

SOURCE-BASED NOMENCLATURE FOR SINGLE-STRAND HOMOPOLYMERS AND COPOLYMERS (IUPAC Recommendations 20XX)*

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Abstract: IUPAC recommendations on source-based nomenclature for single-strand polymers have so far addressed its application mainly to copolymers, non-linear polymers and polymer assemblies, and within generic source-based nomenclature of polymers. In this document, rules are formulated for devising a satisfactory source-based name for a polymer, whether homopolymer or copolymer, which are as clear and rigorous as possible. Thus, the source-based system for naming polymers is presented in a totality that serves as a user-friendly alternative to the structure-based system of polymer nomenclature. In addition, because of their widespread and established use, recommendations for the use of traditional names of polymers are also elaborated.

Keywords:

IUPAC nomenclature; polymer nomenclature; source-based names; monomer; apparent monomer; homopolymer; copolymer; end-groups; traditional names.

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SB-0 INTRODUCTION

A polymer can be named in one of two principal ways by using either the 'Source-based' or the 'Structure-based' systems of nomenclature. Source-based nomenclature does not contain information on the structure of the polymer it names. To draw a polymer structure from a source-based name, knowledge of the chemistry of the polymerization process is required. Structure-based nomenclature is in many cases more complicated but allows the drawing of the polymer structure directly from the name without requiring knowledge of the chemistry involved in the polymer formation.

The general principle that systematic chemical nomenclature should reflect the real structure of compounds to be named is fulfilled in the case of organic polymers through the use of structure-based nomenclature in which the strict rules of IUPAC organic nomenclature are adapted to the naming of the constitutional units of a polymer. Under the auspices of either the former Commission on Macromolecular Nomenclature or the present day Chemical Nomenclature and Structure Representation Division, IUPAC has published four documents [1 - 4] on structure-based nomenclature which enable the naming of most organic polymers. Typically, regardless of how it might have been formed, a polymer known to comprise constitutional repeating units with the formula $-\text{CH}(\text{C}_6\text{H}_5)\text{CH}_2-$ would be named poly(1-phenylethylene) or, alternatively, poly(1-phenylethane-1,2-diyl). However, despite the rigour afforded by the structure-based system, over many years scientists in both industry and academia have continued to use the so-called source-based system of polymer nomenclature and they still favour it for being familiar, simpler to apply and for most purposes more immediately comprehensible (see Appendix SB-7). Under the source-based system, the above structure

would probably have been prepared (sourced) from the monomer styrene and is therefore named polystyrene. As a consequence of the continuing use of this system of polymer nomenclature, the present day IUPAC Polymer Division and the Chemical Nomenclature and Structure Representation Division accepted it as an alternative official nomenclature for polymers. However, although the former Commission had produced documents on the source-based nomenclature of linear copolymers [5], the source-based nomenclature of non-linear polymers and polymer assemblies [6], and generic source-based polymer nomenclature [7], to date there has been no document that formalises in any detail the source-based nomenclature of single-strand (linear) homopolymers.

In this document, rules for generating source-based names of single-strand polymers are elaborated and, since the system has commonly used names for monomers that are no longer retained in IUPAC nomenclature, guidelines for the use of traditional polymer names are presented. In order that rules for all single-strand polymers are collected together in a single document, the content of the recommendations on 'Source-Based Nomenclature for Copolymers' [5] is updated and included here.

Though the IUPAC recommendations for 'Source-Based Nomenclature for Non-Linear Macromolecules and Macromolecular Assemblies' [6], which describe non-linear polymer structures (branched, crosslinked, etc.) and polymer assemblies, are given better foundation by the content of the present document, they are not included here. Generic source-based polymer nomenclature is also not addressed and the earlier recommendations, 'Generic Source-Based Nomenclature for Polymers' [7], should now be viewed as dealing with some additional issues not covered herein. However, refs. [6] and [7] should only be used as if they were revised according to recommendations in the current document and ref. [8].

