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POLYMER DIVISION
COMMISSION ON MACROMOLECULAR NOMENCLATURE*
SUBCOMMITTEE ON MACROMOLECULAR TERMINOLOGY and
SUBCOMMITTEE ON POLYMER TERMINOLOGY

GLOSSARY OF CLASS NAMES OF POLYMERS BASED ON CHEMICAL STRUCTURE AND MOLECULAR ARCHITECTURE

(IUPAC Recommendations 2009)

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Glossary of class names of polymers based on chemical structure and molecular architecture

(IUPAC Recommendations 2009)

Abstract: This document defines class names of polymers based on the class names of starting monomers and characteristic features of the chemical constitution of polymer molecules (macromolecules), i.e., class names that have gained general acceptance in the polymer and material literature, science and technology as well as in public. The glossary is divided into three parts:

- source-based class names, which identify common classes of starting monomers such as “acrylic”, “diene”, “phenolic”, “vinylic”
- class names based on chemical structure, which identify characteristic groups in the main chains (backbones) of the polymer molecules such as (i) inter-unit groups derived from functional groups, e.g., “amide”, “ester”, “ether”; (ii) a specific group of atoms, e.g., “alkenylene”, “siloxane”, “sulfone”; (iii) ring structures, e.g., “benzimidazole”, “benzoxazole”, “quinoxaline”
- class names based on molecular architecture, which identify mainly the overall shapes of polymer molecules through the type of their graphical representation such as “linear”, “branched”, “dendritic”, “comb”

Each part of the glossary is arranged in a non-hierarchical alphabetical order. Each entry provides: (a) the polymer class name; (b) its definition; (c) specific or generic examples, including IUPAC names and a structure or graphical representation; (d) relations to other polymer classes and subclasses; (e) and notes on the inclusion or exclusion of borderline cases. An alphabetical index of all class names is included.

Keywords: IUPAC Polymer Division; macromolecule architecture; polymer class names; source-based polymer names; structure-based polymer names.

CONTENTS

1. INTRODUCTION

In chemistry, a class is a set of compounds sharing a common structural feature to which is attached a variable part (or parts) defining a specific compound of the class. The common feature is often a functional group to which one or a small number of variable parts are attached. This is the principle applied to the published "Glossary of class names of organic compounds" by the former IUPAC Commission on Nomenclature of Organic Chemistry [1].

The former Commission on Macromolecular Nomenclature provided earlier a somewhat different type classification of linear single-strand polymers [2], based on the elemental composition of the constitutional repeating units in the main chain (backbone):

- *homochain polymers* in which the main chains are constructed from atoms of a single element and
- *heterochain polymers* in which the main chains are constructed from atoms of two or more elements.

Within each class, subclasses such as "carbon-chain polymers", "sulfur-chain polymers", "(oxygen, carbon)-chain polymers", and "(oxygen, nitrogen, carbon)-chain polymers" are further defined, and within each subclass such structures as "polyalkylene", "polyether", "polyester", "polycarbonate", "polysulfone", and "polyurea" are further identified.

It is this last type of class, based largely on the inter-unit groups in a polymer backbone, that has gained general acceptance in the polymer literature. It has been used in polymer textbooks, handbooks [3,4], encyclopedias [5–7], and indexes [8]. Such names are useful, not only for classifying chemical structure but also for describing related materials processing and properties. The present recommendations are an extension of the classification of linear single-strand polymers [2], the glossary of basic terms in polymer science [9], and the glossary of class names of organic compounds [1], in order to name polymers in a general structural sense. They may also be viewed as an extension of the generic source-based nomenclature for polymers [10–12].

The former Commission on Macromolecular Nomenclature recognized in its earlier recommendations [11,12] that not all polymers can be identified and named on the basis of their structural features [13,14]. That situation has led to two systems of macromolecular nomenclature, source- and structure-based. Source-based polymer names identify the monomers used, whereas structure-based polymer names identify constitutional repeating units present in macromolecules. This approach is also reflected in the present document on polymer class names.

As in all classifications of chemical compounds, the classes are not mutually exclusive. On the contrary, because of the presence of more than one type of inter-unit groups, or more than one characteristic group in the backbone, a polymer may belong to two or more different classes, e.g., "polyamide" and "polyester", or to a combined class such as "polyetherketone". Some "polysilsesquioxanes" may also be classified on the basis of their molecular architectures as "ladder polymers" and "hyperbranched polymers".

The present compendium of classes of polymer names is in no way exhaustive, since any nomenclature and classification is constantly changing and new names and classes are constantly being added. For example, one can imagine at least the same numbers of source-based polymer class names as there are class names of monomers (or indeed potential monomers). Nevertheless, this glossary implicitly provides guiding principles on derivation of class names of newly already existing and newly emerging polymers.

Each part of the glossary is arranged in a non-hierarchical alphabetical order. Each entry provides:

(a) the preferred polymer class name in boldface type and synonyms in normal face type on subsequent lines;
(b) its definition based on the source (Section 2) or main structural feature (Section 3) or molecular architecture (Section 4);
(c) specific or generic examples;
(d) relations to other polymer classes and subclasses; and
(e) notes on the inclusion or exclusion of borderline cases.

For monomers, recommended systematic IUPAC names [15,16] are used as well as semisystematic or trivial names well established by usage [17].

The polymer class names are defined in the singular to enable an individual polymer within a class to be referred to by using the indefinite article, “a”. For example, poly(3-octylthiophene) is a polythiophene and polythiophene itself is also a polythiophene.

2. SOURCE-BASED CLASS NAMES

2.1 acrylic polymer

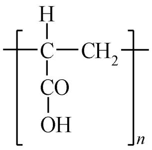
acrylate polymer
acrylic
polyacrylic

Polymer prepared from acrylic acid or a derivative of acrylic acid.

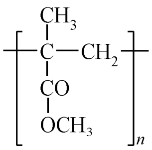
Note 1: Examples of derivatives of acrylic acid are esters, amides, nitriles, chlorides, and aldehydes.

Note 2: An acrylic polymer formed from methacrylic acid and related monomers is often referred to as a methacrylic polymer or a polymethacrylic or a methacrylate polymer. Methacrylic polymers are a subclass of acrylic polymers.

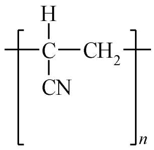
Note 3: The macromolecule of a regular acrylic homopolymer can be described by a constitutional repeating unit of general formula: $-CR(X)-CH_2-$, where R is COOH, $COOR^1$, CN, or $CONR^1R^2$ and X is H, alkyl, aryl, heteroaryl, or CN.



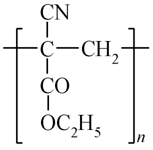
poly(acrylic acid)



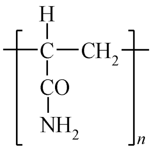
poly(methyl methacrylate)



polyacrylonitrile



poly(ethyl cyanoacrylate)



polyacrylamide

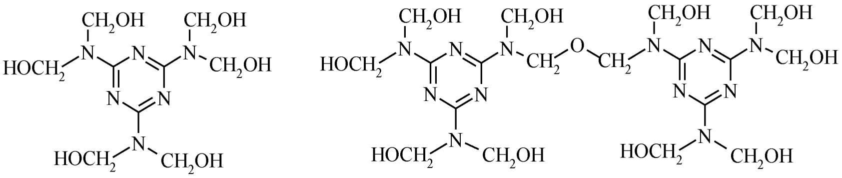
2.2 amino polymer

amine-aldehyde polymer
amide-aldehyde polymer

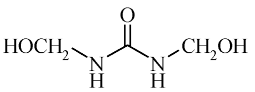
Polymer prepared by polycondensation of an amino component such as amine or amide with an aldehyde, or by curing reactive oligomers prepared from an amino component and an aldehyde.

Note 1: Formaldehyde is commonly used as the aldehyde and (a) melamine or (b) urea as the amino component. The resulting polymer is named (a) melamine polymer or melamine-formaldehyde polymer, (b) urea polymer or urea-formaldehyde polymer.

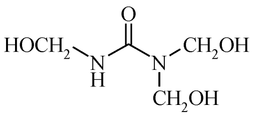
Note 2: A mixture of the reactive oligomers prepared by the condensation of an amino component with an aldehyde is, in a public (popular) use and technological practice, usually referred to as an amino resin, e.g., melamine-formaldehyde resin or urea-formaldehyde resin. Examples of the oligomers present in melamine-formaldehyde and urea-formaldehyde resins are:



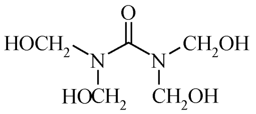
Examples of oligomeric species present in a melamine-formaldehyde resin



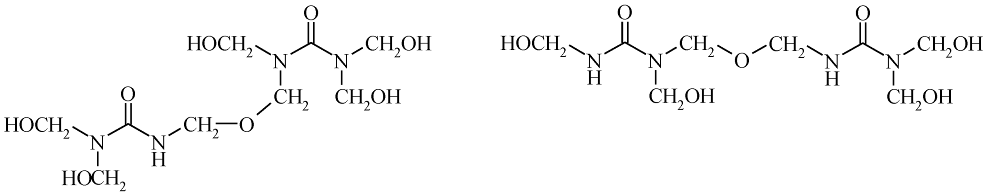
N,*N*′-bis(hydroxymethyl)urea



tris(hydroxymethyl)urea



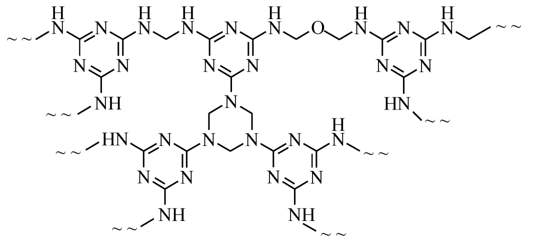
tetrakis(hydroxymethyl)urea



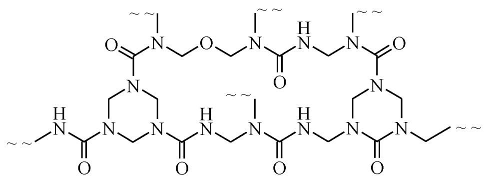
Examples of species present in a urea-formaldehyde resin

Note 3: Use of the term "resin" (for the definition, see ref. [18]) for cured reactive oligomers is discouraged; the cured resin should be named as an amino polymer.

Note 4: An amino polymer is usually a network polymer. To form the polymer, polycondensation takes place at the hydroxymethyl groups of an amino resin. Examples of the network-structure motifs of that form are:



Network structure motif of a melamine-formaldehyde polymer



Network structure motif of a urea-formaldehyde polymer

Note 5: Melamine polymers can be regarded as a subclass of *polytriazines* (see 3.63).

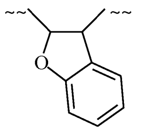
2.3 coumarone-indene polymer

1-benzofuran-indene polymer

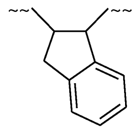
Polymer prepared from a mixture containing 1-benzofuran (formerly coumarone) and indene.

Note 1: A mixture of coal-tar and gas-tar distillates is commonly used to prepare a coumarone-indene polymer.

Note 2: A coumarone-indene polymer contains structural units such as:



coumarone unit
1-benzofuran unit



indene unit

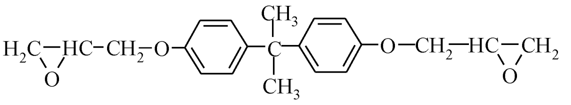
Note 3: Coumarone-indene polymers are film-forming materials.

Note 4: Coumarone-indene polymers are sometimes, particularly in a public (popular) use and technological practice, called coumarone resins or coumarone-indene resins [18]; use of these terms is discouraged.

2.4 epoxy polymer

Polymer prepared by reaction of compounds carrying two or more epoxy groups (reactive epoxides) with curing agents.

Note 1: The reactive epoxides are commonly prepared by condensation of (chloromethyl)oxirane (commonly called epichlorohydrin) with a di- or multi-functional acid, alcohol, amine, or phenol, most often with 4,4'-(propane-2,2-diyl)diphenol (bisphenol A) to give in this case



2,2-bis[4-(2,3-epoxypropoxy)phenyl]propane
2,2'-[(propane-2,2-diyl)bis(4,1-phenyleneoxymethylene)]bis(oxirane)

Note 2: The reactive epoxide is cured by reactions with a di- or higher-functional amine, carboxylic acid, anhydride, or dicyandiamide (i.e., cyanoguanidine).

Note 3: A reactive epoxide or a mixture of reactive epoxides, and also its admixture with curing agent or agents, is usually referred to as an epoxy resin [18], particularly in a public (popular) use and technological practice. Use of the term "epoxy resin" for a cured epoxide is discouraged; it should be named "epoxy polymer".

2.5 fluoropolymer

Polymer prepared from a fluorine-containing monomer.

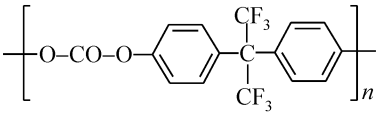
Note 1: In a fluoropolymer, fluorine atoms can be linked either to main-chain carbon atoms such as in poly(tetrafluoroethene) and poly(1,1-difluoroethene), formerly called poly(vinylidene difluoride), or to side-group carbon atoms such as in the polycarbonate derived from 4,4'-(hexafluoropropane-2,2-diyl)diphenol, (bisphenol AF).

$\left[CF_2 \right]_n$

poly(difluoromethylene)
poly(tetrafluoroethene)

$\left[CF_2{-}CH_2 \right]_n$

poly(1,1-difluoroethene)
formerly: poly(vinylidene fluoride)



poly{oxycarbonyloxy-1,4-phenylene[bis-(trifluoromethyl)methylene]-1,4-phenylene)}

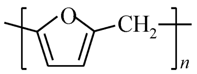
Note 2: The term “fluoropolymer” can be generally regarded as a structure-based name indicating the presence of C–F bonds in constitutional repeating units.

2.6 furan polymer

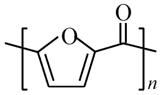
Polymer prepared from furan or a furan derivative.

Note 1: The most widely used furan polymers are linear, branched, and network polymers prepared from (2-furyl)methanol, such as poly(furan-2,5-diylmethylene).

Note 2: Furan polymers prepared from furan-2-carbaldehyde (formerly furfural), such as poly(furan-2,5-diylcarbonyl), are usually referred to as furfural polymers, and they are *conjugated polymers* (see 3.1).



poly(furan-2,5-diylmethylene)



poly(furan-2,5-diylcarbonyl)

Note 3: Branching and network formation can occur through the condensation of methylene groups with terminal –CH_2OH groups.

Note 4: Comonomers such as phenols, aldehydes, and ketones are often used in preparation of furan polymers.

Note 5: Use of the terms “furan resin” or “furfural resin” [18] for “furan polymer” or “furfural polymer”, respectively, is discouraged.

2.7 phenolic polymer

phenol-aldehyde polymer

Polymer prepared by the polycondensation of phenols and aldehydes or by curing reactive oligomers prepared from phenols and aldehydes.

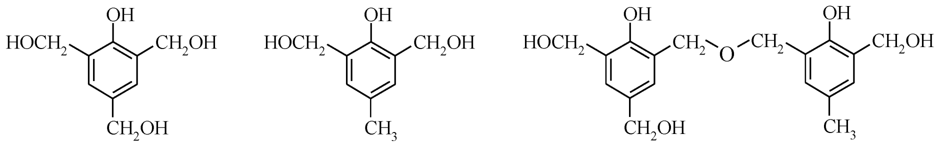
Note 1: A phenolic polymer is usually a network polymer.

