



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

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Objective of the Project

- **To present clear and uniform concepts and definitions of general and specific terms with regard to reactions and functionalization of polymers and to functional polymers.**
- **To provide reasonable classification of reactive polymers and functional polymers in order to aid communication and prevent confusion among scientists and engineers in various areas.**

Features of this Document

- 1. Terms relating to reactions are limited to polymer reactions. Terms for polymerization reactions are given elsewhere:**
 - > IUPAC Basic Classification and Definitions of Polymerization Reactions, *Pure Appl. Chem.*, 66, 2483-2486 (1994).
 - > IUPAC Terminology on Kinetics and Thermodynamics of Polymerization, in preparation (410/26/95).
- 2. This document deals with not only chemical reactivity of polymers but also physical, biological, and other functions of polymers owing to the increasing importance of the fields.**
- 3. Several terms (e.g., resin) that have historical meanings and are used with some confusion are discussed.**

List of Terms in the Document

1. REACTIONS INVOLVING POLYMERS

- 1.1 chemical amplification
- 1.2 chemical modification of a polymer
- 1.3 crosslinking
- 1.4 curing
- 1.5 cyclization
- 1.6 degradation
- 1.7 depolymerization
- 1.8 functionalization of polymer
- 1.9 grafting
- 1.10 interchange reaction
- 1.11 main-chain scission
- 1.12 mechanochemical reaction
- 1.13 polymer complexation
- polymer complex formation
- 1.14 polymer reaction
- 1.15 polymer-supported reaction
- 1.16 protection of a reactive group
- 1.17 radiation reaction
- 1.18 reactive blending
- 1.19 sol-gel process
- 1.20 surface grafting
- 1.21 vulcanization

2. POLYMER REACTANTS AND REACTIVE POLYMERIC MATERIALS

2.1 chelating polymer

2.2 ion exchange polymer

2.3 living polymer

2.4 macromonomer

2.5 polymer catalyst

polymer-supported catalyst

2.6 polymer-metal complex

2.7 polymer phase-transfer
catalyst

2.8 polymeric reactant

polymeric reagent

2.9 prepolymer

2.10 reactive polymer

2.11 redox polymer

electron-exchange polymer

oxidation-reduction polymer

2.12 resin

2.13 telechelic polymer

telechelic oligomer

3. FUNCTIONAL POLYMERIC MATERIALS

- 3.1 biodegradable polymer
- 3.2 conducting polymer
- 3.3 elastomer
- 3.4 electroluminescent polymer
- 3.5 ferroelectric polymer
- 3.6 ferromagnetic polymer
- 3.7 functional polymer
- 3.8 impact-modified polymer
- 3.9 liquid-crystalline polymer
- 3.10 macroporous resin
- 3.11 non-linear optical polymer
- 3.12 optically-active polymer
- 3.13 photoelastic polymer
- 3.14 photoluminescent polymer
- 3.15 photosensitive polymer
- 3.16 piezoelectric polymer
- 3.17 polyelectrolyte
- 3.18 polymer adsorbent
- 3.19 polymer compatibilizer
- 3.20 polymer drug
- 3.21 polymer gel
- 3.22 polymer membrane
- 3.23 polymer solvent
- 3.24 polymer support
- 3.25 polymer surfactant
- 3.26 reinforced polymeric material
- 3.27 resist
- 3.28 rubber
- 3.29 shape-memory polymer
- 3.30 superabsorbent polymer
- 3.31 thermoset

Examples of Terms

1.8 functionalization of polymer

Introduction of chemical groups into a polymer molecule or conversion of one chemical group to another group, which leads to a polymer with chemical, physical, biological, pharmacological, or other functions.

2.10 reactive polymer

A polymer having chemical groups that can be transformed into other chemical groups in a moderate condition or for a specific purpose.

3.7 functional polymer

A polymer that exhibits specific chemical reactivity or has specific physical, biological, pharmacological, or other uses.

Note

Typically functions in functional polymers are to act, e.g., as a catalyst, to bind selectively particular species, to capture and transport electric charge or energy, to convert light into charge carriers and vice versa, to transport immobilized drugs to a particular tissue cell in which a drug is released, etc.

3.24 polymer support

A polymer, usually prepared by suspension polymerization into bead form, to which reacting species or catalyst is chemically bound.

Notes

1. A polymer support can usually be used to immobilize reactant or catalyst species.
2. The location of active sites in a network polymer support depends on the type of polymer support. In **swollen gel beads**, the active sites are evenly distributed. In **macroporous beads**, they may be predominantly on the internal surface of macropores.

1.3 crosslinking

A reaction involving pairs of polymer chains that results in the formation of small regions in a polymer from which at least four chains emanate.

2.12 resin

A term used for soft solid or highly viscous substances, usually containing prepolymers with reactive groups, that are named historically by analogy with natural resins.

Note

1. This term was once used historically in a broad sense to designate any polymer that is a basic material for plastics. However, it has been used more recently in a narrow sense to refer to thermosetting polymers and to some soft network polymers, especially in bead form.
2. It is sometimes used not only for prepolymers of thermosets (thermosetting polymers) but also for cured network polymers (thermosets). (e.g., epoxy resin, phenolic resin). The ambiguous use of the term "resin" for thermosets is strongly discouraged.
3. The second example of using the term "resin" is to describe the spherical suspension-polymerized beads widely applied in solid-phase synthesis and polymer support, catalyst, reagent, and scavenger fields.

3.31 thermoset

An infusible, insoluble polymer network prepared by irreversible curing of a prepolymer by heat or other means.

Notes

1. The material in the soft plastic or viscous state before curing is usually called the prepolymer of a thermoset, or a **thermosetting polymer**.
2. A thermoset cannot be reprocessed by melting or by dissolving in a solvent.
3. A polymer capable of being repeatedly softened by heating and hardened by cooling within a characteristic temperature range is called a **thermoplastic**.

3.2 conducting polymer

A polymer, usually a doped conjugated polymer, that exhibits electric conductivity.

Notes

1. The electric conductivity of a conjugated polymer is markedly increased by doping it with an electron donor or acceptor, such as in the case of polyacetylene doped with iodine.
2. 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).
3. A polymer that shows electric conductivity owing to transport of ionic species is called an **ion-conducting polymer**; an example is sulfonated polyaniline. When the transporting ionic species is a proton as in the case of, e.g., fuel cells, it is called a **proton-conducting polymer**.
4. A polymer that shows electric semiconductivity is called a **semiconducting polymer**.
5. Electrical conductivity of an insulating 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**.

3.15 photosensitive polymer

A polymer that responds to ultraviolet or visible light by exhibiting a change in its molecular shape (**photoresponsive polymer**), a change in its chemical structure (**photoreactive polymer**), or a reversible change in color (**photochromic polymer**), etc.

3.27 resist

A polymeric material that, on exposure to irradiation, changes its solubility or is ablated; the effect can either form patterns directly or lead to pattern formation.

Note

A resist material that is optimized for use with ultraviolet or visible light, electron beam, ion beam, or X-ray is called a **photoresist**, **electron-beam resist**, **ion-beam resist**, or **X-ray resist**, respectively.

This document has been prepared by a Task group of the IUPAC Macromolecular Division - Commission on Macromolecular Nomenclature (IV.1)

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Project present status

After external review of the document (Draft 7), Draft 9 is being discussed in Commission IV.1.