In the present document, terminology is used much of which derives from usage in the so-called IUPAC 'Blue Book', 'Nomenclature of Organic Chemistry' [8]. The relevant terms and their meanings are as follows:

Preferred IUPAC name (PIN)

A name preferred among two or more names generated from two or more IUPAC recommendations including the many synonyms that have been coined and used over the years.

General IUPAC nomenclature

The principles, rules, and conventions by which IUPAC names other than preferred IUPAC names (PINs) are generated.

Traditional name

A name in common use within one or more sectors of the chemical community.

Retained name

A traditional name or a name in common use either as the preferred IUPAC name or as an alternative name in general IUPAC nomenclature.

SB-1 DEFINITIONS

Cross references to terms defined elsewhere in this section are denoted in *italic* typeface. If there are two terms in an entry on successive lines, the second is a synonym.

SB-1.1 apparent monomer

Monomer which from the name of a polymer appears to have been used in the synthesis of the latter when it has actually been prepared from different precursor(s). See also Section SB-2.1.1.

Note: The term replaces both of the formerly used terms ‘hypothetical monomer’ and ‘implicit monomer’ [5, 9].

SB-1.2 block

Portion of a *macromolecule*, comprising many *constitutional units*, that has at least one constitutional or configurational feature which is not present in the adjacent portions [9].

Note: Where appropriate, definitions relating to *macromolecule* may also be applied to block.

SB-1.3 chain

Whole or part of a *macromolecule*, an *oligomer molecule*, or a *block*, comprising a linear or branched sequence of *constitutional units* between two boundary *constitutional units*, each of which may be either an *end-group*, a branch point, or an otherwise-designated characteristic feature of the *macromolecule* [9].

Note 1: Except in linear single-strand *macromolecules*, the definition of a chain may be somewhat arbitrary.

Note 2: A cyclic *macromolecule* has no *end-groups* but may nevertheless be regarded as a chain.

Note 3: Any number of branch points may be present between the boundary units.

Note 4: Where appropriate, definitions relating to *macromolecule* may also be applied to chain.

SB-1.3.1 main chain

backbone

That linear *chain* to which all other *chains*, long or short or both, may be regarded as being pendant [9].

SB-1.3.2 side chain

Oligomeric or polymeric offshoot from a macromolecular *chain* [9].

SB-1.4 chain polymerization

Chain reaction in which the growth of a polymer *chain* proceeds exclusively by the reaction or reactions between a *monomer* or *monomers* and a reactive site or reactive sites on the polymer *chain* with regeneration of the reactive site or reactive sites at the end of each growth step [9].

Note 1: A chain polymerization consists of initiation and propagation reactions, and may also include termination and chain-transfer reactions.

Note 2: The adjective ‘chain’ in chain polymerization denotes a chain reaction rather than a polymer *chain*.

Note 3: The term chain polymerization may be qualified further, if necessary, to specify the type of chemical reactions involved in the growth step, e.g., radical chain polymerization, anionic chain polymerization, cationic chain polymerization.

SB-1.5 constitutional unit

Atom or group of atoms (with pendant atoms or groups, if any) comprising a part of the essential structure of a *macromolecule*, an *oligomer molecule*, a block or a chain [9].

SB-1.6 constitutional repeating unit (CRU)

Smallest constitutional unit, the repetition of which constitutes a *regular macromolecule*, a regular *oligomer molecule*, a regular block or a regular chain [9].

SB-1.7 copolymer

Polymer derived from more than one species of *monomer* or *apparent monomer*.

Note 1: Copolymers that are obtained by copolymerization of two *monomer* species are sometimes termed bipolymers, those obtained from three *monomers* terpolymers, those obtained from four *monomers* quaterpolymers, etc.

Note 2: Adapted from the definition in [9].

SB-1.7.1 alternating copolymer

Copolymer consisting of *macromolecules* comprising two species of *monomeric units* in alternating sequence.