Note 2: Formaldehyde is commonly used as the aldehyde and (a) phenol itself, or (b) a cresol is used as the phenol. Phenol-formaldehyde polymer is a phenolic polymer resulting from the reaction of phenol with formaldehyde.

Note 3: A mixture of the reactive oligomers prepared by the condensation of a phenol and aldehyde, and also its admixture with a curing agent is, in a public (popular) use and technological practice, usually referred to as a phenolic resin or a phenol-aldehyde resin [18].

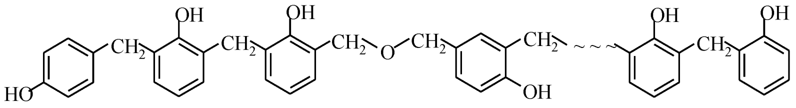
Note 4: Use of the term “phenolic resin” for cured reactive oligomers is discouraged; they should be called “phenolic polymers”.

Note 5: A phenol-formaldehyde polymer prepared under alkaline conditions with an aldehyde-to-phenol mole ratio between 1.5 and 3 is known as a resol. A resol spontaneously undergoes polycondensation at hydroxymethyl groups, to give a network, phenol-formaldehyde polymer known as a resit.



Examples of constituents of resols

Note 6: A phenol-formaldehyde polymer prepared under acidic conditions with a formaldehyde-to-phenol molar ratio less then 1 is known as a *novolak*. A novolak can be cured with formaldehyde or a multifunctional reagent such as 1,3,5,7-tetraazaadamantane (hexamethylenetetramine) to give a network, phenol-formaldehyde polymer.



Structure motif of novolak

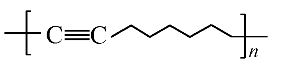
2.8 polyacetylene

Polymer prepared from acetylene (ethyne), a substituted acetylene, or both in admixture by a polymerization reaction involving one or more triple bonds, either in the monomer, or in the polymer, or in both.

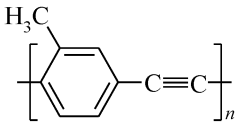
Examples

$\left[CH{=}CH \right]_n$

poly(ethene-1,2-diyl)
formerly: poly(vinylene)
polyacetylene



poly(oct-1-yne-1,8-diyl)



poly[(2-methyl-1,4-phenylene)-ethyne-1,2-diyl]

Note 1: A polymer of buta-1,3-diyne or a substituted buta-1,3-diyne, or both in admixture is referred to as a *polydiacetylene* (see 2.13). Polydiacetylenes are a subclass of polyacetylenes.

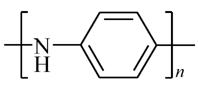
Note 2: The class name polyacetylene is used for both a polymer formed by polyaddition (with transformation of the triple bond into a double bond) and a polymer formed by metathesis ring-opening polymerization or metathesis polycondensation (both with retention of the triple bond).

Note 3: A *polyester* (see 3.23), *polyamide* (see 3.7), *polycarbamate* (see 3.18), for example, prepared from monomers with triple-bond unsaturation such as from hex-3-ynedioic acid or but-2-yne-1,4-diol is excluded. Such polymers should be classified as an unsaturated *polyester* (see 3.23), unsaturated *polyamide* (see 3.7), or unsaturated *polycarbamate* (polyurethane, see 3.18).

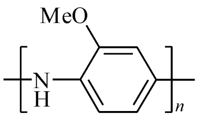
2.9 polyaniline

Polymer prepared exclusively from aniline, or substituted aniline, or both in admixture.

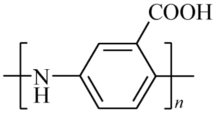
Examples



poly(imino-1,4-phenylene)
polyaniline



poly[imino(2-methoxy-1,4-phenylene)]
poly(2-methoxyaniline)



poly[imino(3-carboxy-1,4-phenylene)]
poly(3-aminobenzoic acid)

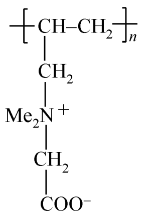
Note 1: Polyanilines are a subclass of polyamines (see 3.9). Partly oxidized polyaniline is a conjugated polymer (see 3.1) and if it is simultaneously protonized, it becomes a conducting polymer (entry 3.2 in ref. [19]).

Note 2: A polycondensate of aniline and an aldehyde is excluded. It is an aniline-aldehyde polymer, a type of amino polymers.

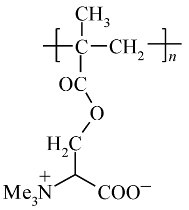
2.10 polybetaine

Polymer prepared from a betaine, i.e., from a zwitterionic monomer containing a trialkylammonium group as the positively charged pole and carboxylate anion as the negatively charged pole.

Examples



poly(1-{[(carboxylatomethyl)dimethylammonio]methyl}ethylene)



poly[2-carboxylato-2-(trimethylammonio)ethyl methacrylate]
poly[2-(methacryloyloxymethyl)betaine]

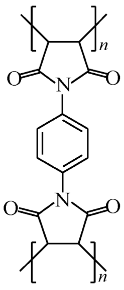
Note 1: Polybetaines are a subclass of *polyzwitterions* (see 2.25).

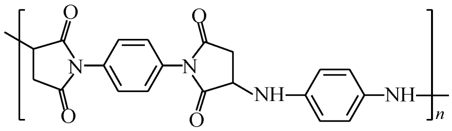
Note 2: From the chemical structure point of view, polybetaine is an ampholytic polymer in which pendant groups have a betain-type structure (entry 26 in ref. [18] and alphabetical entry in ref. [20]) (see also 3.3).

2.11 polybismaleimide

Polymer prepared from a bismaleimide.

Examples





poly[*N*,*N*′-(1,4-phenylene)dimaleimide]

poly[*N*,*N*′-(1,4-phenylene)dimaleimide-*alt*-benzene-1,4-diamine]

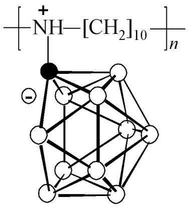
Note 1: Bismaleimides are usually copolymerized with diamines, dicyanates, or aromatic diallyl derivatives.

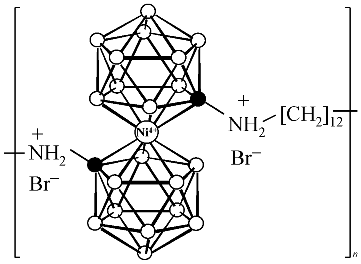
Note 2: A polybismaleimide is usually a *branched polymer* (see 4.2) or, upon curing, a *network polymer* (see 4.14).

2.12 polycarborane

Polymer prepared from a carborane.

Examples





poly{[(7-carba-*nido*-undecaboran(12)-7-yl)iminio]decane-1,10-diyl}

poly{iminio[bis(1,1'-monocarbollide)-nickelate(IV)-1,1'-diyl]iminiododecane-1,12-diyl dibromide}

Note: A polycarborane is usually an *ionic polymer*.

2.13 polydiacetylene

Polymer prepared from buta-1,3-diyne (diacetylene), or a substituted buta-1,3-diyne, or both in admixture.

Note: Polydiacetylenes are a subclass of *conjugated polymers* (see 3.1) as well as a subclass of *polyacetylenes* (see 2.8).

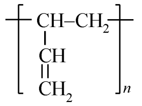
2.14 polydiene

Polymer prepared from a diene, or a substituted diene, or both in admixture.

Examples

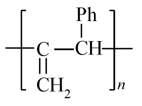
$-\!\!\left[\mathrm{CH{=}CH{-}CH_2{-}CH_2}\right]_n\!\!-$

poly(but-1-ene-1,4-diyl)



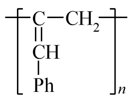
$-\!\!\left[\mathrm{CH(CH{=}CH_2){-}CH_2}\right]_n\!\!-$

poly(1-vinylethylene)



$-\!\!\left[\mathrm{C({=}CH_2){-}CH(Ph)}\right]_n\!\!-$

poly(1-methylidene-2-phenylethylene)



$-\!\!\left[\mathrm{C({=}CH{-}Ph){-}CH_2}\right]_n\!\!-$

poly[1-(phenylmethylidene)ethylene]
poly(1-benzylideneethylene)

Note 1: A polydiene prepared from propadiene (allene) or a substituted propadiene (e.g., buta-1,2,-diene) is usually referred to as a polyallene or a polypropadiene (see the last two examples).

Note 2: Commercially widely spread polydienes, namely, polybutadienes and polyisoprenes, are commonly named with a use of numerical prefixes based on the addition mode taking place during the transformation of a monomer molecule into monomeric unit. The names are, for example: 1,2-polybutadiene for poly(1-vinylethylene) since the addition takes place at only one double bond located between carbon atoms C^1 and C^2 of a buta-1,3-diene molecule and 1,4-polybutadiene for poly(but-1-ene-1,4-diyl) since the conjugative addition resulting in enchainment of a buta-1,3-diene molecule via carbon atoms C^1 and C^4 takes place in the polymerization process. Use of these names is discouraged because a nomenclature locant should always refer to a molecule structure feature and not to a process of the molecule formation.

2.15 polyisocyanate

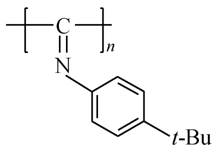
Polymer prepared from an isocyanate.

Note: An isocyanate monomer can be transformed into polymers belonging to various structure-based classes, such as a *polyisocyanurate* (see 3.31, by cyclopolymerization), *polycarbodiimide* (see 3.19, by decarboxylation), *polyurea* (see 3.64, by reaction with water), or *polycarbamate* (see 3.18, by reaction with a diol or a polyol).

2.16 polyisocyanide

Polymer prepared from an isocyanide.

Example



poly(4-*tert*-butylphenyl isocyanide)
poly{[4-(2-methylprop-2-yl)phenylimino]methylene}

Note 1: The class name polyisocyanide is preferably used for polymers in which every isocyanide monomeric unit contributes only one atom to a macromolecule backbone; the majority of these polymers are *helical polymers* (see 4.9).

Note 2: Isocyanide monomers are also polymerized by cyclopolymerization to give *polytriazines* (see 3.63).

2.17 polyolefin

Polymer prepared from an olefin.

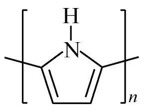
Note 1: A typical polyolefin macromolecule is derived from an alkene and is described by the monomeric unit: $–CR^1R^2–CH_2–$, where R^1 and R^2 are hydrogen, alkyl, or cycloalkyl. Polyolefins with 1,2-disubstituted monomeric units $–CHR^1–CHR^2–$ are rather rare, owing to low thermodynamic stability of their main chains caused by steric effects of the substituents.

Note 2: The structure-based name of a polyolefin prepared from an alkene is a *polyalkylene* (see 3.5).

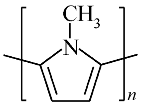
2.18 polypyrrole

Polymer prepared from pyrrole, or a substituted pyrrole, or both in admixture.

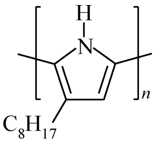
Examples



poly(pyrrole-2,5-diyl)



poly(1-methylpyrrole-2,5-diyl)



poly(3-octylpyrrole-2,5-diyl)

Note 1: An ideal polypyrrole molecule contains exclusively pyrrole-2,5-diyl monomeric units.

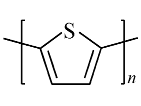
Note 2: Polypyrroles containing exclusively pyrrole-2,5-diyl constitutional repeating units are a subclass of *conjugated polymers* (see 3.1).

Note 3: The term “polypyrrole” can be generally regarded as a structure-based name, indicating the presence of pyrrole constitutional repeating units in the main chain.

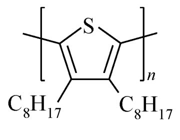
2.19 polythiophene

Polymer prepared from thiophene, or a substituted thiophene, or both in admixture.

Examples



poly(thiophene-2,5-diyl)



poly(3,4-dioctylthiophene-2,5-diyl)

Note 1: An ideal polythiophene molecule contains exclusively thiophene-2,5-diyl monomeric units.

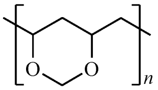
Note 2: Polythiophenes are a subclass of conjugated polymers (see 3.1).

Note 3: The term “polythiophene” can be generally regarded as a structure-based name, indicating the presence of thiophene constitutional units in the main chain.

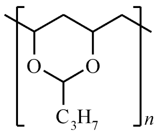
2.20 polyvinyl acetal

Polymer prepared by acetalization of poly(vinyl alcohol) with an aldehyde.

Examples



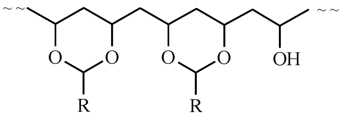
poly[(1,3-dioxane-4,6-diyl)methylene]
commonly named "poly(vinyl formal)"



poly[(2-propyl-1,3-dioxane-4,6-diyl)methylene]
commonly named "poly(vinyl butyral)"

Note 1: The name “polyvinyl acetal” is derived using both source- and structure-based principles: “polyvinyl” comes from the source polymer: poly(vinyl alcohol), and “acetal” indicates the structure of constitutional units that are present in the resulting modified polymer. This approach is reflected in commonly used trivial names of polyvinyl acetals given in the above examples below systematic names.

Note 2: A common polyvinyl acetal does not have the ideal structure shown above but it also contains a low fraction of unreacted hydroxy groups.



polyvinyl acetal

2.21 polyvinyl ester

Polymer prepared from a vinyl ester.

Note 1: A molecule of a regular polyvinyl ester is described by the constitutional repeating unit:

$$\left[\begin{array}{l} CH{-}CH_2 \\ | \\ OCOR \end{array} \right]_n$$

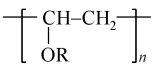
where R is alkyl, aryl, or heteroaryl or substituted alkyl, substituted aryl, or substituted heteroaryl.

Note 2: Polyvinyl esters are a subclass of *vinyl polymers* (see 2.27).

2.22 polyvinyl ether

Polymer prepared from a vinyl ether.

Note 1: A molecule of a regular polyvinyl ether is described by the constitutional repeating unit:



$$\left[\begin{array}{l} CH{-}CH_2 \\ | \\ OR \end{array} \right]_n$$

where R is alkyl, aryl, or heteroaryl or substituted alkyl, substituted aryl, or substituted heteroaryl.

Note 2: Polyvinyl ethers are a subclass of *vinyl polymers* (see 2.27).

2.23 polyvinyl halide

Polymer prepared from a vinyl halide (monohalogenoethene).

Note 1: A molecule of a regular polyvinyl halide is described by the constitutional repeating unit:

$$-\!\!\left[\mathrm{CHX{-}CH_2}\right]_n\!\!-$$

where X is F, Cl, Br, or I.

Note 2: Polyvinyl halides are a subclass of *vinyl polymers* (see 2.27).

2.24 polyvinyl ketone

Polymer prepared from a vinyl ketone.

Note 1: A molecule of a regular polyvinyl ketone is described by the constitutional repeating unit:

$$-\!\!\left[\begin{array}{l}\mathrm{CH{-}CH_2}\\ |\\ \mathrm{COR}\end{array}\right]_n\!\!-$$

where R is alkyl, aryl, or heteroaryl or substituted alkyl, substituted aryl, or substituted heteroaryl.

