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DEFINITIONS OF TERMS RELATING TO REACTIONS OF POLYMERS AND TO FUNCTIONAL POLYMERIC MATERIALS

(IUPAC Recommendations 2003)

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Definitions of terms relating to reactions of polymers and to functional polymeric materials

(IUPAC Recommendations 2003)

Abstract: The document defines the terms most commonly encountered in the field of polymer reactions and functional polymers. The scope has been limited to terms that are specific to polymer systems. The document is organized into three sections. The first defines the terms relating to reactions of polymers. Names of individual chemical reactions are omitted from the document, even in cases where the reactions are important in the field of polymer reactions. The second section defines the terms relating to polymer reactants and reactive polymeric materials. The third section defines the terms describing functional polymeric materials.

CONTENTS

INTRODUCTION

Chemical reactions of polymers have received much attention during the last two decades. Many fundamentally and industrially important reactive polymers and functional polymers are prepared by the reactions of linear or cross-linked polymers and by the introduction of reactive, catalytically active, or other groups onto polymer chains. Characteristics of polymer reactions may be appreciably different from both reactions of low-molar-mass compounds and polymerization reactions. Basic definitions of polymerization reactions have been included in the original [1] and revised [2] documents on basic terms in polymer science published by the IUPAC Commission on Macromolecular Nomenclature. Furthermore, the basic classification and definitions of polymerization reactions [3] and some polymer reactions such as degradation, aging, and related chemical transformations of polymers have been defined [4]. However, in spite of the growing importance of the field, a clear and uniform terminology covering the field of reactions and the functionalization of polymers has not been presented until now. For example, combinatorial chemistry using reactive polymer beads has become a new field in recent years. The development of a uniform terminology for such multidisciplinary areas can greatly aid communication and avoid confusion.

This document presents clear concepts and definitions of general and specific terms relating to reactions of polymers and functional polymers. The document is divided into three sections. In Section 1, terms relating to reactions of polymers are defined. Names of individual chemical reactions (e.g., chloromethylation) are omitted from this document, even in cases where the reactions are important in the field of polymer reactions, because such names are usually already in widespread use and are well defined in organic chemistry and other areas of chemistry [5]. Sections 2 and 3 deal with the terminology of reactive and functional polymers. The term “functional polymer” has two meanings: (a) a polymer bearing functional groups (such as hydroxy, carboxy, or amino groups) that make the polymer reactive and (b) a polymer performing a specific function for which it is produced and used. The function in the latter case may be either a chemical function such as a specific reactivity or a physical function like electric conductivity. Polymers bearing reactive functional groups are usually regarded as polymers capable of undergoing chemical reactions. Thus, Section 2 deals with polymers and polymeric materials that undergo various kinds of chemical reactions (i.e., show chemical functions). Section 3 deals with terms relating to polymers and polymeric materials exhibiting some specific physical functions. For definitions of some physical functions, see also *Compendium of Chemical Terminology* ("Gold Book") [6].

A functional polymer according to Definition **3.6** of the present document is a polymer that exhibits specified chemical reactivity or has specified physical, biological, pharmacological, or other uses that depend on specific chemical groups. Thus, several terms concerned with properties or the structure of polymers are included in Section 3 whenever they are closely related to specific functions.

Terms that are defined implicitly in the notes and related to the main terms are given in bold type.

1. REACTIONS INVOLVING POLYMERS

1.1 chemical amplification

Process consisting of a chemical reaction that generates a species that catalyzes another reaction and also the succeeding catalyzed reaction.

Note 1: Chemical amplification can lead to a change in structure and by consequence to a change in the physical properties of a polymeric material.

Note 2: The term "chemical amplification" is commonly used in photoresist lithography employing a **photo-acid generator** or **photo-base generator**.

Note 3: An example of chemical amplification is the transformation of [(*tert*-butoxycarbonyl)oxy]phenyl groups in polymer chains to hydroxyphenyl groups catalyzed by a photogenerated acid.

Note 4: The term "amplification reaction" as used in analytical chemistry is defined in [6], p. 21.

1.2 chemical modification

Process by which at least one feature of the chemical constitution of a polymer is changed by chemical reaction(s).