Note 1: An alternating *copolymer* may be considered as a *homopolymer* derived from an *apparent monomer*.

Note 2: Adapted from the definition in [9].

SB-1.7.2 block copolymer

Copolymer that is comprised of *blocks* in linear sequence.

Note 1: In the constituent *macromolecules* of a block copolymer, adjacent *blocks* are constitutionally different, i.e., adjacent *blocks* comprise *constitutional units* derived from different species of *monomer* or from the same species of *monomer* but with a different composition or sequence distribution of *constitutional units*.

Note 2: Adapted from the definition in [9].

SB-1.7.3 graft copolymer

Copolymer that is a *graft polymer* [9].

Note: In the constituent *macromolecules* of a graft copolymer, adjacent *blocks* in the *main chain* or *side-chains*, or both, are constitutionally different, i.e., adjacent *blocks* comprise *constitutional units* derived from different species of *monomer* or from the same species of *monomer* but with a different composition or sequence distribution of *constitutional units*.

SB-1.7.4 periodic copolymer

Copolymer consisting of *macromolecules* comprising more than two species of *monomeric units* in regular sequence [9].

SB-1.7.5 random copolymer

Copolymer consisting of *macromolecules* in which the probability of finding a given *monomeric unit* at any given site in the *chain* is independent of the nature of the adjacent units [9].

Note: In a random *copolymer*, the sequence distribution of *monomeric units* follows Bernoullian statistics.

SB-1.7.6 statistical copolymer

Copolymer consisting of *macromolecules* in which the sequential distribution of the *monomeric units* obeys known statistical laws [9].

Note: An example of a statistical *copolymer* is one consisting of *macromolecules* in which the sequential distribution of *monomeric units* follows Markovian statistics.

SB-1.8 end group

Constitutional unit that is an extremity of a *macromolecule* or *oligomer molecule* [9].

SB-1.9 graft polymer

Polymer comprising *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 also *graft homopolymer*.

Note: Adapted from definitions 1.28 and 2.23 in [9].

SB-1.10 homopolymer

Polymer derived from one species of a real *monomer* or an *apparent monomer*.

Note: Adapted from the definition in [9].

SB-1.10.1 block homopolymer

Homopolymer that is composed of *macromolecules* comprising *blocks* that have at least one constitutional or configurational feature which is not present in the adjacent portions.

Note: Adapted from definitions 1.26 and 2.22 in [9].

SB-1.10.2 graft homopolymer

Homopolymer comprising *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*.

Note: Adapted from definitions 1.28, 1.30, 1.34 and 2.23 in [9].

SB-1.11 irregular polymer

Polymer composed of irregular *macromolecules*, the structures of which essentially comprise the repetition of more than one type of *constitutional unit*, or *macromolecules* the structures of which comprise *constitutional units* not all connected identically with respect to directional sense.

Note: Adapted from definitions 1.5 and 2.16 in [9].

SB-1.12 locant

Numerical or letter that identifies position in a structure [1].

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Note: A locant appears in a name or general expression such as ‘2-substituted’.

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SB-1.13 macromolecule
polymer molecule

Molecule of high relative molecular mass, the structure of which essentially comprises the multiple repetition of units derived, actually or conceptually, from molecules of low relative molecular mass [9].

SB-1.13.1 regular macromolecule

Macromolecule, the structure of which essentially comprises the repetition of a single *constitutional unit* with all units connected identically with respect to directional sense [9].

SB-1.14 monomer

Substance composed of *monomer molecules* [9].

SB-1.15 monomeric unit
monomer unit

Largest *constitutional unit* contributed by a single *monomer molecule* to the structure of a *macromolecule* or *oligomer molecule* [9].

Note: The largest *constitutional unit* contributed by a single *monomer molecule* to the structure of a *macromolecule* or *oligomer molecule* may be described as either monomeric, or by monomer used adjectivally.

SB-1.16 monomer molecule

Molecule which contributes *constitutional units* to the essential structure of a *macromolecule*.