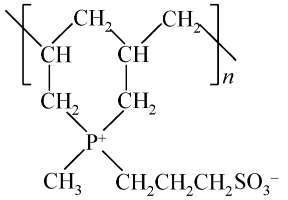
Note 2: Polyvinyl ketones are a subclass of *vinyl polymers* (see 2.27).

2.25 polyzwitterion

zwitterionic polymer
polyamphion
poly(inner salt)

Polymer prepared by polymerization of a zwitterionic monomer.

Example



poly{[1-methyl-1-(3-sulfonatopropyl)-1λ⁵-phosphinan-1-ium-3,5-diyl]methylene}

Note 1: In a common polyzwitterion, zwitterionic groups are usually located in pendent groups. Such a polyzwitterion is a type of polyelectrolyte.

Note 2: *Polybetaines* (see 2.10) are a subclass of polyzwitterions.

Note 3: Unlike a common polyampholyte, a zwitterionic polymer contains both anion and cation in the same monomeric unit.

Note 4: From the chemical structure point of view, a zwitterionic polymer is an ampholytic polymer containing ionic groups of opposite sign, commonly in the same pendent group [17,19].

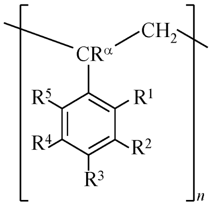
Note 5: The term "polyzwitterion" can be generally regarded as a structure-based name, indicating the presence of zwitterionic constitutional repeating units in the polymer chain.

2.26 styrene polymer

polystyrene

Polymer prepared from styrene, or a substituted styrene, or both in admixture.

Note 1: Macromolecule of a regular styrene homopolymer is described by the constitutional repeating unit:



where R^α and R^1 to R^5 are each H, alkyl, aryl, or heteroaryl.

Note 2: Styrene polymers are a subclass of *vinyl polymers* (see 2.27).

Note 3: In common usage, "polystyrene" means a polymer prepared from pure styrene, frequently cross-linked with 1,4-divinylbenzene, rather than a styrene polymer.

2.27 vinyl polymer

Polymer prepared from a monomer containing the vinyl group $-CH{=}CH_2$.

Note 1: Macromolecule of a regular vinyl homopolymer is described by the constitutional repeating unit: $-CHR-CH_2-$, where R is alkyl, aryl, heteroaryl, halogen, or a heteroatom containing pendent group.

Note 2: *Acrylic polymers* (see 2.1), *polyolefins* (see 2.17), *polyvinyl acetals*, *polyvinyl esters*, *polyvinyl ethers*, *polyvinyl halides*, *polyvinyl ketones* (see 2.20–24), and *styrene polymers* (see 2.26), with R^α = H are subclasses of vinyl polymers.

2.28 vinylidene polymer

Polymer prepared from a monomer containing the ethene-1,1-diyl group $>C{=}CH_2$, formerly called vinylidene.

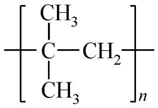
Note 1: A macromolecule of a regular vinylidene polymer is described by the constitutional repeating unit: $-CR^1R^2-CH_2-$, where R^1 and R^2 are each alkyl, aryl, heteroaryl, or halogen, such as by the units:

$\left[\mathrm{CCl_2{-}CH_2}\right]_n$

poly(1,1-dichloroethene)
formerly: poly(vinylidene dichloride)

$\left[\mathrm{CF_2{-}CH_2}\right]_n$

poly(1,1-difluoroethene)
formerly: poly(vinylidene difluoride)



$\left[\underset{\mathrm{CH_3}}{\overset{\mathrm{CH_3}}{\mathrm{C}}}\mathrm{{-}CH_2}\right]_n$

poly(2-methylpropene)
polyisobutylene (trivial name)

Note 2: Vinylidene is correctly defined as ethenylidene only, meaning a divalent attachment to the same atom of a senior group, i.e., it is the correct name for the group $=\mathrm{C}=\mathrm{CH_2}$ but not for the group $>\mathrm{C}=\mathrm{CH_2}$.

3. CLASS NAMES BASED ON CHEMICAL STRUCTURE

3.1 conjugated polymer

Polymer composed of macromolecules with main chains consisting of a sequence of conjugated multiple bonds:

$\left[\mathrm{CR^1{=}CR^2}\right]_n$
polyvinylenes

$\left[\mathrm{Ar{-}CR^1{=}CR^2}\right]_n$
polyarylenevinylenes

$\left[\mathrm{Ar}\right]_n$
polyarylenes

$\left[\mathrm{Ar{-}C{\equiv}C}\right]_n$
polyaryleneethynylenes

$\left[\mathrm{R^1C{=}CR^2{-}C{\equiv}C}\right]_n$
polydiacetylenes

where R^1 and R^2 are each hydrogen, alkyl, aryl, or heteroaryl and Ar is arenediyl (formerly arylene) or heteroarenediyl (formerly heteroarylene).

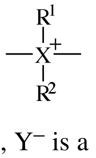
Note 1: A conjugated polymer in molecules of which π-electrons are delocalized along the main chain is referred to as a π-conjugated polymer. *Polyacetylene* (see 2.8)*, polypyrrole* (see 2.18), or *polythiophene* (see 2.19) are examples of π-conjugated polymers.

Note 2: A conjugated polymer in molecules of which σ-electrons are delocalized along the main chain is referred to as a σ-conjugated polymer. *Polysilanes* (see 3.51) and *polygermanes* (see 3.25) are examples of σ-conjugated polymers.

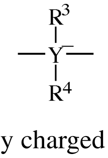
Note 3: *Polyanilines* (see 2.9), *polyaryleneethynylenes* (see 3.12), *polyarylenes* (see 3.11), *polyarylenevinylenes* (see 3.13), *polydiacetylenes* (see 2.18), *polygermanes* (see 3.25), *polyphenylenes* (see 3.40), *polyphenyleneethynylenes* (see 3.41), *polyphenylenevinylenes* (see 3.43), *polypyrroles* (see 2.18), *polysilanes* (see 3.51), *polythiophenes* (see 2.19), and *polyvinylenes* (see 3.65) are examples of subclasses of conjugated polymers.

3.2 ionene

Polymer composed of macromolecules containing charged atoms in the backbone:



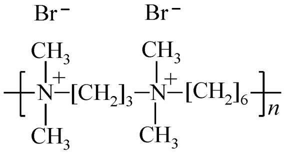
$-\underset{\mathrm{R^2}}{\overset{\mathrm{R^1}}{\mathrm{X^+}}}-$



$-\underset{\mathrm{R^4}}{\overset{\mathrm{R^3}}{\mathrm{Y^-}}}-$

where X^+ is a positively charged atom, Y^- is a negatively charged atom, R^1 and R^2 are each hydrogen, alkyl, aryl, heteroaryl, or aralkyl, and R^3 and R^4 are each aryl, heteroaryl, or another electron-withdrawing group.

Note 1: Nitrogen or phosphorus atoms are positively charged main-chain atoms in a common ionene.

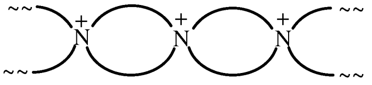


$$\left[\underset{\mathrm{CH_3}}{\overset{\overset{\mathrm{Br^-}}{\mathrm{CH_3}}}{\mathrm{N}^+}}-[\mathrm{CH_2}]_3-\underset{\mathrm{CH_3}}{\overset{\overset{\mathrm{Br^-}}{\mathrm{CH_3}}}{\mathrm{N}^+}}-[\mathrm{CH_2}]_6\right]_n$$

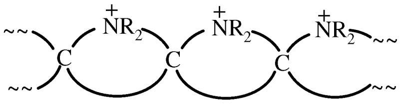
poly[(dimethyliminio)propane-1,3-diyl(dimethyliminio)hexane-1,6-diyl dibromide]

Note 2: Ionenes are a subclass of *ionic polymers* (see 3.3).

Note 3: An ionic *spiro polymer* (see 4.17) is an ionene only if all strands of its macromolecule include all charged atoms. Polymers failing to meet this criterion are spiro *polyelectrolytes*.



spiro ionene



spiro polyelectrolyte

3.3 ionic polymer

ion-containing polymer

Polymer composed of macromolecules containing ionic groups irrespective of their nature, content, and location.

Note: Ionic polymers are more in detail classified according to the nature, content, and location of ionic groups in their macromolecules. Those with clearly defined structure are included in this document: *ionene* (see 3.3.2), *polybetaine* (see 2.10), or *polyzwitterion* (see 2.25); those for definition of which content of ionic groups is also important ("*ionomer*", "*polyampholyte*", "*polyelectrolyte*", and others), are defined elsewhere [19].

3.4 polyalkenylene

Polymer composed of macromolecules containing exclusively alkene-α,ω-diyl (formerly alkenylene) constitutional repeating units:

$$\left[\mathrm{CH{=}CH{-}[CH_2]}_m\right]_n$$

Note 1: Polyalkenylenes are sometimes referred to as polyalkenamers; use of this term is discouraged.

Note 2: *Polyvinylenes* (see 3.65) ($m = 0$) are excluded.

3.5 polyalkylene

Polymer composed of macromolecules containing exclusively alkane-α,ω-diyl (formerly alkylene) constitutional repeating units:

$$\left[\mathrm{CR^1R^2}\right]_n$$

where R^1 and R^2 are each hydrogen, alkyl, or cycloalkyl.

Note: *Polyolefins* (see 2.17) are the most common polyalkylenes.

3.6 polyalkynylene

Polymer composed of macromolecules containing exclusively alkyne-α,ω-diyl (formerly alkynylene) constitutional repeating units:

$$\left[\!\!-\mathrm{C{\equiv}C{-}[CH_2]_{\mathit{m}}}-\!\!\right]_n$$

Note: Poly(oct-1-yne-1,8-diyl) (see 2.8) is an example of polyalkynylene.

3.7 polyamide

Polymer composed of macromolecules containing carboxamide groups as linkages in the backbone:

$$\mathrm{{-}NR{-}CO{-}}$$

where R is hydrogen, alkyl, aryl, or heteroaryl.

Note 1: A polyamide containing, besides –NR–CO– linkages, exclusively aliphatic constitutional units is an aliphatic polyamide; examples are:

$$\left[\!\!-\mathrm{NH{-}CO{-}[CH_2]_4{-}CO{-}NH{-}[CH_2]_6}-\!\!\right]_n$$

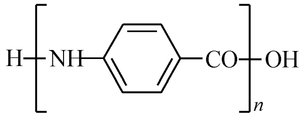
poly[*N,N′*-(hexane-1,6-diyl)adipamide]
poly[(1,8-diazatetradecan-2,7-dione)-1,14-diyl]
formerly: poly[*N,N′*-(hexamethylene)adipamide]
polyamide 6,6 (trivial name)

$$\left[\!\!-\mathrm{NH{-}CO{-}[CH_2]_5}-\!\!\right]_n$$

poly[imino(1-oxohexane-1,6-diyl)
poly(hexano-6-lactam)
poly(ε-caprolactam)
polyamide 6 (trivial name)

Trivial names of the type: polyamide *m* and polyamide *m,n* are only used for aliphatic polyamides. Polyamide *m* stands for a homopolymeric polyamide derived from an amino acid or a lactam comprising *m* carbon atoms; polyamide *m,n* stands for a copolymeric polyamide derived from an alkane-1,*m*-diamine containg *m* carbon atoms and an alkanedioic acid containing *n* carbon atoms (including those in CO groups).

Note 2: A polyamide containing, besides –NR–CO– linkages, exclusively aromatic constitutional units is an aromatic polyamide commonly referred to as an aramide; example is:



poly(imino-1,4-phenylenecarbonyl)
poly(4-aminobenzoic acid)

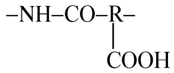
Note 3: A polyamide containing pendent carboxy groups is a *polyamide acid* commonly referred to as a polyamic acid (see 3.8).

Note 4: A polymer containing only pendent amide groups is excluded, e.g., polyacrylamide.

3.8 polyamide acid

polyamic acid

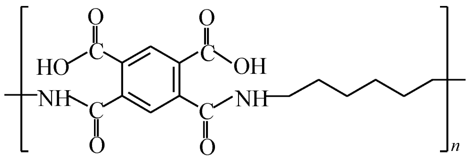
Polyamide containing pendent carboxy groups:



$$\mathrm{{-}NH{-}CO{-}\underset{\displaystyle COOH}{\underset{|}{R}}{-}}$$

where R is a constitutional unit with a connectivity three or higher.

Note: A polyamide acid is mostly prepared as a processable precursor giving a polyimide upon thermal curing. The polyamide acid prepared from benzene-1,2:4,5-tetracarboxylic dianhydride (formerly pyromellitic anhydride) and hexane-1,6-diamine (formerly hexamethylenediamine) is an example of such a precursor:



poly[iminocarbonyl(4,6-dicarboxy-1,3-phenylene)carbonyliminohexane-1,6-diyl]
(one of two possible structures)

3.9 polyamine

Polymer composed of macromolecules containing imino groups as linkages in the backbone:

$$-\mathrm{NR}-$$

where R is hydrogen, alkyl, aryl, or heteroaryl.

Note 1: Examples of polyamines are:

$$\left[\mathrm{NR{-}[CH_2]_6{-}NR{-}[CH_2]_{10}}\right]_n$$

poly[(alkylimino)hexane-1,6-diyl-(alkylimino)decane-1,10-diyl]

$$\left[\mathrm{NR{-}CH_2CH_2}\right]_n$$

poly[(alkylimino)ethylene]
poly(1-alkylaziridine)

Note 2: A polymer containing only pendent amino groups is excluded. However, in organic chemistry, low-molecular-weight compounds containing three or more amino groups are also called polyamines.

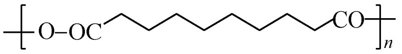
Note 3: Quaternized polyamines have iminio linkages, $-\mathrm{N^+R^1R^2}-$, in the backbone (R^1 and R^2 are each hydrogen, or an alkyl, aryl, or heteroaryl group) and they are a structure-based subclass of *ionenes* (see 3.2).

3.10 polyanhydride

Polymer composed of macromolecules containing carboxylic anhydride groupings as linkages in the backbone:

$$-\mathrm{CO{-}O{-}CO}-$$

Note: An example of a polyanhydride is:



poly(oxydecanedioyl)

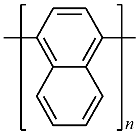
3.11 polyarylene

Polymer composed of macromolecules containing exclusively arenediyl (formerly arylene) or heteroarenediyl (formerly heteroarylene) units in the backbone:

$$-\!\!\left[\text{Ar}\right]\!\!-_n$$

where Ar is a divalent arenediyl or heteroarenediyl group.

Note 1: An example of a polyarylene is:



poly(naphthalene-1,4-diyl)

Note 2: Polyarylenes (however, not all) are a structure-based subclass of *conjugated polymers* (see 3.1); e.g., poly(1,3-phenylene) is not a conjugated polymer.

Note 3: *Polyphenylenes* (see 3.40) (Ar is phenylene or substituted phenylene) are a subclass of polyarylenes.

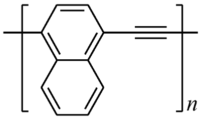
3.12 polyaryleneethynylene

Polymer composed of macromolecules containing exclusively alternating arenediyl or heteroarenediyl (formerly arylene or heteroarylene, respectively) and ethynediyl (formerly ethynylene) constitutional repeating units in the backbone:

$$-\!\!\left[\text{Ar}-\text{C}\equiv\text{C}\right]\!\!-_n$$

where Ar is a divalent arenediyl or heteroarenediyl group.

