Water-Swellable Polymer Networks
From Hydrogels to Superabsorbers

Hydrogels are characterized by the pronounced affinity of their chemical structures for aqueous solutions in which they swell rather than dissolve. Such polymeric networks may range from being mildly absorbing, typically retaining 30 wt. % of water within their structure, to superabsorbing, where they retain many times their weight of aqueous fluids. Several synthetic strategies[1] have been proposed to prepare absorbent polymers: (i) polyelectrolyte(s) subjected to covalent cross-linking,[2] (ii) associative polymers consisting of hydrophilic and hydrophobic components ("effective" cross-links through hydrogen bonding),[3-5] and (iii) physically interpenetrating polymer networks yielding absorbent polymers of high mechanical strength.[6] Clearly, these strategies are not mutually exclusive, and efforts have focused on tailoring composite gels which are critically reliant on the balance between polymer–polymer and polymer–solvent interactions under various stimuli including changes in temperature, pH, ionic strength, solvent, concentration, pressure, stress, light intensity, and electric or magnetic fields.[7,8] Such stimuli-responsive polymers, the so-called "smart gels", continue to be the subject of extensive investigation for applications in diverse fields. These applications range from biomedical (controlled drug release, ocular devices, and biomimetics),[9-11] agricultural (soil additive to conserve water, plant root coating to increase water availability, and seed coating to increase germination rates), and personal care (diapers and adult hygiene products),[2,12] to industrial (thickener, gelling agent, cable wrap, specialty packaging, tack reduction for natural rubber, and fine coal dewatering).[13-16]

A sampling of **absorbent polymers** of synthetic (petrochemical) origin, available from Aldrich, is provided below along with morphology[17] and absorption characteristics. We also offer an extensive selection of polymers of natural (starches, etc.) and semisynthetic (cellulose ethers, etc.) origins for use in the synthesis of multicomponent hydrogels.[18] To aid in designing your application-specific hydrogel, Aldrich offers over 1,500 **monomers** and a wide selection of **cross-linking agents**. We invite you to use the chemical structure search capability on our Web site, **www.sigma-aldrich.com**, to locate those best suited to your needs.

Aldrich Catalog No.	Absorbent Polymer	Morphology	Absorption Characteristics	Units
43,532-5	**Poly(acrylic acid), potassium salt**, lightly cross-linked	Powder; particle size 99% < 1,000µm	Absorbs *ca.* 27g/g of 1% saline solution; rate of absorption more rapid than for corresponding Na salt	**250g; 1kg**
43,636-4	**Poly(acrylic acid), sodium salt**, lightly cross-linked	Powder; particle size 99% < 1,000µm	Absorbs *ca.* 45g/g of 1% saline solution	**250g; 1kg**
43,277-6	**Poly(acrylic acid-*co*-acrylamide), potassium salt**, cross-linked	Granules; 200-1,000µm; pH 5.5–6.0	Absorbs many times its weight of aqueous fluids	**250g; 1kg**
43,278-4	**Poly(acrylic acid), sodium salt-*graft*-poly(ethylene oxide)**, cross-linked	Granular powder; 100-850µm	Absorbs many times its weight of aqueous fluids	**250g; 1kg**
19,206-6	**Poly(2-hydroxyethyl methacrylate)**, average M_v *ca.* 300,000	Crystals	—	**1g; 10g ;25g**
18,213-3	**Poly(2-hydroxypropyl methacrylate)**	Crystals	—	**10g; 25g**
42,427-7	**Poly(isobutylene-*co*-maleic acid)**, sodium salt, cross-linked	Fiber; 24-40µm diameter	Absorption of 0.9 wt. % saline solution is *ca.* 65g/g; Absorption of distilled water is *ca.* 300g/g	**250g; 1kg**

Polymer Products From Aldrich—The Link to All Your Polymer Needs!

References: (1) *Chemical and Physical Networks*; te Nijenhuis, K., Mijs, W., Eds.; *The Wiley Polymer Networks Group Review, Vol. 1*; Wiley: New York, NY, 1998. (2) Buchholz, F.L. *Chem. Ind.* Jan 18, 1999, p 56. (3) Aoki, T. et al. *Macromolecules* **1994**, *27*, 947. (4) Hourdet, D. et al. *ibid.* **1998**, *31*, 5323. (5) Lowman, A.M.; Peppas, N.A. *ibid.* **1997**, *30*, 4959. (6) Philippova, O.E. et al. *ibid.* **1998**, *31*, 1168. (7) Wexler, A. et al. *Chem. Mater.* **1995**, *7*, 1583. (8) Dagani, R. *Chem. Eng. News* **1997**, *75* (Jun 9), 26. (9) Park, K.; Shalaby, W.S.W.; Park, H.; *Biodegradable Hydrogels for Drug Delivery*; Technomic Publishing Co., Inc.: Lancaster, PA, 1993; Aldrich Cat. No. **Z26,966-2.** (10) *Chemistry of Advanced Materials: An Overview*; Interrante, L.V., Hampden-Smith, M.J., Eds.; Wiley-VCH: New York, NY, 1998; p 530; Aldrich Cat. No. **Z40,863-8**. (11) Branda, F. et al. *J. Mater. Sci.* **1999**, *34*, 1319. (12) *Modern Superabsorbent Polymer Technology*; Buchholz, F.L., Graham, A.T., Eds.; Wiley-VCH: New York, NY, 1997. (13) *Polyelectrolyte Gels*; Hartland, R.S., Prud'home, R.E., Eds.; ACS Symposium Series 480; American Chemical Society: Washington, D.C., 1992. (14) Jin, Z.-F. et al. *HTD (Am. Soc. Mech. Eng.)* **1998**, *357* (ASME Proceedings 7th AIAA/ASME Joint Thermophysics and Heat Transfer Conference, Vol. 4); *Chem. Abstr.* **1999**, *130*:223768. (15) Ratnam, C.T. et al. *J. Appl. Polym. Sci.* **1999**, *72*, 1421. (16) Dzinomwa, G.P.T. et al. *Polym. Adv. Technol.* **1997**, *8*, 767. (17) For effects of morphology and superporosity on absorbent properties: (a) Omidian, H. et al. *Polymer* **1999**, *40*, 1753. (b) Chen, J. et al. *J. Biomed. Mater. Res.* **1999**, *44*, 53. (18) de Nooy, A.E.J. et al. *Macromolecules* **1999**, *32*, 1318.

ALDRICH®

chemists helping chemists in research & industry

P.O. Box 355, Milwaukee, WI 53201 USA **Telephone:** 414-273-3850 • 800-558-9160 **Fax:** 414-273-4979 • 800-962-9591 **Web Site:** www.sigma-aldrich.com