Note: A configurational change (e.g., cis–trans isomerization) is not usually referred to as a chemical modification.

1.3 cross-linking

Reaction involving sites or groups on existing macromolecules or an interaction between existing macromolecules that results in the formation of a small region in a macromolecule from which at least four chains emanate.

Note 1: See [6], p. 94 and Definition 1.59 in [2] for cross-link.

Note 2: The small region may be an atom, a group of atoms, or a number of branch points connected by bonds, groups of atoms, or oligomeric chains.

Note 3: A reaction of a reactive chain end of a linear macromolecule with an internal reactive site of another linear macromolecule results in the formation of a branch point, but is not regarded as a cross-linking reaction.

1.4 curing

Chemical process of converting a prepolymer or a polymer into a polymer of higher molar mass and connectivity and finally into a network.

Note 1: Curing is typically accomplished by chemical reactions induced by heating (**thermal curing**), photo-irradiation (**photo-curing**), or electron-beam irradiation (**EB curing**), or by mixing with a chemical curing agent.

Note 2: Physical aging, crystallization, physical cross-linking, and postpolymerization reactions are sometimes referred to as "curing". Use of the term "curing" in these cases is discouraged.

Note 3: See also Definition **1.22**.

1.5 depolymerization

Process of converting a polymer into its monomer or a mixture of monomers (see [6], p. 106 and Definition 3.25 in [2]).

1.6 grafting

Reaction in which one or more species of block are connected to the main chain of a macromolecule as side chains having constitutional or configurational features that differ from those in the main chain.

Note: See [6], p. 175 and Definition 1.28 in [2] for graft macromolecule.

1.7 interchange reaction

Reaction that results in an exchange of atoms or groups between a polymer and low-molar-mass molecules, between polymer molecules, or between sites within the same macromolecule.

Note: An interchange reaction that occurs with polyesters is called **transesterification**.

1.8 main-chain scission

Chemical reaction that results in the breaking of main-chain bonds of a polymer molecule.

Note 1: See [6], p. 64 and Definition 3.24 in [2] for chain scission.

Note 2: Some main-chain scissions are classified according to the mechanism of the scission process: **hydrolytic**, **mechanochemical**, **thermal**, **photochemical**, or **oxidative scission**. Others are classified according to their location in the backbone relative to a specific structural feature, for example, **α-scission** (a scission of the C-C bond alpha to the carbon atom of a photo-excited carbonyl group) and **β-scission** (a scission of the C-C bond beta to the carbon atom bearing a radical), etc.

1.9 mechanochemical reaction

Chemical reaction that is induced by the direct absorption of mechanical energy.

> *Note*: Shearing, stretching, and grinding are typical methods for the mechanochemical generation of reactive sites, usually macroradicals, in polymer chains that undergo mechanochemical reactions.

1.10 photochemical reaction

Chemical reaction that is caused by the absorption of ultraviolet, visible, or infrared radiation ([6], p. 302).

> *Note 1*: Chemical reactions that are induced by a reactive intermediate (e.g., radical, carbene, nitrene, or ionic species) generated from a photo-excited state are sometimes dealt with as a part of photochemistry.
>
> *Note 2*: An example of a photochemical reaction concerned with polymers is **photopolymerization**.
>
> *Note 3*: See also Definitions **1.1**, **1.18**, **3.14**, and **3.25**.

1.11 polymer complexation
polymer complex formation

Process that results in the formation of a polymer–polymer complex or a complex composed of a polymer and a low-molar-mass substance.

1.12 polymer cyclization

Chemical reaction that leads to the formation of ring structures in or from polymer chains.

> *Note 1*: Examples of cyclization along polymer chains are: (a) cyclization of polyacrylonitrile, (b) acetalization of poly(vinyl alcohol) with an aldehyde, (c) cyclization of polymers of conjugated dienes such as polyisoprene or polybutadiene leading to macrocycles.
>
> *Note 2*: Examples of cyclization of polymer molecules are: (a) cyclization of poly(dimethylsiloxane), (b) back-biting reaction during ionic polymerizations of heterocyclic monomers.