Note 1: An example of a polyaryleneethynylene is:



poly[naphthalene-1,4-diylethynediyl]

Note 2: Polyaryleneethynylenes (however, not all, see Note 2, entry 3.11) are a subclass of *conjugated polymers* (see 3.1).

Note 3: A polymer for which Ar is phenylene is a *polyphenyleneethynylene* (see 3.41).

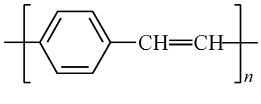
3.13 polyarylenevinylene

Polymer composed of macromolecules containing exclusively alternating arenediyl or heteroarenediyl (formerly arylene or heteroarylene, respectively) and ethene-1,2-diyl (formerly vinylene) or substituted vinylene constitutional repeating units in the backbone:

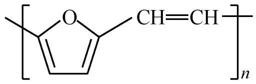
$$-\!\!\left[\text{Ar}-\text{CR}^1\!=\!\text{CR}^2\right]\!\!-_n$$

where Ar is a divalent arenediyl or heteroarenediyl group and R^1 and R^2 are each hydrogen, or an alkyl, aryl, or heteroaryl group.

Note 1: Examples of a polyarylenevinylene are:



poly(1,4-phenyleneethene-1,2-diyl)
formerly: poly(1,4-phenylenevinylene)



poly(furan-2,5-diylethene-1,2-diyl)
formerly: poly(furan-2,5-diylvinylene)

Note 2: Polyarylenevinylenes (however, not all, see Note 2, entry 3.11) are a subclass of *conjugated polymers* (see 3.1).

Note 3: *Polyphenylenevinylenes* (see 3.43) (Ar is phenylene or substituted phenylene) are a subclass of polyarylenevinylenes.

3.14 polyazomethine

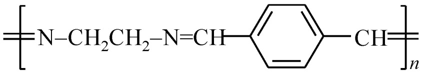
poly(Schiff base)

Polymer composed of macromolecules containing azomethine linkages in the backbone:

–N=CR–

where R is hydrogen, or an alkyl or aryl group.

Note 1: An example of a polyazomethine is:



poly(nitriloethylenenitrilomethanylylidene-1,4-phenylenemethanylylidene)

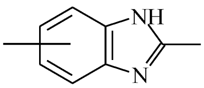
Note 2: A polymer with only pendent azomethine groups is excluded.

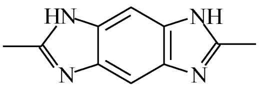
Note 3: The group name “azomethine” is derived from the obsolete name “methine” for the methanylylidene group.

Note 4: The original distinction between polyazomethines and poly(Schiff base)s, which is that R substituent in –N=CR– cannot be hydrogen in a polyazomethine but can be hydrogen in poly(Schiff base)s, making polyazomethines a subclass of poly(Schiff base)s, has been nearly completely lost in the literature.

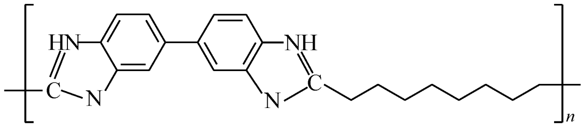
3.15 polybenzimidazole

Polymer composed of macromolecules containing benzimidazole groups in the backbone, such as the groups:





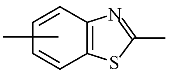
Note: An example of a polybenzimidazole is:

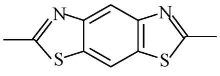


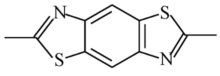
poly([5,5'-bibenzimidazole]-2,2'-diyloctane-1,8-diyl)

3.16 polybenzothiazole

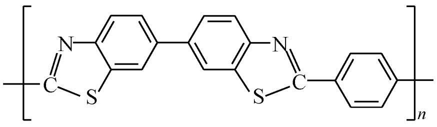
Polymer composed of macromolecules containing benzothiazole groups in the backbone, such as the groups:







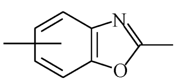
Note: An example of a polybenzothiazole is:

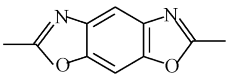


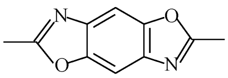
poly{[6,6'-bi(1,3-benzothiazole)]-2,2'-diyl-1,4-phenylene}

3.17 polybenzoxazole

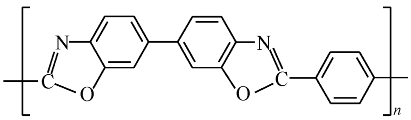
Polymer composed of macromolecules containing benzoxazole linkages in the backbone, such as the linkages:







Note: An example of a polybenzoxazole is:



poly{[6,6'-bi(1,3-benzoxazole)]-2,2'-diyl-1,4-phenylene}

3.18 polycarbamate

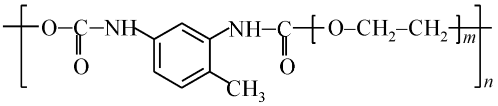
polyurethane

Polymer composed of macromolecules containing carbamate (formerly urethane) or N-substituted carbamate linkages in the backbone:

–NR–CO–O–

where R is hydrogen, alkyl, aryl, heteroaryl, substituted alkyl, substituted aryl, or substituted heteroaryl.

Note 1: An example of a polycarbamate is:



poly{oxycarbonylimino(4-methyl-1,3-phenylene)iminocarbonyl[poly(oxyethylene)]}

Note 2: A polymer containing only pendent carbamate (urethane) groups is excluded.

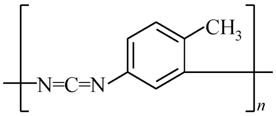
Note 3: The commonly used class name polyurethane has been derived from the historic name urethane for ethyl carbamate.

3.19 polycarbodiimide

Polymer composed of macromolecules containing carbodiimide linkages in the backbone:

–N=C=N–

Note 1: An example of a polycarbodiimide is:



poly[nitrilo(methanediylidene)nitrilo-(4-methyl-1,3-phenylene)]
poly[carbodiimide-(4-methyl-1,3-phenylene)]

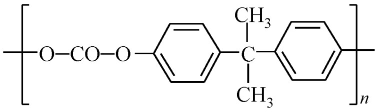
Note 2: A polymer containing only pendent carbodiimide linkages is excluded.

3.20 polycarbonate

Polymer composed of macromolecules containing carbonate linkages in the backbone:

–O–CO–O–

Note 1: An example of a polycarbonate is:



poly[oxycarbonyloxy-1,4-phenylene(dimethylmethylene)-1,4-phenylene]
poly(bisphenol A carbonate)

Note 2: A polymer containing only pendent carbonate linkages is excluded.

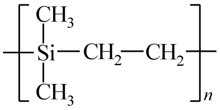
3.21 polycarbosilane

Polymer composed of macromolecules containing carbon–silicon linkages in the backbone:

$$-\mathrm{SiR^1R^2{-}CR^3R^4}-$$

where R^1, R^2, R^3, and R^4 are each hydrogen, alkyl, aryl, or heteroaryl.

Note 1: An example of a polycarbosilane is:



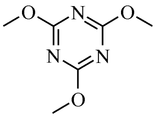
$$\left[\underset{CH_3}{\overset{CH_3}{Si}} - CH_2 - CH_2 \right]_n$$

poly[(dimethylsilanediyl)ethylene]

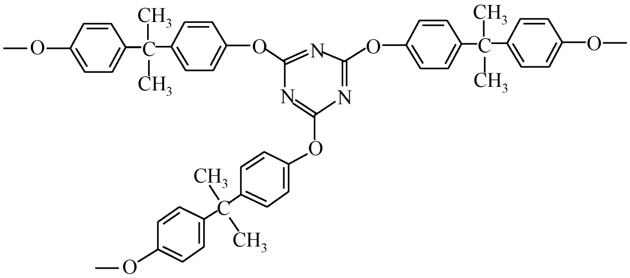
Note 2: A polycarbosilane containing, in addition to silanediyl groups, exclusively alkanediyl (formerly alkylene) or substituted alkanediyl constitutional repeating units is referred to as a polysilalkylene, whereas that involving exclusively arenediyl (formerly arylene) constitutional repeating units is referred to as a polysilarylene.

3.22 polycyanurate

Polymer composed of macromolecules containing 1,3,5-triazine-2,4,6-triyltrioxy constitutional units (formerly cyanurate groups) in the backbone:



Note 1: An example of structure of a polycyanurate is:



Structure motif of a polycyanurate prepared from
2,2-bis(4-cyanatophenyl)propane (bisphenol A dicyanate)

Note 2: Cyanurate is not an IUPAC approved name for 1,3,5-triazinetris(olate).

Note 3: Polycyanurates are isomeric with *polyisocyanurates* (see 3.31).

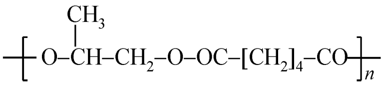
Note 4: Polycyanurates can be regarded as a subclass of *polytriazines* (see 3.63).

3.23 polyester

Polymer composed of macromolecules containing carboxylic ester linkages in the backbone:

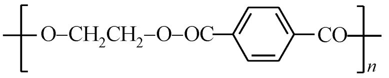
–O–CO–

Note 1: Examples of polyesters are:



$$\left[O-\overset{CH_3}{CH}-CH_2-O-OC-[CH_2]_4-CO \right]_n$$

poly[oxy(1-methylethylene)oxyadipoyl]



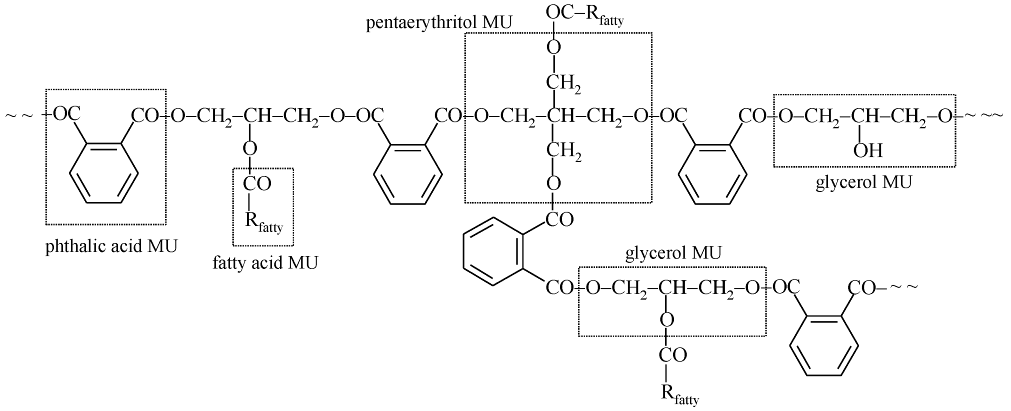
poly(oxyethyleneoxyterephthaloyl)
poly(ethylene terephthalate)

Note 2: A polyester comprising unsaturated constitutional units such as a polyester prepared from maleic anhydride or from but-2-yne-1,4-diol is referred to as an unsaturated polyester.

$$-\!\!\left[\text{O–CO–CH=CH–CO–O–}[\text{CH}_2]_4\right]\!\!-_n$$

poly[oxy(butenedioyl)oxybutane-1,4-diyl]

Note 3: A polyester prepared from a polyol (typically a triol or tetrol), and a mixture of dicarboxylic anhydrides and fatty acids (e.g., linseed oil or tall oil) is referred to as an alkyd polymer or alkyd. Structure motifs of an alkyd polymer prepared from phthalic anhydride, glycerol, pentaerythritol [2,2-bis(hydroxymethyl)propane-1,3-diol], and fatty acids are shown below (MU stands for monomeric unit):



Note 4: *Polycarbonates* (see 3.30), *polythioesters* (see 3.61), and unsaturated polyesters are subclasses of polyesters.

Note 5: A polymer containing only pendent ester groups is excluded, for example, an *acrylic polymer* (see 2.1).

3.24 polyether

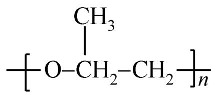
Polymer composed of macromolecules containing ether linkages in the backbone:

–O–

Note 1: Examples of polyethers are:

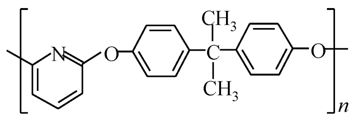
$$-\!\!\left[\text{O–CH}_2\text{–CH}_2\text{–CH}_2\text{–CH}_2\right]\!\!-_n$$

poly(oxybutane-1,4-diyl)



$$-\!\!\left[\text{O–}\underset{}{\overset{\text{CH}_3}{\text{CH}}}_2\text{–CH}_2\right]\!\!-_n$$

poly(oxy-1-methylethylene)



poly[(pyridine-2,6-diyl)oxy-1,4-phenylene-(dimethylmethylene)-1,4-phenyleneoxy]

Note 2: *Polyoxyalkylenes* (see 3.37) and *polyoxyarylenes* (see 3.11) are subclasses of polyethers.

Note 3: A polymer containing only pendent ether groups is excluded.

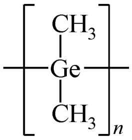
3.25 polygermane

Polymer composed of macromolecules containing exclusively germanium atoms in the backbone:

$$-\!\!\left[\mathrm{GeR_2}\right]_n\!\!-$$

where R is alkyl, aryl or heteroaryl.

Note 1: An example of a polygermane is:



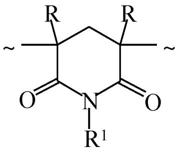
$$-\!\!\left[\begin{array}{c}\mathrm{CH_3}\\ |\\ -\mathrm{Ge}-\\ |\\ \mathrm{CH_3}\end{array}\right]_n\!\!-$$

poly(dimethylgermanediyl)

Note 2: Polygermanes are sometimes referred to as polygermylenes. Use of this term is discouraged.

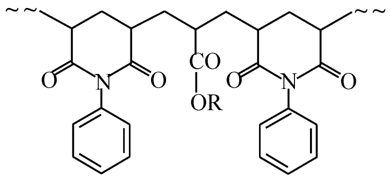
3.26 polyglutarimide

Polymer composed of macromolecules containing glutarimide rings in the backbone:



where R is hydrogen or alkyl (usually methyl) and R^1 is hydrogen, or an alkyl, aryl, or heteroaryl group.

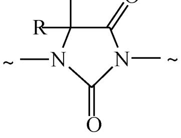
Note: A polyglutarimide is commonly prepared by modification of a poly(alkyl acrylate) with an amine, such as aniline, so it also contains residual acrylic units:



Structure motifs of a polyglutarimide prepared
from poly(alkyl acrylate) and aniline

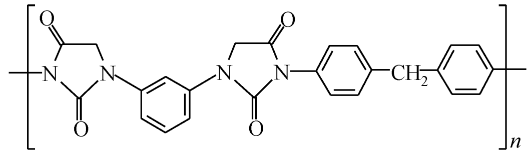
3.27 polyhydantoin

Polymer composed of macromolecules containing hydantoin (imidazolidine-2,4-dione) rings in the backbone:



where R is hydrogen, or an alkyl, aryl, or heteroaryl group.

Note 1: An example of a polyhydantoin is:



poly[(2,5-dioxoimidazolidine-1,3-diyl)-1,3-phenylene-
(2,4-dioxoimidazolidine-1,3-diyl)-1,4-phenylenemethylene-1,4-phenylene]

Note 2: Polyhydantoins are a subclass of *polyimides* (see 3.30).

3.28 polyhydrazide

Polymer composed of macromolecules containing hydrazide linkages in the backbone:

$$-CO-NR^1-NR^2-CO-$$

where R^1 and R^2 are each hydrogen, alkyl, aryl, or heteroaryl.