Note: Corrected from [9] in which the definition implies that a single molecule can undergo polymerization.

SB-1.17 oligomer molecule
oligomeric molecule

Molecule of intermediate relative molecular mass, the structure of which essentially comprises a small plurality of units derived, actually or conceptually, from molecules of lower relative molecular mass [9].

Note 1: A molecule is regarded as having an intermediate relative molecular mass if it has properties which do vary significantly with the removal of one or a few of the units.

Note 2: If a part or the whole of the molecule has an intermediate relative molecular mass and essentially comprises a small plurality of units derived, actually or conceptually, from molecules of lower relative molecular mass, it may be described as oligomeric, or by 'oligomer' used adjectivally.

SB-1.18 polyaddition

Polymerization in which the growth of polymer chains proceeds by addition reactions between molecules of all degrees of polymerization [9].

SB-1.19 polycondensation

Polymerization in which the growth of polymer chains proceeds by condensation reactions between molecules of all degrees of polymerization [9].

SB-1.20 regular polymer

Polymer composed of *regular macromolecules*, regular star *macromolecules* or regular comb *macromolecules* [9].

SB-1.21 ring-opening polymerization

Polymerization in which a cyclic *monomer* yields a *monomeric unit* which is acyclic or contains fewer cycles than the *monomer* [9].

Note: If the *monomer* is polycyclic, the opening of a single ring is sufficient to classify the reaction as a ring-opening polymerization.

SB-1.22 single-strand polymer

Polymer, the *macromolecules* of which are single-strand *macromolecules*, i.e. *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* [1,9].

SB-1.23 stereodescriptor

Prefix to specify configuration (absolute or relative) or conformation.

Note: Typical examples are *R*, *S*; *r*, *s*; *P*, *M*; *Re*, *Si*; *E*, *Z*; *ap*, *sp*; *t*, *g*₊, *g*₋, *D*, *L* [10].

SB-2 SOURCE-BASED NAMES OF HOMOPOLYMERS**SB-2.1 Monomer names***Rule 1*

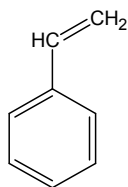
The monomer names recommended for use in the source-based nomenclature of polymers shall be the systematic names or retained trivial names presently recommended by the IUPAC rules of organic and inorganic nomenclature [8,11].

Note 1: Where there are alternative names it is recommended that the preferred IUPAC name (PIN) is used.

Note 2: There is a limited number of commonly encountered inorganic monomers. Within source-based polymer nomenclature it is recommended that these are named in accordance with the IUPAC rules of inorganic nomenclature [11] but where there are alternative names it is proposed that the one closer to organic-chemical usage is used.

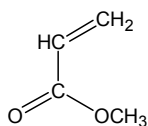
Examples

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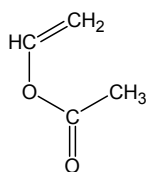
styrene (PIN)

1.2

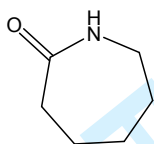


methyl acrylate

1.3

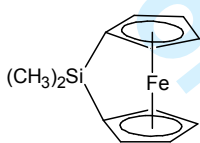
vinyl acetate
ethenyl acetate (PIN)

1.4



azepan-2-one (PIN)