1.13 polymer degradation

Chemical changes in a polymeric material that usually result in undesirable changes in the in-use properties of the material.

> *Note 1*: In most cases (e.g., in vinyl polymers, polyamides) degradation is accompanied by a decrease in molar mass. In some cases (e.g., in polymers with aromatic rings in the main chain), degradation means changes in chemical structure. It can also be accompanied by cross-linking.
>
> *Note 2*: Usually, degradation results in the loss of, or deterioration in useful properties of the material. However, in the case of **biodegradation** (degradation by biological activity), polymers may change into environmentally acceptable substances with desirable properties (see Definition **3.1**).
>
> *Note 3*: See Definition 16 in [4] for degradation.

1.14 polymer functionalization

Introduction of desired chemical groups into polymer molecules to create specific chemical, physical, biological, pharmacological, or other properties.

1.15 polymer reaction

Chemical reaction in which at least one of the reactants is a high-molar-mass substance.

1.16 polymer-supported reaction

Chemical reaction in which at least one reactant or a catalyst is bound through chemical bonds or weaker interactions such as hydrogen bonds or donor–acceptor interactions to a polymer.

> *Note 1*: The easy separation of low-molar-mass reactants or products from the polymer-supported species is a great advantage of polymer-supported reactions.
>
> *Note 2*: Typical examples of polymer-supported reactions are: (a) reactions performed by use of polymer-supported catalysts, (b) solid-phase peptide synthesis, in which intermediate peptide molecules are chemically bonded to beads of a suitable polymer support.

1.17 protection of a reactive group

Temporary chemical transformation of a reactive group into a group that does not react under conditions where the nonprotected group reacts.

> *Note*: For example, **trimethylsilylation** is a typical transformation used to protect reactive functional groups such as hydroxy or amino groups from their reaction with growing anionic species in anionic polymerization.

1.18 radiation reaction

Chemical reaction that is induced by ionizing radiation with γ-ray, X-ray, electron, or other high-energy beams.

> *Note 1*: Radiation reactions involving polymers often lead to chain scission and cross-linking.
>
> *Note 2*: A **photochemical reaction** (see Definition **1.10**) is sometimes regarded as a type of radiation reaction.

1.19 reactive blending

Mixing process that is accompanied by the chemical reaction(s) of components of a polymer mixture.

> *Note 1*: Examples of reactive blending are: (a) blending accompanied by the formation of a polymer-polymer complex, (b) the formation of block or graft copolymers by a combination of radicals formed by the mechanochemical scission of polymers during blending.
>
> *Note 2*: Reactive blending may also be carried out as reactive extrusion or reaction injection molding (RIM).

1.20 sol-gel process

Formation of a polymer network by the reaction of monomer(s), liquid or in solution, to form a gel, and in most cases finally to form a dry network.

Note: An inorganic polymer (e.g., silica-gel or organic-inorganic hybrid) can be prepared by the sol-gel process.

1.21 surface grafting

Process in which a polymer surface is chemically modified by grafting or by the generation of active sites that can lead to the initiation of a graft polymerization.

Note 1: Peroxidation, ozonolysis, high-energy irradiation, and plasma etching are methods of generating active sites on a polymer surface.

Note 2: See also Definition **1.6**.

1.22 vulcanization

Chemical cross-linking of high-molar-mass linear or branched polymer or polymers to give a polymer network.

Note 1: The polymer network formed often displays rubberlike elasticity. However, a high concentration of cross-links can lead to rigid materials.

Note 2: A classic example of vulcanization is the cross-linking of *cis*-polyisoprene through sulfide bridges in the thermal treatment of natural rubber with sulfur or a sulfur-containing compound.

2. POLYMER REACTANTS AND REACTIVE POLYMERIC MATERIALS

2.1 chelating polymer

Polymer containing ligand groups capable of forming bonds (or other attractive interactions) between two or more separate binding sites within the same ligand group and a single atom.

Note 1: Chelating polymers mostly act as ion-exchange polymers specific to ions that form chelates with chelating ligands of the polymer.

Note 2: See [6], p. 68 for chelation.

2.2 ion-exchange polymer

Polymer that is able to exchange ions (cations or anions) with ionic components in solution.