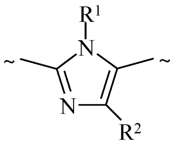
Note: An example of a polyhydrazide is:

$$\left[NH-NH-OC-[CH_2]_4-CO \right]_n$$

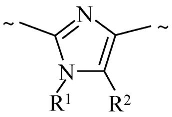
poly(hydrazine-1,2-diyladipoyl)
poly(hydrazine-1,2-diylhexanedioyl)

3.29 polyimidazole

Polymer composed of macromolecules containing imidazole rings in the backbone:

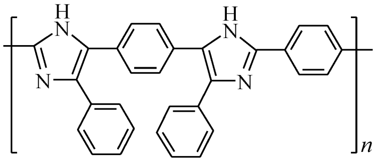


or



where R^1 and R^2 are each hydrogen, or an alkyl or aryl group.

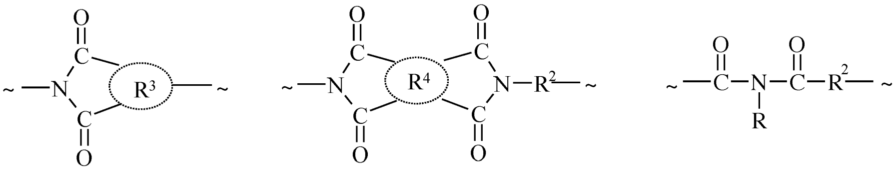
Note: An example of a polyimidazole is:



poly[(4-phenylimidazole-2,5-diyl)-1,4-phenylene-
(4-phenylimidazole-5,2-diyl)-1,4-phenylene)

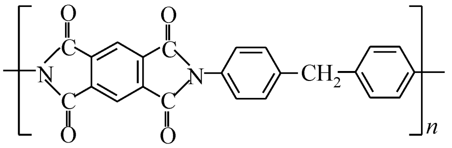
3.30 polyimide

Polymer composed of macromolecules containing cyclic dicarboximide groupings in the backbone:



where R, R^2, R^3, and R^4 are groups with connectivity one, two, three, and four, respectively.

Note 1: An example of a polyimide is:

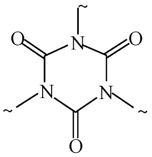


poly[1,3,5,7-tetraoxo-1,2,3,5,6,7-hexahydrobenzo[1,2-*c*:4,5-*c*′]dipyrrole-2,6-diyl)-1,4-phenylenemethylene-1,4-phenylene]
poly{*N*,*N*′-[methylenedi(4,1-phenylene)]benzene-1,2:4,5-bis(dicarboximide)}

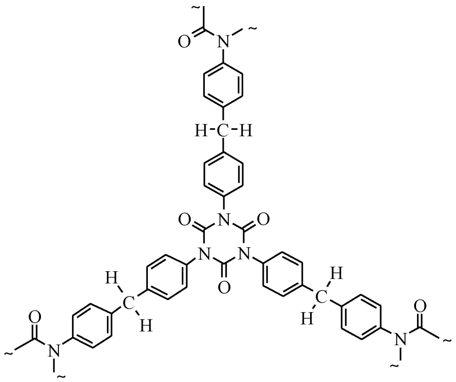
Note 2: A polymer containing only pendent dicarboximide groups is excluded.

3.31 polyisocyanurate

Polymer composed of macromolecules containing 2,4,6-trioxo-1,3,5-triazinane-1,3,5-triyl (formerly isocyanurate) rings in the backbone:



Note 1: An example of structure motifs of a polyisocyanurate is shown below:



Structure motifs of a polyisocyanurate

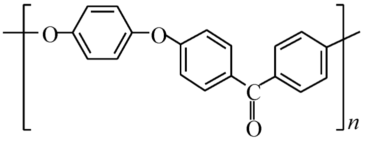
Note 2: Polyisocyanurates are isomeric with *polycyanurates* (see 3.22).

3.32 polyketone

Polymer composed of macromolecules containing keto groups as linkages in the backbone:

–CO–

Note 1: A polyketone containing in addition to keto groups also ether linkages in the main chains is usually referred to as a *polyetherketone.*



poly(oxy-1,4-phenyleneoxy-1,4-phenylene-carbonyl-1,4-phenylene)

Note 2: A polymer containing only pendent keto groups, such as a polyvinyl ketone, as well as a polymer containing main-chain carbonyl groups directly linked to a main-chain heteroatom, such as a *polyester* (see 3.23) or a *polyamide* (see 3.7), is excluded.

3.33 polymetaloxane

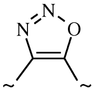
Organometallic polymer composed of macromolecules containing exclusively alternating metal and oxygen atoms in the main chain:

$$-\mathrm{ML}_x-\mathrm{O}-$$

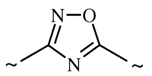
where M is a metal atom such as Al, Ge, Sn, or Ti, and L is a metal-bonded substituent (ligand).

3.34 polyoxadiazole

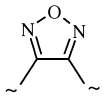
Polymer composed of macromolecules containing exclusively oxadiazole rings in the backbone:



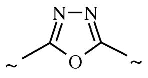
1,2,3-oxadiazole-4,5-diyl



1,2,4-oxadiazole-3,5-diyl



1,2,5-oxadiazole-4,5-diyl



1,3,4-oxadiazole-2,5-diyl

Note: Poly(1,2,3-oxadiazole-4,5-diyl) and poly(1,3,4-oxadiazole-2,5-diyl) are *conjugated polymers* (see 3.1).

3.35 polyoxyalkylene

Polymer composed of macromolecules containing exclusively oxyalkane-α,ω-diyl (formerly oxyalkylene) constitutional repeating units in the backbone:

$$\left[\!-\mathrm{O}-\mathrm{Y}-\!\right]_n$$

where Y is an alkane-α,ω-diyl (formerly alkylene) or substituted alkane-α,ω-diyl group contributing at least two carbon atoms to the main chain.

Note 1: An example of a polyoxyalkylene is:

$$-\!\!\left[\text{O}-\text{CH}_2-\text{CH}_2\right]\!\!-_n$$

poly(oxyethylene)

Note 2: An analog of polyoxyalkylene, for which Y is $-\text{CR}_2-$ (R = H, alkyl, aryl, etc.) is a *polyoxymethylene* (see 3.37).

Note 3: Polyoxyalkylenes are a subclass of *polyethers* (see 3.24).

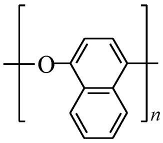
3.36 polyoxyarylene

Polymer composed of macromolecules containing exclusively oxyarenediyl (formerly oxyarylene) constitutional repeating units in the backbone:

$$-\!\!\left[\text{O}-\text{Ar}\right]\!\!-_n$$

where Ar is an arenediyl (formerly arylene), heteroarenediyl (formerly heteroarylene), substituted arenediyl or substituted heteroarenediyl.

Note 1: An example of polyoxyarylene is:



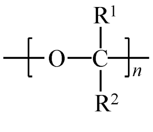
poly(oxynaphthalene-1,4-diyl)

Note 2: Polyoxyarylenes are a subclass of *polyethers* (see 3.24).

Note 3: A polyoxyarylene in which arenediyl is phenylene or a substituted phenylene is a *polyoxyphenylene* (see 3.38).

3.37 polyoxymethylene

Polymer composed of macromolecules containing exclusively oxymethylene or substituted oxymethylene constitutional repeating units in the backbone:



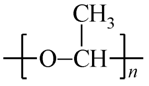
$$-\!\!\left[\text{O}-\overset{\text{R}^1}{\underset{\text{R}^2}{\text{C}}}\right]\!\!-_n$$

where R^1 and R^2 are each hydrogen, alkyl, aryl, or heteroaryl.

Note 1: Examples of polyoxymethylenes are:

$$-\!\!\left[\text{O}-\text{CH}_2\right]\!\!-_n$$

poly(oxymethylene)
polyformaldehyde



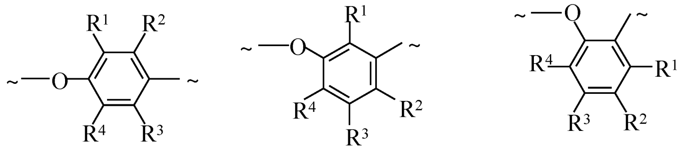
$$-\!\!\left[\text{O}-\overset{\text{CH}_3}{\text{CH}}\right]\!\!-_n$$

poly(oxymethylmethylene)
polyacetaldehyde

Note 2: A polyoxymethylene is also referred to as a polyacetal, polyketal, or acetal resin. Use of the last term is discouraged.

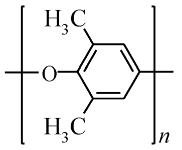
3.38 polyoxyphenylene

Polymer composed of macromolecules containing exclusively oxyphenylene or ring-substituted oxyphenylene constitutional repeating units in the backbone:

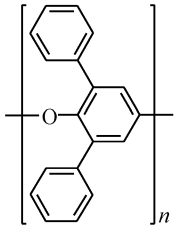


where R^1, R^2, R^3, and R^4 are each hydrogen or an alkyl, aryl, or aralkyl group.

Note 1: Examples of a polyoxyphenylene are:



poly[oxy(2,6-dimethyl-1,4-phenylene)]

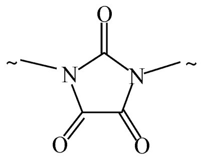


poly[oxy(2,6-diphenyl-1,4-phenylene)]
poly[oxy(1,1':3',1''-terphenyl-2',5'-diyl)]

Note 2: Polyoxyphenylenes are a subclass of *polyoxyarylenes* (see 3.36) as well as a subclass of *polyethers* (see 3.24).

3.39 polyparabanic acid

Polymer composed of macromolecules containing imidazolidine-2,4,5-trione (parabanic acid) rings in the backbone:

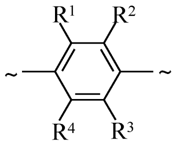


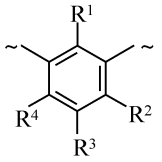
Note 1: Polyparabanic acids are a subclass of *polyimides* (see 3.30).

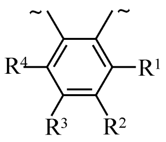
Note 2: Parabanic acid is not an IUPAC-approved name for imidazolidine-2,4,5-trione.

3.40 polyphenylene

Polymer composed of macromolecules containing exclusively σ-bonded benzene or substituted benzene rings in the backbone:

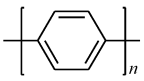






where R^1, R^2, R^3, and R^4 are each hydrogen or a monovalent group.

Note 1: An example of a polyphenylene is:

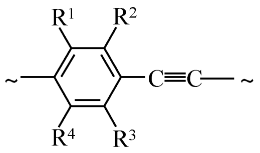


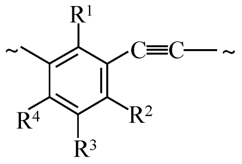
poly(1,4-phenylene)

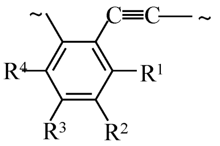
Note 2: Polyphenylenes are a subclass of *polyarylenes* (see 3.11) and also a subclass of *conjugated polymers* (see 3.1), except for poly(1,3-phenylene)s, which are not conjugated polymers.

3.41 polyphenyleneethynylene

Polymer composed of macromolecules containing exclusively alternating phenylene or substituted phenylene and ethynediyl (formerly ethynylene) constitutional repeating units in the backbone:

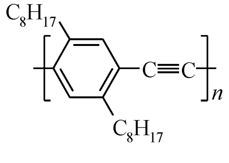






where R^1, R^2, R^3, and R^4 are each hydrogen, alkyl, aryl, halogen, trialkylsilyl, etc.

Note 1: An example of polyphenyleneethynylene is:

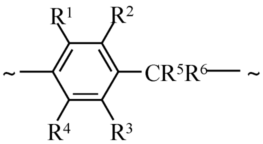


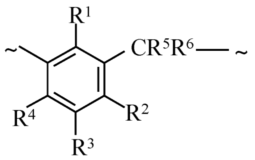
poly[(2,5-dioctyl-1,4-phenylene)ethynediyl]

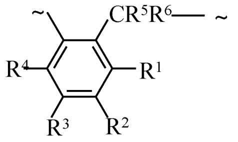
Note 2: Polyphenyleneethynylenes are a subclass of *polyaryleneethynylenes* (see 3.12) and also a subclass of *conjugated polymers* (see 3.1, except for those containing 1,3-phenylene or substituted 1,3-phenylene constitutional repeating units).

3.42 polyphenylenemethylene

Polymer composed of macromolecules containing exclusively alternating phenylene or substituted phenylene and methylene or substituted methylene constitutional units in the backbone:

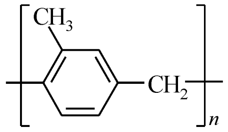






where R^1, R^2, R^3, R^4, R^5, and R^6 are each hydrogen, alkyl, aryl, halogen, trialkylsilyl, etc.

Note 1: An example of a polyphenylenemethylene is:

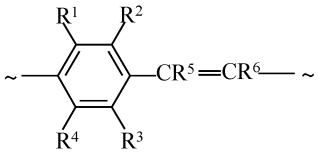


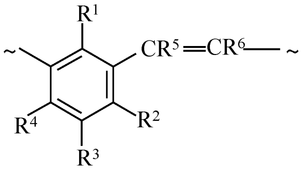
poly[(2-methyl-1,4-phenylene)methylene]

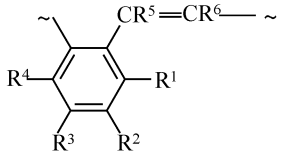
Note 2: Polyphenylenemethylenes were also referred to as polybenzyls; this name is obsolete and strongly discouraged.

3.43 polyphenylenevinylene

Polymer composed of macromolecules containing exclusively alternating phenylene or substituted phenylene and ethene-1,2-diyl (formerly vinylene) or substituted ethene-1,2-diyl constitutional repeating units in the backbone:

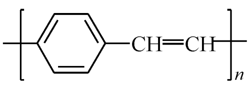






where R^1, R^2, R^3, R^4, R^5, and R^6 are each hydrogen, alkyl, aryl, heteroaryl, halogen, trialkylsilyl, etc.

Note 1: An example of a polyphenylenevinylene is:

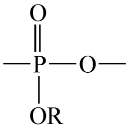


poly(1,4-phenyleneethene-1,2-diyl)
formerly: poly(1,4-phenylenevinylene)

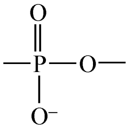
Note 2: Polyphenylenevinylenes are a subclass of *polyarylenevinylenes* (see 3.13) and also a subclass of *conjugated polymers* (see 3.1, except for those containing 1,3-phenylene or substituted 1,3-phenylene constitutional repeating units).

3.44 polyphosphate

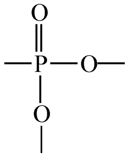
Polymer composed of macromolecules containing phosphate constitutional repeating units:



$$-\overset{\overset{\displaystyle O}{\|}}{\underset{\underset{\displaystyle OR}{|}}{P}}-O-$$



$$-\overset{\overset{\displaystyle O}{\|}}{\underset{\underset{\displaystyle O^-}{|}}{P}}-O-$$

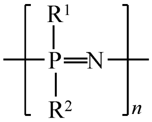


$$-\overset{\overset{\displaystyle O}{\|}}{\underset{\underset{\underset{\displaystyle |}{\displaystyle O}}{|}}{P}}-O-$$

where R is hydrogen, alkyl, aryl, or heteroaryl.