1.5



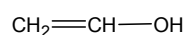
1,1'-(dimethylsilanediyl)ferrocene

SB-2.1.1 Apparent monomers

Sometimes the structure of a polymer makes it appear that it might have been made by the polymerization of a monomer which has either not been used or might not even exist. Such a monomer is known as an apparent monomer. For example, poly(vinyl alcohol) has a repeating unit which suggests that it is the polymerization product of the monomer vinyl alcohol [12], the unstable enolic tautomer of acetaldehyde depicted in Example 1.6. However, the monomer normally used in the preparation of this polymer is vinyl acetate that polymerizes to poly(vinyl acetate), after which hydrolysis gives poly(vinyl alcohol). Likewise, the polymer traditionally known by the name poly(lactic acid) has a repeating unit that suggests that it is the product of the ring-opening polymerization of the unknown cyclic monomer depicted in Example 1.7. A similar situation applies to poly[*N,N'*-(hexane-1,6-diyl)hexanediamide], i.e., nylon 6,6, which might be considered to be the polymerization product of the cyclic monomer, *N,N'*-(hexane-1,6-diyl)hexanediamide, depicted in Example 1.8. Another such instance is that of poly(ethylene terephthalate) which appears to be the polymerization product of the cyclic monomer, ethylene terephthalate, depicted in Example 1.9, which in theory might be prepared by the cyclization of ethylene glycol and terephthalic acid. Likewise, a polymer prepared from 2,6-dimethylphenol through oxidative coupling polymerization is traditionally named poly(2,6-dimethyl-1,4-phenylene oxide), apparently derived from the non-existent monomer, 2,6-dimethyl-1,4-phenylene oxide, depicted in Example 1.10, rather than poly(2,6-dimethylphenol).

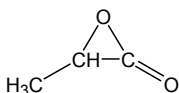
Examples

1.6



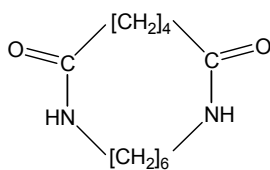
vinyl alcohol

1.7

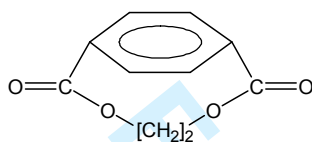


3-methyloxiran-2-one

1.8

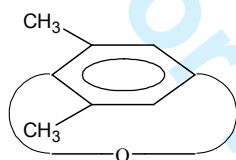
*N,N'*-(hexane-1,6-diyl)adipamide

1.9



ethylene terephthalate

1.10



2,6-dimethyl-1,4-phenylene oxide

SB-2.2 Source-based names of homopolymers formed by chain polymerization, ring-opening polymerization or polyaddition

Rule 2

The source-based name of a homopolymer formed by chain polymerization, ring-opening polymerization or polyaddition is made by prefixing the monomer name with 'poly'. The name of the monomer is parenthesized if it consists of more than one word, includes one or more locants or stereodescriptors, or ambiguity in meaning can arise.

Note 1: Ambiguity can in most cases arise if the monomer name starts with a part or prefix that can be multiplied to produce a different monomer, e.g. poly(chlorostyrene) is a polymer whereas polychlorostyrene might be a multi-substituted styrene monomer.

Note 2: Depending on the polymerization conditions, a single monomer may give rise to two or more polymer structures, as in the case of buta-1,3-diene. In this instance, it is possible to induce the polymerization to proceed almost exclusively by 1,4- or 1,2- addition of the monomer to the growing chain. Both products are regular homopolymers, but with different repeating units. However, under different polymerization conditions, combinations of the 1,4- and 1,2- modes of polymerization lead to irregular homopolymers. Accordingly, in instances such as these in which a certain monomer can contribute two or more types of constitutional unit to the polymer structure, the nominal distinction between the different products is made by using generic source-based nomenclature [7] or structure-based nomenclature [3].

Note 3: When a cyclic monomer is an oligomer (dimer, trimer, etc.) of a smaller monomer then the constitutional repeating unit will be deemed to be derived from the smaller monomer. For example, the monomer trioxane is a cyclic trimer of formaldehyde so the polymer derived from it is named polyformaldehyde and not polytrioxane.