Note 1: See [6], p. 208 for ion exchange.

Note 2: An ion-exchange polymer in ionized form may also be referred to as a **polyanion** or a **polycation**.

Note 3: Synthetic ion-exchange organic polymers are often network polyelectrolytes.

Note 4: A membrane having ion-exchange groups is called an **ion-exchange membrane**.

Note 5: Use of the term “ion-exchange resin” for “ion-exchange polymer” is strongly discouraged.

2.3 living polymer

Polymer with stable, polymerization-active sites formed by a chain polymerization in which irreversible chain transfer and chain termination are absent.

Note 1: See [6], p. 236 and Definition 3.21 in [2] for living polymerization.

2.4 macromonomer

Polymer or oligomer whose molecules each have one end-group that acts as a monomer molecule, so that each polymer or oligomer molecule contributes only a single monomer unit to a chain of the product polymer.

Note 1: The homopolymerization or copolymerization of a macromonomer yields a comb or graft polymer.

Note 2: In the present definition, Definition 2.35 in [2] has been combined with Definition 1.9 in [2]. See also [6], p. 241.

Note 3: Macromonomers are also sometimes referred to as macromers®. The use of the term "macromer" is strongly discouraged.

2.5 polymer catalyst

Polymer that exhibits catalytic activity.

Note 1: Certain synthetic polymer catalysts can behave like enzymes.

Note 2: Poly(4-vinylpyridine) in its basic form and sulfonated polystyrene in its acid form are examples of polymers that can act as catalysts in some base- and acid-catalyzed reactions, respectively.

2.6 polymer-metal complex

Complex comprising a metal and one or more polymeric ligands.

2.7 polymer phase-transfer catalyst

Polymer that acts as a phase-transfer catalyst and thereby causes a significant enhancement of the rate of a reaction between two reactants located in neighboring phases owing to its catalysis of the extraction of one of the reactants across the interface to the other phase where the reaction takes place.

Note 1: Polymer phase-transfer catalysts in the form of beads are often referred to as **triphase catalysts** because such catalysts form the third phase of the reaction system.

Note 2: See [6], p. 299 for phase-transfer catalyst.

2.8 polymer-supported catalyst

Catalyst system comprising a polymer support in which catalytically active species are immobilized through chemical bonds or weaker interactions such as hydrogen bonds or donor–acceptor interactions.

Note 1: Polymer-supported catalysts are often based on network polymers in the form of beads. They are easy to separate from reaction media and can be used repeatedly.

Note 2: Examples of polymer-supported catalysts are: (a) a polymer-metal complex that can coordinate reactants, (b) colloidal palladium dispersed in a swollen network polymer that can act as a hydrogenation catalyst.

Note 3: **Polymer-supported enzymes** are a type of polymer-supported catalysts.

2.9 polymer reactant
polymer reagent
polymer-supported reagent

Reactant (reagent) that is or is attached to a high-molar-mass linear polymer or a polymer network.

Note: The attachment may be by chemical bonds, by weaker interactions such as hydrogen bonds, or simply by inclusion.

2.10 prepolymer

Polymer or oligomer whose molecules are capable of entering, through reactive groups, into further polymerization and thereby contributing more than one structural unit to at least one type of chain of the final polymer.

Note: Definition 2.37 in [2] has been combined with Definition 1.11 in [2]. See also [6], p. 318.

2.11 reactive polymer

Polymer having reactive functional groups that can undergo chemical transformation under the conditions required for a given reaction or application.

2.12 redox polymer
electron-exchange polymer
oxidation-reduction polymer

Polymer containing groups that can be reversibly reduced or oxidized.

Note 1: Reversible redox reaction can take place in a polymer main-chain, as in the case of polyaniline and quinone/hydroquinone polymers, or on side-groups, as in the case of a polymer carrying ferrocene side-groups.

Note 2: See [7] p. 346.

Note 3: Use of the term “redox resin” is strongly discouraged.

2.13 resin

Soft solid or highly viscous substance, usually containing prepolymers with reactive groups.