3.45 polyphosphazene

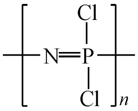
Polymer composed of macromolecules containing exclusively nitrilophosphanylylidene (formerly phosphazene) constitutional repeating units in the backbone:



$$\left[\overset{\overset{\displaystyle R^1}{|}}{\underset{\underset{\displaystyle R^2}{|}}{P}}{=}N\right]_n$$

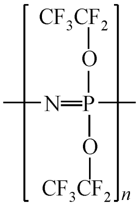
where R^1 and R^2 are each a monovalent group, such as a halogen or an alkoxy group.

Note: Examples of polyphosphazenes are:



$$\left[N{=}\overset{\overset{\displaystyle Cl}{|}}{\underset{\underset{\displaystyle Cl}{|}}{P}}\right]_n$$

poly[nitrilo(dichloro-λ^5-phosphanylylidene)]
poly(dichlorophosphazene)



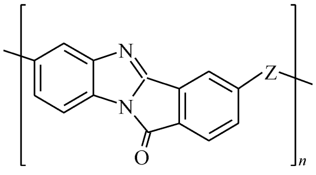
$$\left[N{=}\overset{\overset{\displaystyle CF_3CF_2}{|}}{\overset{\displaystyle O}{|}}\!\!\!\underset{\underset{\displaystyle CF_3CF_2}{|}}{\underset{\displaystyle O}{|}}\!\!\!P\right]_n$$

poly{nitrilo[bis(pentafluoroethoxy)-λ^5-phosphanylylidene]}
poly[bis(pentafluoroethoxy)phosphazene]

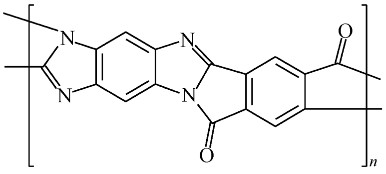
3.46 polypyrrone

polyisoindolobenzimidazole

Polymer composed of *single strand* (see 4.16) or *ladder* (see 4.11) macromolecules comprising isoindolo[2,1-*a*]benzimidazole (formerly pyrrone) constitutional repeating units such as:

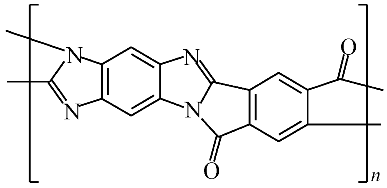


or



where Z is a divalent linking group or atom.

Note 1: An example of a polypyrrone is:



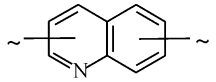
poly[(10-oxo-3,10-dihydroimidazo[4,5-*f*]isoindolo[2,1-*a*]benzimidazole-2,3,7,8-tetrayl)-7-carbonyl]

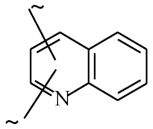
Note 2: Polypyrrones are also referred to as polybenzimidazolimides, polybenzimidazolones, polybenzimidazopyrrolones, polybenzoylenebenzimidazoles (usage strongly discouraged), polyimidazopyrrolones, and polyisoindolobenzimidazoles.

Note 3: Pyrrone is not an IUPAC approved name.

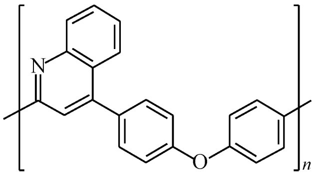
3.47 polyquinoline

Polymer composed of macromolecules containing quinoline moieties in the backbone:





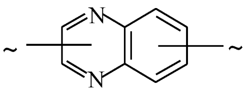
Note: An example of a polyquinoline is:

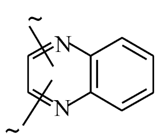


poly(quinoline-2,4-diyl-1,4-phenyleneoxy-1,4-phenylene)

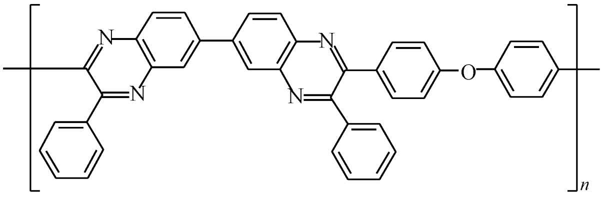
3.48 polyquinoxaline

Polymer composed of macromolecules containing quinoxaline groups in the backbone:





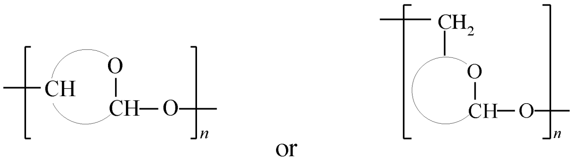
Note: An example of a polyquinoxaline is:



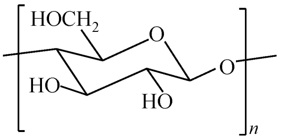
poly[(3,3'-diphenyl[6,6'-biquinoxaline]-2,2'-diyl)-1,4-phenyleneoxy-1,4-phenylene]

3.49 polysaccharide

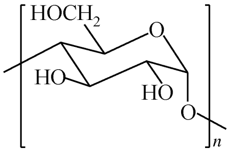
Polymer composed of macromolecules containing in the backbone exclusively monosaccharide rings or chemically modified monosaccharide rings linked through glycosidic (acetal) bonds.



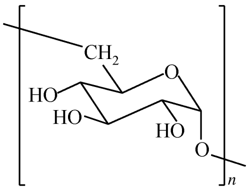
Note: The most important polysaccharides—cellulose, glycogen, amylose, dextran, and amylopectin—are derived from D-glucose:



cellulose



amylose



dextran

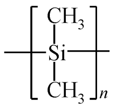
3.50 polysilane

Polymer composed of macromolecules containing exclusively silicon atoms in the backbone:

$$\left[\mathrm{SiR^1R^2} \right]_n$$

where R^1 and R^2 are each hydrogen or an alkyl, aryl, or heteroaryl group.

Note 1: An example of a polysilane is:



$$\left[\mathrm{Si(CH_3)_2} \right]_n$$

poly(dimethylsilanediyl)

Note 2: Polysilanes are often referred to as polysilylenes. Use of this term is discouraged.

Note 3: Polysilanes are σ-*conjugated polymers* (see 3.1).

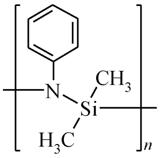
3.51 polysilazane

Polymer composed of macromolecules containing exclusively alternating nitrogen and silicon atoms in the backbone:

$$\left[\mathrm{NR^1{-}SiR^2R^3} \right]_n$$

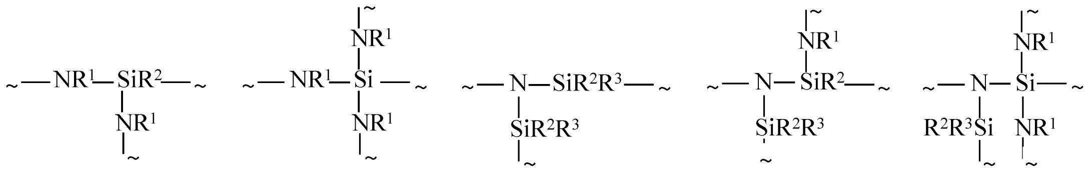
where R^1, R^2, and R^3 are each hydrogen or an alkyl or aryl group.

Note 1: An example of a polysilazane is:



poly[(phenylimino)(dimethylsilanediyl)]

Note 2: Polysilazanes can comprise both silicon and nitrogen branching points, the former being formed from ammonia and the latter from, for example, alkyltrichlorosilanes or tetrachlorosilane used as monomers:



where R^1, R^2, and R^3 are each hydrogen or an alkyl or aryl group.

3.52 polysiloxane

silicones

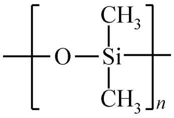
polyoxysilylenes

Polymer composed of macromolecules containing alternating oxygen and silicon atoms in the backbone:

$$-\!\!\left[\mathrm{O{-}SiR^1R^2}\right]_n\!\!-$$

where R^1 and R^2 are each hydrogen or an alkyl or aryl group.

Note 1: An example of a polysiloxane is:



$$-\!\!\left[\mathrm{O}-\underset{\mathrm{CH_3}}{\overset{\mathrm{CH_3}}{\mathrm{Si}}}\right]_n\!\!-$$

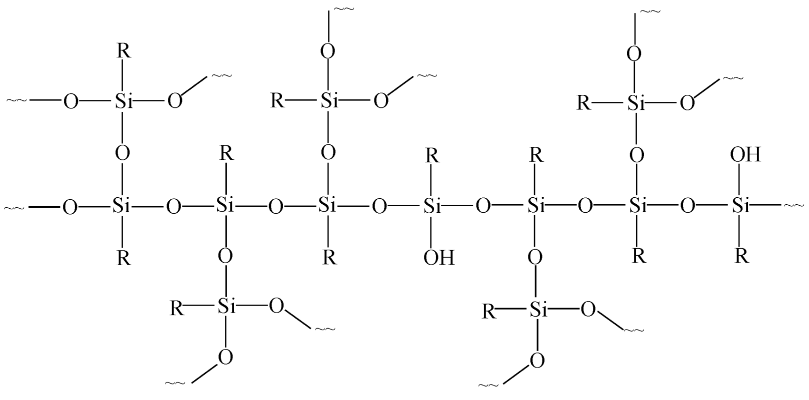
poly[oxy(dimethylsilanediyl)]
poly(dimethylsiloxane)

Note 2: Polysiloxanes are often referred to as silicones or polyoxysilylenes. Use of the last term is discouraged.

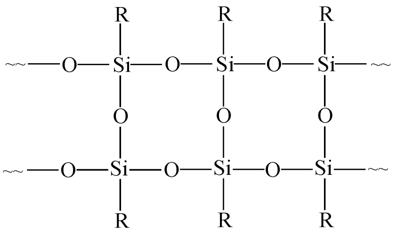
Note 3: *Polysilsesquioxanes* (see 3.53) are a subclass of polysiloxanes.

3.53 polysilsesquioxane

Polymer composed of macromolecules containing silicon and oxygen atoms in the ratio 1:1.5 (ideal ratio for infinite macromolecule), which alternate in a *hyperbranched* (see 4.10) or *ladder* (see 4.11) structure such as:



hyperbranched silsesquioxane



ladder silsesquioxane

where R is alkyl, aryl, or heteroaryl.

Note 1: The ideal value of the O:Si ratio of 1.5:1 is achieved only in the case of *a ladder polymer* (see 4.11). For hyperbranched polysilsesquioxanes, the value of the O:Si ratio is higher.

Note 2: Polysilsesquioxanes are a subclass of *polysiloxanes* (see 3.52).

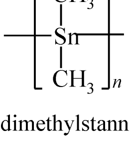
3.54 polystannane

Polymer composed of macromolecules containing exclusively tin atoms in the backbone:

$$-\!\!\left[\text{SnR}^1\text{R}^2\right]_n\!\!-$$

where R^1 and R^2 are each hydrogen or an alkyl or aryl group.

Note: An example of a polystannane is:



$$-\!\!\left[\begin{array}{c}\text{CH}_3\\ |\\ \text{Sn}\\ |\\ \text{CH}_3\end{array}\right]_n\!\!-$$

poly(dimethylstannanediyl)

3.55 polysulfide

Polymer composed of macromolecules containing sulfur–sulfur linkages in the backbone:

$$-S_x- \ (x > 1)$$

Note 1: An example of a polysulfide is:

$$\left[O-CH_2CH_2-S-S-CH_2CH_2 \right]_n$$

poly(oxyethylenedisulfanediylethylene)

Note 2: A polymer with $x = 1$ is a *polythioether* (see 3.62).

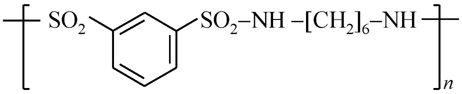
3.56 polysulfonamide

Polymer composed of macromolecules containing sulfonamide linkages in the backbone:

$$-SO_2-NR-$$

where R is hydrogen or an alkyl, aryl, or heteroaryl group.

Note: An example of a polysulfonamide is:



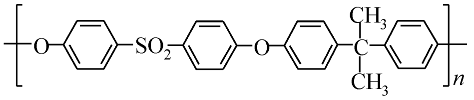
poly(sulfonyl-1,3-phenylenesulfonyliminohexane-1,6-diylimino)

3.57 polysulfone

Polymer composed of macromolecules containing sulfonyl linkages in the backbone:

$$-SO_2-$$

Note 1: An example of a polysulfone is:



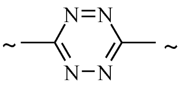
poly[oxy-1,4-phenylenesulfonyl-1,4-phenyleneoxy-
-1,4-phenylene(dimethylmethylene)-1,4-phenylene]

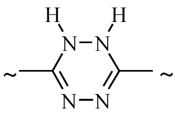
Note 2: Polysulfones that also comprise ether linkages in the backbone are more exactly classified as polyethersulfones. Similarly, other subclasses of polysulfones can be derived.

Note 3: *Polysulfonamides* (see 3.56) and polysulfonates are excluded.

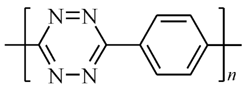
3.58 polytetrazine

Polymer composed of macromolecules containing tetrazine or hydrogenated tetrazine rings in the backbone:





Note 1: An example of a polytetrazine is:

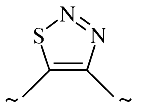


poly(1,2,4,5-tetrazine-3,6-diyl-1,4-phenylene)

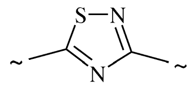
Note 2: A typical polytetrazine contains 1,2,4,5-tetrazine or hydrogenated 1,2,4,5-tetrazine rings since 1,2,3,4- and 1,2,3,5-tetrazine rings are unstable.

3.59 polythiadiazole

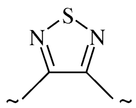
Polymer composed of macromolecules containing thiadiazole rings in the backbone:



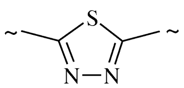
1,2,3-thiadiazole-4,5-diyl



1,2,4-thiadiazole-3,5-diyl

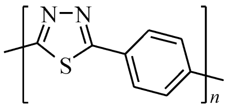


1,2,5-thiadiazole-3,4-diyl



1,3,4-thiadiazole-2,5-diyl

Note 1: An example of a polythiadiazole is:

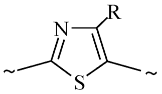


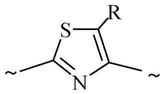
poly(1,3,4-thiadiazole-2,5-diyl-1,4-phenylene)

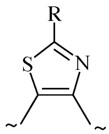
Note 2: Poly(1,2,3-thiadiazole-4,5-diyl) and poly(1,3,4-thiadiazole-2,5-diyl) are *conjugated polymers* (see 3.1).

3.60 polythiazole

Polymer composed of macromolecules containing thiazole rings in the backbone:

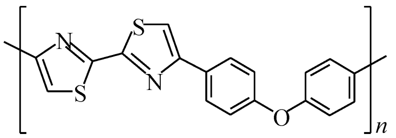






where R is hydrogen, alkyl, aryl, heteroaryl, substituted alkyl, substituted aryl, or substituted heteroaryl.