Note 4: The specification of quantitative properties of a polymer, such as relative molecular mass, degree of polymerization, or, in the case of copolymers, composition, is not usually incorporated in a polymer name

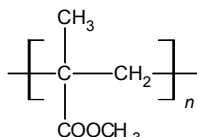
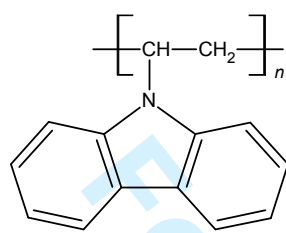
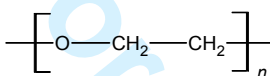
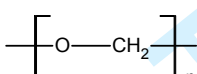
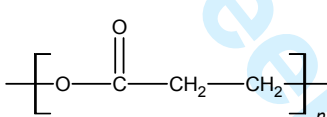
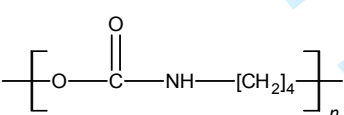
but if relevant may be added afterwards in parentheses. Thus, for example, one can write ‘polystyrene (30 200 $M_{r,n}$)’ (see Ref. 12, p. 49) to indicate a polymer of styrene with a number-average relative molecular mass of 30 200. For full details, the reader is referred to Section 8 of reference 5.

Examples

- 2.1 $\left[\text{CH}_2 - \text{CH}_2 \right]_n$ polyethene
- 2.2 $\left[\begin{array}{c} \text{CH} - \text{CH}_2 \\ | \\ \text{CH}_3 \end{array} \right]_n$ polypropene
- 2.3 $\left[\begin{array}{c} \text{CH} - \text{CH}_2 \\ | \\ \text{CN} \end{array} \right]_n$ polyacrylonitrile
- 2.4 $\left[\begin{array}{c} \text{CH} - \text{CH}_2 \\ | \\ \text{OH} \end{array} \right]_n$ poly(vinyl alcohol)
- 2.5 $\left[\text{CH} = \text{CH} - \text{CH}_2 - \text{CH}_2 \right]_n$ poly(buta-1,3-diene)

Note: The preferred graphic representation of the polymer is with the double bond in the 1-position (lowest possible locant for unsaturation), i.e., that which corresponds to the structure-based name poly(but-1-ene-1,4-diyl) [1,13].

- 2.6 $\left[\begin{array}{c} \text{CH} - \text{CH}_2 \\ | \\ \text{C}_6\text{H}_5 \end{array} \right]_n$ polystyrene
- 2.7 $\left[\begin{array}{c} \text{CH} - \text{CH}_2 \\ | \\ \text{C}_6\text{H}_4 - \text{CH}_3 \end{array} \right]_n$ poly(3-methylstyrene)
- 2.8 $\left[\begin{array}{c} \text{CH}_3 \\ | \\ \text{C} - \text{CH}_2 \\ | \\ \text{C}_6\text{H}_5 \end{array} \right]_n$ poly(isopropenylbenzene)

- 2.9  poly(methyl methacrylate)
- 2.10  poly(9-vinyl-9H-carbazole)
- 2.11  poly(oxirane)
- 2.12  polyformaldehyde
- 2.13  poly(oxetan-2-one)
- 2.14  poly(4-isocyanatobutan-1-ol)

Note: While the name given for Example 2.14 is correct, the polymer, notionally the product of a one-monomer polyaddition, can only be formed using protecting-group chemistry. The monomer indicated is thereby an apparent monomer. The more familiar products of two-monomer polyaddition reactions are classified as alternating copolymers. Their nomenclature is covered in Section SB-3.2 and typified in Example 3.12.

SB-2.3 Source-based names of polymers formed by polycondensation

There are two distinct types of polycondensation: polycondensation of a single monomer, denoted by x-A-y, and that of a pair of monomers, x-A-x and y-B-y, where x and y are mutually-reactive functional groups, for example, x might be a hydroxy, alkoxy, amino, or alkylamino group, while y might be a carboxy or carboxylate group. In order that the source-based nomenclature of their polymers is as far as possible consistent with the principles elaborated in the foregoing sections, it is recommended that both types of polycondensation use the apparent monomer approach.