Note 1: This term was used originally because of its analogy with a natural resin (rosin) and designated, in a broad sense, any polymer that is a basic material for plastics, organic coatings, or lacquers. However, the term is now used in a more narrow sense to refer to prepolymers of thermosets (thermosetting polymers).

Note 2: The term is sometimes used not only for prepolymers of thermosets, but also for cured thermosets (e.g., epoxy resins, phenolic resins). Use of the term for cured thermosets is strongly discouraged.

Note 3: Use of the term “resin” to describe the polymer beads used in solid-phase synthesis and as polymer supports, catalysts, reagents, and scavengers is also discouraged.

2.14 telechelic polymer
telechelic oligomer

Prepolymer capable of entering into further polymerization or other reactions through its reactive end-groups.

Note 1: Reactive end-groups in telechelic polymers come from initiator or termination or chain-transfer agents in chain polymerizations, but not from monomer(s) as in polycondensations and polyadditions.

Note 2: See [6], p. 414 and the Note to Definition 1.11 in [2] for telechelic molecule.

2.15 thermosetting polymer

Prepolymer in a soft solid or viscous state that changes irreversibly into an infusible, insoluble polymer network by curing.

Note 1: Curing can be by the action of heat or suitable radiation, or both.

Note 2: A cured thermosetting polymer is called a **thermoset**.

3. FUNCTIONAL POLYMERIC MATERIALS

3.1 biodegradable polymer

Polymer susceptible to degradation by biological activity, with the degradation accompanied by a lowering of its molar mass.

Note 1: See also Note 2 to Definition 1.13.

Note 2: See [6], p. 43 for biodegradation. In the case of a polymer, its biodegradation proceeds not only by catalytic activity of enzymes, but also by a wide variety of biological activities.

3.2 conducting polymer

Polymeric material that exhibits bulk electric conductivity.

Note 1: See [6], p. 84 for conductivity.

Note 2: The electric conductivity of a conjugated polymer is markedly increased by doping it with an electron donor or acceptor, as in the case of polyacetylene doped with iodine.

Note 3: A polymer showing a substantial increase in electric conductivity upon irradiation with ultraviolet or visible light is called a **photoconductive polymer**; an example is poly(*N*-vinylcarbazole) (see [6], p. 302 for photoconductivity).

Note 4: A polymer that shows electric conductivity due to the transport of ionic species is called an **ion-conducting polymer**; an example is sulfonated polyaniline. When the transported ionic species is a proton as, e.g., in the case of fuel cells, it is called a **proton-conducting polymer**.

Note 5: A polymer that shows electric semiconductivity is called a **semiconducting polymer** (See [6], p. 372 for semiconductor).

Note 6: Electric conductance of a nonconducting polymer can be achieved by dispersing conducting particles (e.g., metal, carbon black) in the polymer. The resulting materials are referred to as *conducting* **polymer composites** or **solid polymer-electrolyte composites**.

3.3 electroluminescent polymer

Polymeric material that shows luminescence when an electric current passes through it such that charge carriers can combine at luminescent sites to give rise to electronically excited states of luminescent groups or molecules.

Note 1: Electroluminescent polymers are often made by incorporating luminescent groups or dyes into conducting polymers.

Note 2: Electrogenerated chemiluminescence (see [6], p. 130) directly connected with electrode reactions may also be called electroluminescence.

3.4 ferroelectric polymer

Polymer in which spontaneous polarization arises when dipoles become arranged parallel to each other by electric fields.

Note 1: See [6], p. 153 for ferroelectric transition.

Note 2: Poly(vinylidene fluoride) after being subjected to a corona discharge is an example of a ferroelectric polymer.

3.5 ferromagnetic polymer

Polymer that exhibits magnetic properties because it has unpaired electron spins aligned parallel to each other or electron spins that can easily be so aligned.

3.6 functional polymer

(a) Polymer that bears specified chemical groups
or
(b) Polymer that has specified physical, chemical, biological, pharmacological, or other uses which depend on specific chemical groups.

Note: Examples of functions of functional polymers under definition (b) are catalytic activity, selective binding of particular species, capture and transport of electric charge carriers or energy, conversion of light to charge carriers and vice versa, and transport of drugs to a particular organ in which the drug is released.