Note: An example of a polythiazole is:



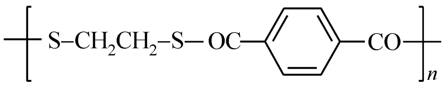
poly{[2,2'-bi(1,3-thiazole)]-4,4'-diyl-1,4-phenyleneoxy-1,4-phenylene}

3.61 polythioester

Polymer composed of macromolecules containing thiocarboxylate (thioester) linkages in the backbone:

–S–CO – or –O–CS – or –S–CS –

Note 1: An example of a polythioester is:



poly(sulfanediylethylenesulfanediylterephthaloyl)

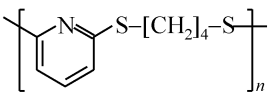
Note 2: A polymer containing only pendent thioester groups is excluded.

3.62 polythioether

Polymers composed of macromolecules containing thioether (sulfide) linkages in the backbone:

–S–

Note 1: An example of a polythioether is:



poly(pyridine-2,6-diylsulfanediylbutane-1,4-diylsulfanediyl)

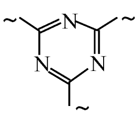
Note 2: A polymer containing only pendent thioether groups is excluded.

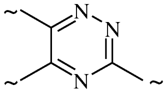
Note 3: A polymer with sulfanediylalkan-α,ω-diyl (formerly thioalkylene), sulfanediylarenediyl (formerly thioarylene), sulfanediylmethylene, or sulfanediylphenylene constitutional repeating units is classified more narrowly as a polythioalkylene, polythioarylene, polythiomethylene, or polythiophenylene.

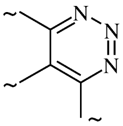
Note 4: A polymer with S_x ($x > 1$) linkages is a *polysulfide* (see 3.55).

3.63 polytriazine

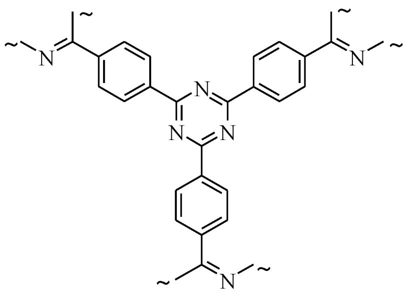
Polymer composed of macromolecules containing triazine rings in the backbone:







Note 1: A polytriazine is usually a branched or network polymer:



Note 2: A *polycyanurate* and an *amino polymer* prepared from 1,3,5-triazine-2,4,6-triamine (trivial name: melamine) are excluded; however, these polymers can be regarded as subclasses of polytriazines.

Note 3: A molecule of a typical polytriazine contains 1,3,5-triazine rings, however, polytriazines containing 1,2,4-triazine rings and, less likely, 1,2,3-triazine rings are also possible.

3.64 polyurea

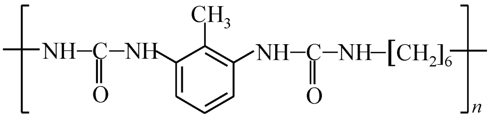
polyureylene

Polymer composed of macromolecules containing ureylene or N-substituted ureylene linkages in the backbone:

–NR–CO–NR–

where R is hydrogen, alkyl, aryl, heteroaryl, substituted alkyl, substituted aryl, or substituted heteroaryl.

Note 1: An example of a polyurea is:



poly[ureylene(2-methyl-1,3-phenylene)ureylenehexane-1,6-diyl]

Note 2: An *amino polymer* (see 2.2) prepared from urea and an aldehyde is excluded.

Note 3: A polymer containing only pendent ureylene groups is excluded.

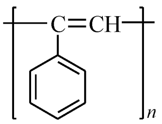
3.65 polyvinylene

Polymer composed of macromolecules containing exclusively ethene-1,2-diyl (formerly vinylene) or substituted ethene-1,2-diyl constitutional repeating units in the backbone:

$$(\text{–CR}^1\text{=CR}^2\text{–})_n$$

where R^1 and R^2 are each hydrogen or an alkyl, aryl, or heteroaryl group.

Note 1: An example of a polyvinylene is:



poly(1-phenylethene-1,2-diyl)
poly(phenylacetylene)

Note 2: Polyvinylenes are a subclass of *polyacetylenes*. Unsubstituted poly(ethene-1,2-diyl) is mostly referred to as polyacetylene.

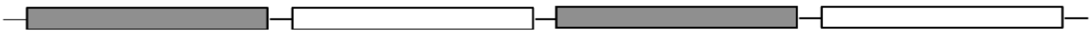
Note 3: Polyvinylenes are *conjugated polymers* (see 3.1).

4. CLASS NAMES BASED ON MOLECULAR ARCHITECTURE

4.1 block polymer

Polymer composed of macromolecules consisting of a linear sequence of two or more blocks (see definitions 1.26, 1.62, 2.22, and 2.24 in ref. [9] and definition in ref. [20]).

Note 1: A block polymer can be represented graphically as follows:

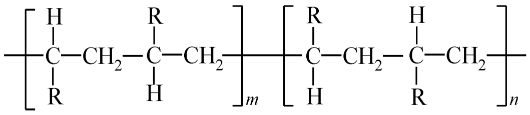


Note 2: A block polymer is a block homopolymer if all its blocks are derived from one species of monomer, or a block copolymer if its blocks are derived from two or more species of monomer.

Note 3: In a block homopolymer, particular blocks differ in structural features such as regularity or tacticity:

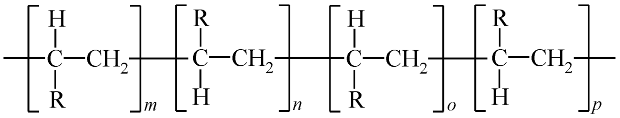
regular-A_k— irregular-A_m isotactic-A_k— syndiotactic-A_m

or the blocks of the same tacticity can be linked through a diad of a configuration different from that of the diads inside blocks; this gives rise to so-called stereoblock or segmented stereoblock homopolymers:



$$\left[\overset{\text{H}}{\underset{\text{R}}{\text{C}}}-\text{CH}_2-\overset{\text{R}}{\underset{\text{H}}{\text{C}}}-\text{CH}_2\right]_m\left[\overset{\text{R}}{\underset{\text{H}}{\text{C}}}-\text{CH}_2-\overset{\text{H}}{\underset{\text{R}}{\text{C}}}-\text{CH}_2\right]_n$$

distereoblock
syndiotactic homopolymer



$$\left[\overset{\text{H}}{\underset{\text{R}}{\text{C}}}-\text{CH}_2\right]_m\left[\overset{\text{R}}{\underset{\text{H}}{\text{C}}}-\text{CH}_2\right]_n\left[\overset{\text{H}}{\underset{\text{R}}{\text{C}}}-\text{CH}_2\right]_o\left[\overset{\text{R}}{\underset{\text{H}}{\text{C}}}-\text{CH}_2\right]_p$$

segmented stereoblock
isotactic homopolymer

Note 4: In a block copolymer, each block may consist of only one type of constitutional repeating unit, or it can comprise two or more different constitutional units.

-A-A-A-A-A-A-A-A— B-B-A-B-A-A-B-B-B-A-B- A-(BA) diblock copolymer

Copolymer is defined as polymer derived from more than one species of monomers (see definition 2.5 in ref. [9] reprinted as Chapter 1 in ref. [10] and definition in ref. [20]).

Note 5: According to the number of blocks present in their macromolecules, block polymers are divided into diblock, triblock, tetrablock, …, multiblock polymers. Multiblock polymers are often referred to as segmented polymers.

Note 6: The order of blocks along a block polymer molecule is usually specified as follows (in the representations, A, B, and C indicate monomeric units of different chemical or other structural features):

...-A-A-A-A-A-A—B-B-B-B-B-B-...	A-B diblock (co)polymer
...-A-A-A-A-A-A—B-B-B-...-B-B-B—C-C-C-C-C-C-...	A-B-C triblock (co)polymer
...-A-A-A-A-A-A—B-B-B-...-B-B-B—A-A-A-A-A-A-...	A-B-A triblock (co)polymer
$(A_i)–(B_n)–(A_j)–(B_n)–(A_k)–(B_n)–...$ i.e. $[(A_k)–(B_m)]_n$	A-B multiblock (co)polymer [A-B segmented (co)polymer]

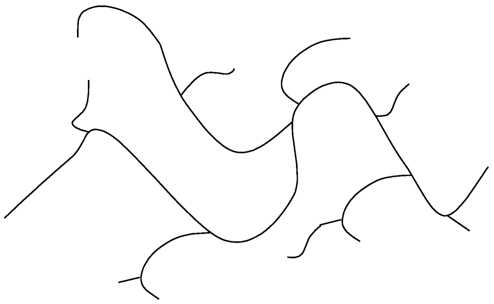
and names of block polymers are derived in accordance with that representation, e.g.: poly(A)-*block*-poly(B)-*block*-poly(C) for an A-B-C triblock polymer (not poly(A-*block*-B-*block*-C); see rule 5.1 in ref. [17] reprinted as Chapter 19, ref. [10] and definitions in ref. [20]).

Note 7: Complex classification of a block polymer also includes specification of the number of species of monomers from which the block polymer is derived; for a copolymer, this number is specified by the prefix derived from Latin number: bi-, ter-, quarter-, ... (while the number of blocks is specified by the Greek prefix: di-, tri-, tetra-, ...). Examples are: A-B diblock homopolymer, A-B diblock bipolymer, A-B-A triblock bipolymer, A-B-C triblock terpolymer, A-B-A-C-A-D hexablock quarterpolymer, etc.; hyphens are often omitted, e.g., ABACAD hexablock quarterpolymer.

4.2 branched polymer

Polymer composed of macromolecules with branched main chains.

Note 1: A molecule of a branched polymer can be represented graphically as follows:



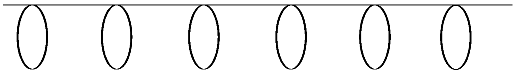
Note 2: Branched polymers are polymers composed of macromolecules having a linear main chain from which one or more oligomeric or polymeric offshoots (side chains, branches) emanate (see definitions 1.33 and 2.34 in ref. [9] and definition in ref. [20]).

Note 3: Polymer molecules can be branched randomly (or statistically), which is the case of randomly (or statistically) branched polymers, or the branching can have some order giving to polymer molecules a formal shape corresponding to a pattern, according to which such polymers are classified as, e.g., *comb polymers* (see 4.5), *dendritic polymers* (see 4.6), *graft polymers* (see 4.8), *hyperbranched polymers* (see 4.10), and *star polymers* (see 4.18), which all are subclasses of branched polymers.

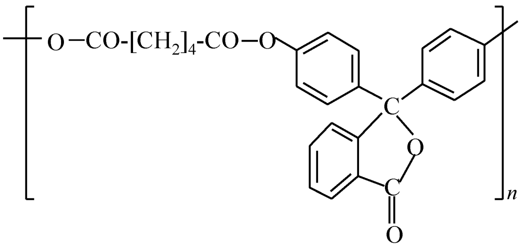
4.3 cardo polymer

Polymer composed of macromolecules consisting of a single-strand main chain and many ring units, each having one atom in common with the main chain.

Note 1: A cardo polymer can be represented graphically as follows:



Note 2: An example of a cardo polymer is:



poly[oxyadipoyloxy-1,4-phenylene(3-oxo-1,3-dihydro-2-benzofuran-1,1-diyl)-1,4-phenylene]

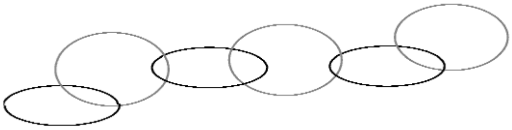
Note 3: A cardo polymer can also be defined as a polymer composed of macromolecules containing loop-like cyclic side groups, one ring atom of which is part of the backbone.

Note 4: The adjective “cardo” is derived from the Latin word for heart because the cyclic unit, together with adjacent parts of the main chain, resembles the shape of a heart with arteries.

4.4 catenane polymer

Polymer composed of macromolecules consisting of physically catenated macrorings that have no atom in common and cannot be separated unless chemical bonds are broken.

Note 1: A catenane polymer can be graphically represented as follows:



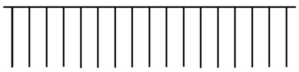
Note 2: A catenane-polymer main chain resembles a jewelry or technical chain of physically interlocked rings.

Note 3: A catenane polymer can be a linear, branched, or network polymer.

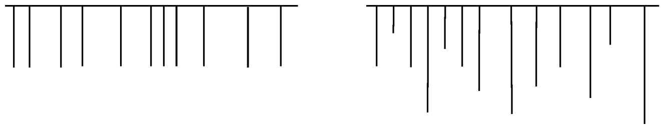
4.5 comb polymer

Polymer composed of macromolecules consisting of a linear main chain from which a large number of linear oligomeric side chains emanate, so resembling a comb-like shape in the planar projection.

Note 1: A comb polymer can be represented graphically as follows:



regular comb macromolecule



irregular comb macromolecules

Note 2: Comb polymers are polymers composed of macromolecules comprising a main chain with multiple trifunctional branch points from each of which a linear side chain emanates (see definitions 1.52 and 2.33 in ref. [9] and definition in ref. [20]).

Note 3: A comb polymer where we also know the position of the branches is usually referred to as an exact comb polymer.

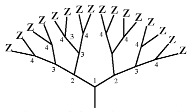
Note 4: A comb polymer can also be regarded as a graft polymer; however, the density of side chains is typically much higher and constitutional repeating units in the main chain (except for branching units) and side chains need not be different in a comb polymer.

Note 5: A comb macromolecule in which branching points along a chain are separated by a few atoms only, typically by one atom, acquires the shape of a brush due to steric reasons and, therefore, it is usually referred to as a brush macromolecule. A polymer composed of such macromolecules is usually called a brush polymer.

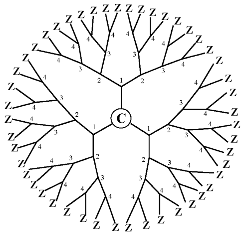
Note 6: Comb polymers are a subclass of *branched polymers* (see 4.2).

4.6 dendritic polymer

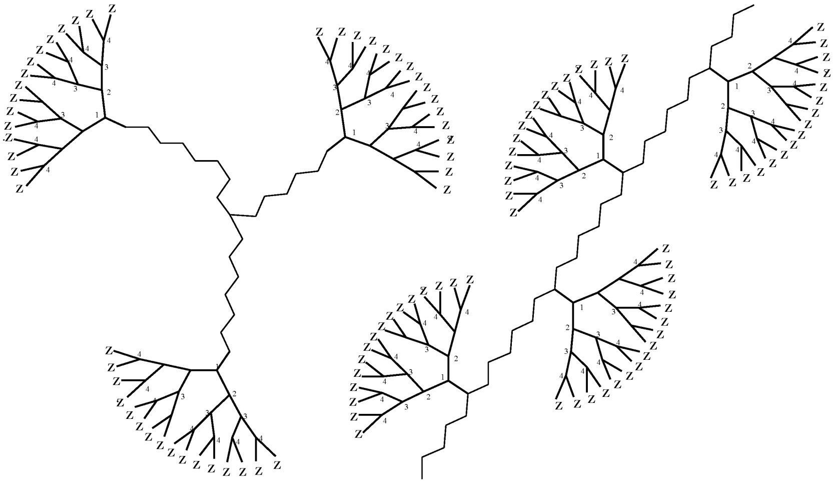
Polymer composed of molecules containing one or more subchains with regular, cascade-like branching architecture, which are referred to as dendrons.



dendron of fourth generation composed of constitutional repeating units of connectivity 3 and terminal units Z



dendrimer of fourth generation composed of three dendrons given above emanating from a core unit C



examples of more complicated dendritic polymer molecules; the molecules of the structure type shown are usually referred to as the dendristar (on the left) or the dendrigraft (on the right) molecules

Note 1: A single, regularly branched chain exclusively consisting of constitutional repeating units of connectivity three or higher and a number of terminal units Z is called a dendron.

