acronym | - | PGA | |
| CAS number | - | 26124-68-5; 26009-03-0 | |
| Linear formula | |  | |
| HISTORY | | | |
| Person to discover | - | Norton Higgins, DuPont; Edward Schmitt and Rocco Polistina, American Cyanamid | |
| Date | - | 1954; 1960 | |
| Details | - | Higgins patented production process and in 1960 it was first used for production of surgical gut (sutures), known as Dextron | |
| SYNTHESIS | | | |
| Monomer(s) structure | - |  | |
| Monomer(s) CAS number(s) | - | 502-97-6; 79-14--1 | |
| Monomer(s) molecular weight(s) | dalton, g/mol, amu | 116.07 | |
| Monomer ratio | - | 100% | |
| Method of synthesis | - | several methods can be used, including polycondensation of glycolic acid, ring opening polymerization of glycolide, or reaction of formaldehyde with carbon monoxide in the presence of acid | Takahashi, K; Taniguchi, I; Miyamoto, M; Kimura, Y, Polymer, 41, 8725-28, 2000. |
| Mass average molecular weight, M _w | dalton, g/mol, amu | 100,000-200,000 | |
| Polydispersity, M _w /M _n | - | 1.7-2.3 | Takahashi, K; Taniguchi, I; Miyamoto, M; Kimura, Y, Polymer, 41, 8725-28, 2000. |
| STRUCTURE | | | |
| Crystallinity | % | 33-55 | Sekine, S; Yamauchi, K; Aoki, A; Asakura, T, Polymer, 50, 6083-90, 2009. |
| Cell type (lattice) | - | orthorhombic | Chatani, Y; Suehiro, K; Okita, Y; Tadokoro, H; Chujo, K, Makromol. Chem., 113, 215, 1968. |
| Cell dimensions | nm | a:b:c=0.522:0.619:0.702 | Sekine, S; Yamauchi, K; Aoki, A; Asakura, T, Polymer, 50, 6083-90, 2009. |
| Number of chains per unit cell | - | 2 | |
| Crystallite size | nm | 27.5, 6.8, 2.1 (in three crystalline directions) | Marega, C; Marigo, A; Zannetti, R; Paganetto, G, Eur. Polym. J, 28, 12, 1485-86, 1992. |
| Chain conformation | - | planar zig-zag | |

PGA poly(glycolic acid)

| PARAMETER | UNIT | VALUE | REFERENCES |
|---|--------------------------------------|--|---|
| COMMERCIAL POLYMERS | | | |
| Some manufacturers | - | Kureha | |
| Trade names | - | Kuredux | |
| PHYSICAL PROPERTIES | | | |
| Density at 20°C | g cm ⁻³ | 1.46-1.74; 1.70 (crystalline); 1.5 (amorphous) | Nakafuku, C; Yoshimura, H, Polymer, 45, 3583-85, 2004. |
| Refractive index, 20°C | - | 1.45-1.51 | |
| Birefringence | - | 1.556, 1.466 | |
| Haze | % | <1 | |
| Melting temperature, DSC | °C | 200-231 | |
| Storage temperature | °C | 2-8 | |
| Thermal expansion coefficient, 23-80°C | 10 ⁻⁴ °C ⁻¹ | 0.54 | |
| Thermal conductivity, melt | W m ⁻¹ K ⁻¹ | 0.35 | |
| Glass transition temperature | °C | 35-53 | |
| Specific heat capacity | J K ⁻¹ kg ⁻¹ | 1,120 | |
| Heat of fusion | J g ⁻¹ | 183.2 | Nakafuku, C; Yoshimura, H, Polymer, 45, 3583-85, 2004. |
| Enthalpy of melting | J g ⁻¹ | 50.77 | Shum, A W T; Mak, A F T, Polym. Deg. Stab., 81, 141-9, 2003. |
| Hansen solubility parameters, dD, dP, dH | (J cm ⁻³) ^{0.5} | 17.70, 6.21, 12.50 | Agrawal, A; Saran, A D; Rath, S S; Khanna, A, Polymer, 45, 8603-12, 2004. |
| Molar volume | (J cm ⁻³) ^{0.5} | 1.92 | Agrawal, A; Saran, A D; Rath, S S; Khanna, A, Polymer, 45, 8603-12, 2004. |
| MECHANICAL & RHEOLOGICAL PROPERTIES | | | |
| Tensile strength | MPa | 61-72; 1,100 (highly oriented fibers) | de Oca, H M; Farrar, D F; Ward, I M, Acta Biomater., 7, 1535-41, 2011. |
| Elongation | % | 5-20 | |
| Flexural strength | MPa | 178 | |
| Young's modulus | MPa | 6,080-7,180 | |
| Melt viscosity, shear rate=1000 s ⁻¹ | Pa s | 360-950 | |
| Melt index, 250°C/2.16 kg | g/10 min | 6-22 | |
| Water absorption, equilibrium in water at 23°C | % | 28 | |
| CHEMICAL RESISTANCE | | | |
| Acid dilute/concentrated | - | poor | |
| Alkalis | - | poor | |
| Esters | - | good | |
| Halogenated hydrocarbons | - | good | |
| Ketones | - | good | |
| Good solvent | - | hexafluoroisopropanol | |

PGA poly(glycolic acid)

| PARAMETER | UNIT | VALUE | REFERENCES |
|---|---------------------|--|--|
| FLAMMABILITY | | | |
| Heat of combustion | J g ⁻¹ | 12,000 | |
| BIODEGRADATION | | | |
| Typical biodegradants | - | decomposes in 6 month at 37°C at pH=9.0 | |
| TOXICITY | | | |
| NFPA: Health, Flammability, Reactivity rating | - | 1/1/0 | |
| Carcinogenic effect | - | not listed by ACGIH, NIOSH, NTP | |
| PROCESSING | | | |
| Typical processing methods | - | electrospinning, extrusion | |
| Processing temperature | °C | 240 | |
| Applications | - | monofilaments, orthopaedics, packaging, suture, wound dressing | |
| Outstanding properties | - | biodegradable, resorbable | |
| BLENDS | | | |
| Suitable polymers | - | PCL, PLA | |
| ANALYSIS | | | |
| FTIR (wavenumber-assignment) | cm ⁻¹ /- | C=O (ester) – 1744; C=O (acetate end group) – 1630; C-O – 1229; C-OH – 1096 | Shum, A W T; Mak, A F T, Polym. Deg. Stab., 81, 141-9, 2003; Kister, G; Cassanas, G; Vert, M, Spectrochim. Acta, 53A, 1399-1403, 1999. |
| Raman (wavenumber-assignment) | cm ⁻¹ /- | CH ₂ – 2988; C=O – 1776, 1759; C-O-C – 1165, 1087, 1032; and more for crystalline and amorphous | Kister, G; Cassanas, G; Vert, M, Spectrochim. Acta, 53A, 1399-1403, 1999. |
| NMR (chemical shifts) | ppm | C NMR: amorphous peak – 61; all <i>trans</i> conformation – 62.5; CH ₂ – 63.5; C=O – 168 | Sekine, S; Yamauchi, K; Aoki, A; Asakura, T, Polymer, 50, 6083-90, 2009. |
| x-ray diffraction peaks | degree | 22.5, 29 | Marega, C; Marigo, A; Zannetti, R; Paganetto, G, Eur. Polym. J, 28, 12, 1485-86, 1992. |