3.7 impact-modified polymer

Polymeric material whose impact resistance and toughness have been increased by the incorporation of phase microdomains of a rubbery material.

Note: An example is the incorporation of soft polybutadiene domains into glassy polystyrene to produce high-impact polystyrene.

3.8 liquid-crystalline polymer

Polymeric material that, under suitable conditions of temperature, pressure, and concentration, exists as a liquid crystalline mesophase (Definition 6.1 in [7]).

Note 1: See [4], p. 235 for liquid-crystal.

Note 2: A liquid-crystalline polymer can exhibit one or more liquid state(s) with one- or two-dimensional, long-range orientational order over certain ranges of temperatures either in the melt (**thermotropic liquid-crystalline polymer**) or in solution (**lyotropic liquid-crystalline polymer**).

3.9 macroporous polymer

Glass or rubbery polymer that includes a large number of macropores (50 nm–1 µm in diameter) that persist when the polymer is immersed in solvents or in the dry state.

Note 1: Macroporous polymers are often network polymers produced in bead form. However, linear polymers can also be prepared in the form of macroporous polymer beads.

Note 2: Macroporous polymers swell only slightly in solvents.

Note 3: Macroporous polymers are used, for example, as precursors for ion-exchange polymers, as adsorbents, as supports for catalysts or reagents, and as stationary phases in size-exclusion-chromatography columns.

Note 4: Porous polymers with pore diameters from ca. 2 to 50 nm are called **mesoporous polymers**.

3.10 nonlinear optical polymer

Polymer that exhibits an optical effect brought about by electromagnetic radiation such that the magnitude of the effect is not proportional to the irradiance.

Note 1: See [6], p. 275 for nonlinear optical effect.

Note 2: An example of nonlinear optical effects is the generation of higher harmonics of the incident light wave.

Note 3: A polymer that exhibits a nonlinear optical effect due to anisotropic electric susceptibilities when subjected to electric field together with light irradiation is called an **electro-optical polymer**. A polymer that exhibits electro-optical behavior combined with photoconductivity is called a **photorefractive polymer**.

3.11 optically active polymer

Polymer capable of rotating the polarization plane of a transmitted beam of linear-polarized light.

Note 1: See [6], p. 282 for optical activity.

Note 2: The optical activity originates from the presence of chiral elements in a polymer such as chiral centers or chiral axes due to long-range conformational order in a polymer (helicity) (see [6], p. 182 for helicity).

3.12 photoelastic polymer

Polymer that under stress exhibits birefringence.

3.13 photoluminescent polymer

Polymer that exhibits luminescence (i.e., fluorescence or phosphorescence arising from photoexcitation).

> *Note*: See [6], p. 304 for photoluminescence.

3.14 photosensitive polymer

Polymer that responds to ultraviolet or visible light by exhibiting a change in its physical properties or its chemical constitution.

> *Note 1*: Examples of the changes in photosensitive polymers are a change in molecular shape (**photoresponsive polymer**), a change in its constitution (**photoreactive polymer**), and a reversible change in color (**photochromic polymer**).
>
> *Note 2*: Photosensitivity in photosensitive polymers means that the polymers are sensitive to the irradiated light leading to some change in properties or structure. It is different from photosensitization defined in [6], p. 307.
>
> *Note 3*: See [6], p. 307 for photoreaction and [6], p. 302 for photochromism.

3.15 piezoelectric polymer

(a) Polymer that exhibits a change in dielectric properties on application of pressure
or
(b) Polymer that shows a change in its dimensions when subjected to an electric field.

3.16 polyelectrolyte

Polymer composed of molecules in which a portion of the constitutional units has ionizable or ionic groups, or both.

> *Note 1*: A polymer bearing both anionic and cationic groups in the same molecule is called an **amphoteric polyelectrolyte**.
>
> *Note 2*: A polymer bearing acid or basic groups is called a **polymer acid** or a **polymer base**, respectively.
>
> *Note 3*: A polymer acid or a polymer base can be used as a matrix for ion-conducting polymers.
>
> *Note 4*: Definition 2.38 in [2] has been combined with Definition 1.65 in [2]. The present definition replaces the one in [6], p. 312.