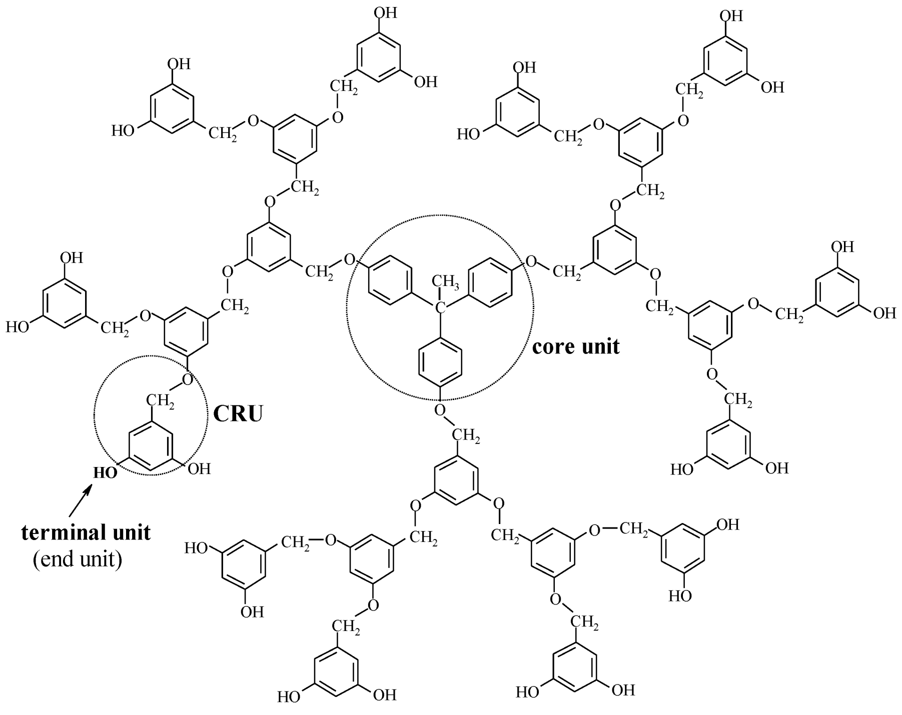
Note 2: The term “dendron” is also used for naming the simplest possible dendrimer having a core unit with connectivity one.

Note 3: Connectivity of a constitutional unit is equal to the number of connections through which the constitutional unit is built in a molecule.

Note 4: A molecule of a dendritic polymer consisting of one or more dendrons emanating from a single non-repeating unit, referred to as a core unit, is called a dendrimer.

Note 5: Constitutional repeating units linked directly to the core unit are referred to as the constitutional repeating units of the first generation; the constitutional repeating units forming the next layer are of the second generation, etc. (see numbers in the scheme of a dendrimer of fourth generation shown above).

Note 6: An example of the chemical structure of a dendrimer is:



α-[ethane-1,1,1-triyltri(1,4-phenylene)]-ω-hydroxy-*dendro*-(oxymethylenebenzene-1,3,5-triyl)

core unit

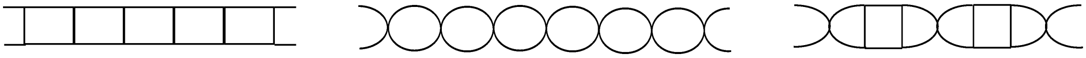
terminal units
(end units)

constitutional repeating units
(CRU)

Note 7: Dendritic polymers are a subclass of *branched polymers* (see 4.2).

4.7 double-strand polymer

Polymers composed of virtually linear macromolecules consisting of two single-strand subchains multiply connected by a short transverse linkage, or a single atom in common, or both.

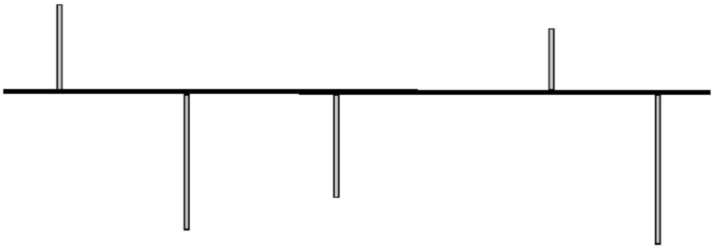


Note 1: Polymers composed of macromolecules comprising constitutional units connected in such a way that adjacent constitutional units are joined to each other through three or four atoms, two on one side and either one or two on the other side of each constitutional unit (see definitions 1.40, 1.41, and 2.30 in ref. [9] and definition in ref. [20]).

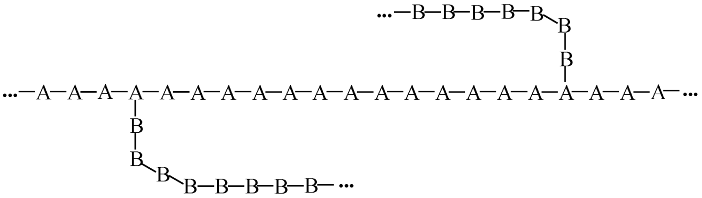
Note 2: *Ladder polymers* (see 4.11) and *spiro polymers* (see 4.17) are subclasses of double-strand polymers.

4.8 graft polymer

Polymer composed of branched or comb-like macromolecules, in which chemical constitution of the side chains differs from that of the main chain.



Note 1: Graft polymers are polymers composed of macromolecules with one or more species of block connected to the main chain as side chains, these side chains having constitutional or configurational features that differ from those in the main chain (see definitions 1.28, 2.23, and 2.26 in ref. [9] and definition in ref. [20]), for example:

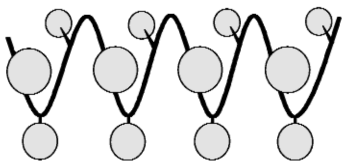


where A and B are constitutional repeating units that differ in the chemical structure, configurational arrangement, or both.

Note 2: Graft polymers are a subclass of *branched polymers* (see 4.2).

4.9 helical polymer

Polymer composed of macromolecules that adopt partly or completely a helical conformation.

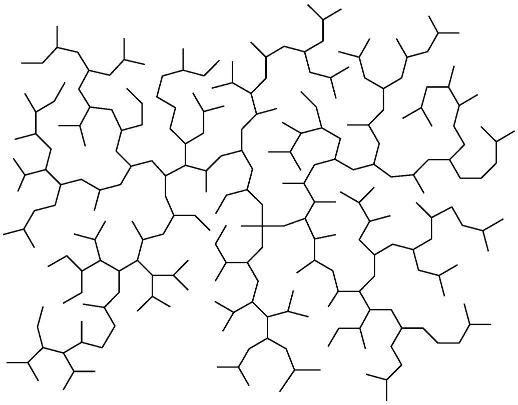


Note 1: Biopolymers such as nucleic acids, amylose, and some proteins are typical helical polymers.

Note 2: A helical structure is generated by regularly repeating rotations around the backbone bonds of a linear macromolecule (see definition 2.6 in ref. [10], chapter 4).

4.10 hyperbranched polymer

Polymer composed of highly branched macromolecules in which any linear subchain may lead in either direction to at least two other subchains.



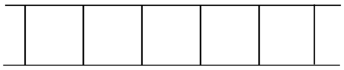
Note 1: A hyperbranched polymer molecule can also have a core unit (4.6).

Note 2: Macrocycles can also occur in a real hyperbranched macromolecule.

Note 3: Hyperbranched polymers are a subclass of *branched polymers* (see 4.2); mostly they are randomly branched polymers.

4.11 ladder polymer

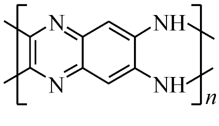
Polymer composed of double-strand macromolecules in which two parallel single-strand chains are multiply connected with a short transverse linkage, so resembling a ladder by the shape in the planar projection.



Note 1: Ladder polymers are polymers composed of double-strand macromolecules consisting of an uninterrupted linear sequence of rings, with adjacent rings having two or more atoms in common (see definitions 1.44, 1.45, and 2.30 in ref. [9] and definition in ref. [20]).

Note 2: Ladder polymers are a subclass of *double-strand polymers* (see 4.7) as well as a subclass of *linear polymers* (see 4.12).

Note 3: An example of ladder polymer is:



poly[(quinoxaline-2,3:6,7-tetrayl)-6,7-diimino]

Note 4: An imperfect ladder polymer, in molecules of which single-strand linkages occur between ladder sequences, is commonly referred to as a semiladder polymer.

4.12 linear polymer

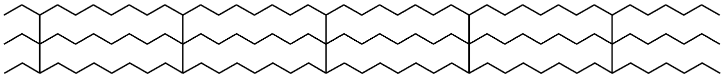
Polymer composed of macromolecules, the cross-section of which is negligible compared to the contour length.

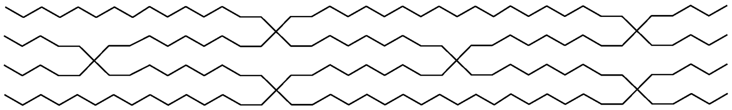
Note 1: Linear polymers are polymers composed of macromolecules, the structure of which essentially comprises the multiple repetition in linear sequence of units derived, actually or conceptually, from molecules of low relative molecular mass (see definitions 1.6, 1.32, 2.27, and 2.28 in ref. [9] and definition in ref. [20]).

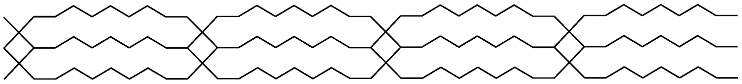
Note 2: *Single-strand polymers* (see 4.16)*, double-strand polymers* (see 4.7), *multi-strand polymers* (see 4.13), *ladder polymers* (see 4.11), *and spiro polymers* (see 4.17) are subclasses of linear polymers.

4.13 multi-strand polymer

Polymer composed of linear macromolecules consisting of three or more parallel single-strand chains multiply connected by short transverse linkages, or single atoms in common, or both.







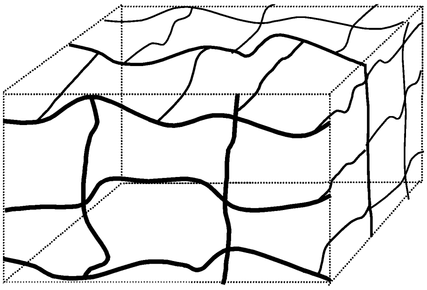
Note 1: Multi-strand polymers are polymers composed of macromolecules comprising constitutional units connected in such a way that adjacent constitutional units are joined to each other through more than four atoms, more than two on at least one side of each constitutional unit (see definitions 1.46 and 1.47 in ref. [9] and definition in ref. [20]).

Note 2: Multi-strand polymers are a subclass of *linear polymers* (see 4.12).

4.14 network polymer

polymer network

Polymer composed of macromolecule(s) consisting of a large number of conjoined macrocycles, each having at least three subchains in common with neighboring macrocycles.



Note 1: Network is defined (see definitions 1.58 and 2.41 in ref. [9] and definition in ref. [20]) as a highly ramified macromolecule in which essentially each constitutional unit is connected to each other constitutional unit and to the macroscopic phase boundary by many permanent paths through the macromolecule, the number of such paths increasing with the average number of intervening bonds.

Note 2: Some pendent linear and branched chains with free ends commonly occur in network polymers.

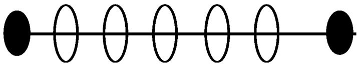
Note 3: A network polymer prepared by a cross-linking of an original linear or branched polymer is commonly named on the process-based principle as a cross-linked polymer.

Note 4: A polymer network of colloidal dimensions is referred to as a micronetwork (see definition 1.60 in ref. [9]).

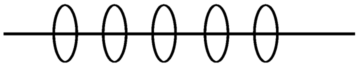
Note 5: A swollen network polymer is a gel; a swollen micronetwork is a microgel.

4.15 rotaxane polymer

Polymer composed of complex macromolecules consisting of cyclic molecules threaded by a linear macromolecule that is eventually capped with bulky end units preventing dethreading of cyclic molecules.



rotaxane

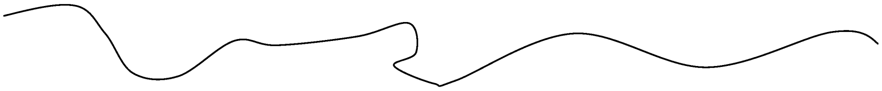


pseudorotaxane

Note: A rotaxane polymer composed of molecules without bulky end-groups on the central macromolecule is usually referred to as a pseudorotaxane polymer.

4.16 single-strand polymer

Polymer composed of macromolecules consisting of a single linear chain:

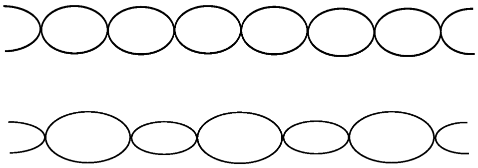


Note 1: Single-strand polymers are polymers composed of macromolecules comprising constitutional units connected in such a way that adjacent constitutional units are joined to each other through two atoms, one on each constitutional unit (see definitions 1.38, 1.39, and 2.29 in ref. [9] and definition in ref. [20]).

Note 2: Single-strand polymers are a subclass of *linear polymers.*

4.17 spiro polymer

Polymer composed of double-strand macromolecules consisting of two single-strand subchains multiply connected by a single atom in common.



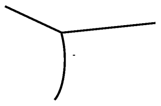
Note 1: Polymers composed of double-strand macromolecules consisting of an uninterrupted linear sequence of rings, with adjacent rings having only one atom in common (see definitions 1.42 and 1.43 in ref. [9] and definition in ref. [20]).

Note 2: Spiro polymers are a subclass of *linear polymers* (see 4.12) and a subclass of *double-strand polymers* (see 4.7).

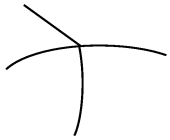
Note 3: For polymers consisting of cyclic macromolecules, the definition of a spiro macromolecule is: macromolecule having one atom as the only common member of two macrocycles (see definition CM-1.17 in ref. [21]).

4.18 star polymer

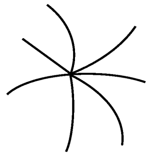
Polymer composed of branched macromolecules containing only one common branch unit, so resembling a star by shape.



three-star macromolecule
(three-arm star macromolecule)



four-star macromolecule
(four-arm star macromolecule)



seven-star macromolecule
(seven-arm star macromolecule)

Note 1: Star polymers are polymers composed of macromolecules containing a single branch point (either a single atom or a group of atoms) from which three or more linear chains (arms) emanate (see definitions 1.51 and 2.32 in ref. [9] and definition in ref. [20]).

Note 2: A star macromolecule with *n* linear chains (arms) attached to the branch point is termed an *n*-star macromolecule (see definition 1.51 in ref. [9] and definition in ref. [20]) or *n*-arm star macromolecule (in literature).

Note 3: A polymer composed of star macromolecule having chemically different arms is often referred to as miktoarm star polymer, e.g., 3-miktoarm star terpolymer (star-ABC polymer).

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6. ALPHABETICAL INDEX OF TERMS

(bold characters refer to main entries)