3.17 polymer compatibilizer

Polymeric additive that, when added to a blend of immiscible polymers, modifies their interfaces and stabilizes the blend.

> *Note*: Typical polymer compatibilizers are block or graft copolymers.

3.18 polymer drug

Polymer that contains either chemically bound drug molecules or pharmacologically active moieties.

Note: A polymer drug is usually used to provide drug delivery targeted to an organ and controlled release of an active drug at the target organ.

3.19 polymer gel

Gel in which the network component is a polymer network.

Note 1: A gel is an elastic colloid or polymer network that is expanded throughout its whole volume by a fluid.

Note 2: The polymer network can be a network formed by covalent bonds or by physical aggregation with region of local order acting as network junctions.

Note 3: An example of covalent polymer gels is *net*-poly(*N*-isopropylacrylamide) swollen in water, which shows volume phase transition during heating.

Note 4: Examples of physically aggregated polymer gels are poly(vinyl alcohol) gel and agarose gel, which show reversible sol-gel transitions.

Note 5: See Definition 1.58 in [2] for network.

Note 6: The definition for gel in [6], p. 170 does not include a polymer gel.

3.20 polymer membrane

Thin layer of polymeric material that acts as a barrier permitting mass transport of selected species.

Note: See [6], p. 251 for membrane.

3.21 polymer solvent

Polymer that acts like a solvent for compounds of low molar mass.

Note: An example of a polymer solvent is poly(oxyethylene); it can dissolve various inorganic salts by complexation.

3.22 polymer sorbent

Polymer that adsorbs or absorbs a certain substance or certain substances from a liquid or a gas.

Note 1: A polymer sorbent may be a **polymer adsorbent** or a **polymer absorbent**. The former acts by surface sorption and the latter by bulk sorption.

Note 2: See [6], p. 383 for sorption, [6], p. 11 for adsorption, and [6], p. 3 for absorption.

3.23 polymer support

Polymer to or in which a reagent or catalyst is chemically bound, immobilized, dispersed, or associated.

Note 1: A polymer support is usually a network polymer.

Note 2: A polymer support is usually prepared in bead form by suspension polymerization.

Note 3: The location of active sites introduced into a polymer support depends on the type of polymer support. In a **swollen-gel-bead polymer support** the active sites are distributed uniformly throughout the beads, whereas in a **macroporous-bead polymer support** they are predominantly on the internal surfaces of the macropores.

3.24 polymer surfactant

Polymer that lowers the surface tension of the medium in which it is dissolved, or the interfacial tension with another phase, or both.

Note: See [6], p. 409 for surfactant.

3.25 resist polymer

Polymeric material that, when irradiated, undergoes a marked change in solubility in a given solvent or is ablated.

Note 1: A resist polymer under irradiation either forms patterns directly or undergoes chemical reactions leading to pattern formation after subsequent processing.

Note 2: A resist material that is optimized for use with ultraviolet or visible light, an electron beam, an ion beam, or X-rays is called a **photoresist** (see [6], p. 307), **electron-beam resist**, **ion-beam resist**, or **X-ray resist**, respectively.

Note 3: In a **positive-tone resist**, also called a **positive resist**, the material in the irradiated area not covered by a mask is removed, which results in an image with a pattern identical with that on the mask. In a **negative-tone resist**, also called a **negative resist**, the non-irradiated area is subsequently removed, which results in an image with a pattern that is the complement of that on the mask.

3.26 shape-memory polymer

Polymer that, after heating and being subjected to a plastic deformation, resumes its original shape when heated above its glass-transition or melting temperature.

Note: Crystalline *trans*-polyisoprene is an example of a shape-memory polymer.

3.27 superabsorbent polymer

Polymer that can absorb and retain extremely large amounts of a liquid relative to its own mass.

Note 1: The liquid absorbed can be water or an organic liquid.

Note 2: The swelling ratio of a superabsorbent polymer can reach the order of 1000:1.

Note 3: Superabsorbent polymers for water are frequently polyelectrolytes.

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ALPHABETICAL INDEX OF TERMS