Rule 3

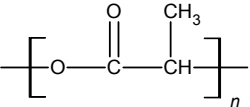
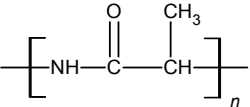
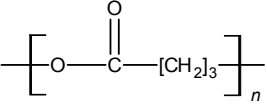
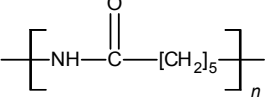
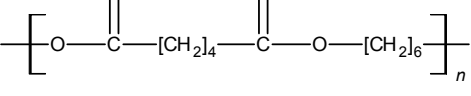
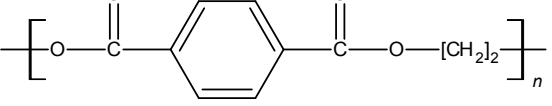
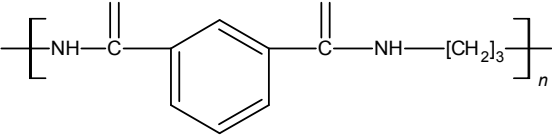
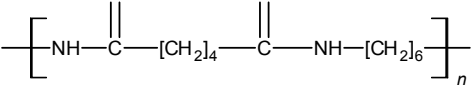
The source-based name of the homopolymeric product of a polycondensation is made by prefixing the apparent monomer name with 'poly'.

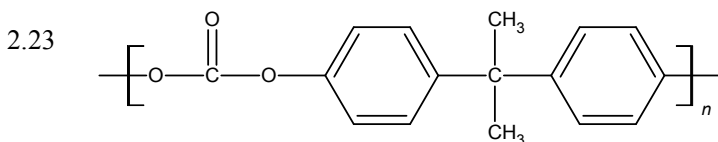
Note 1: In some instances of polycondensation of a single monomer denoted by x-A-y, the custom has been to derive the name of the polymer directly from the name of the monomer, typically poly(lactic acid), rather

than from an apparent monomer. Though not recommended, this is still permitted as long as the monomer name is retained within IUPAC nomenclature [8, 11].

Note 2: In the case of the polycondensation of two monomers, a particular polymer structure might be synthesised from more than just one pair of monomers. For example, poly(ethylene terephthalate) can be prepared by the reaction of ethane-1,2-diol (or ethylene oxide), x-A-x, and terephthalic acid (or its derivatives, such as esters or halides), y-B-y. According to *Rule 5* (see **Section SB-3.2**) the name of the polymer could be poly[(ethylene oxide)-*alt*-(terephthalic acid)] or poly[(ethylene glycol)-*alt*-(terephthaloyl dichloride)]; other names are also possible, depending on the particular selection of the two monomers. Many of these polycondensations are indeed met in practice, in contrast to the rather rare cases of the self-condensation of different single monomers to give the same polymer. The fact that a given polymer, with a particular structure, can have many different source-based names could lead to confusion so names of the type poly(A-*alt*-B) are not permitted except in the very rare instances that an apparent monomer cannot be named.

Examples

- 2.15  poly(3-methyloxiran-2-one)
poly(2-hydroxypropanoic acid)
poly(lactic acid)
- 2.16  poly(3-methylaziridin-2-one)
poly(2-aminopropanoic acid)
polyalanine
- 2.17  poly(oxolan-2-one)
poly(4-hydroxybutanoic acid)
- 2.18  poly(azepan-2-one)
poly(6-aminohexanoic acid)
- 2.19  poly(hexane-1,6-diyl adipate)
- 2.20  poly(ethylene terephthalate)
- 2.21  poly[*N,N'*-(propane-1,3-diyl)isophthalamide]
- 2.22  poly[*N,N'*-(hexane-1,6-diyl)hexanediamide]



poly[(dimethylmethylene)bis(4,1-phenylene) carbonate]

SB-3 SOURCE-BASED NAMES OF COPOLYMERS

There are three types of source-based names for copolymers, depending on the sequential arrangement of the monomer units [5]:

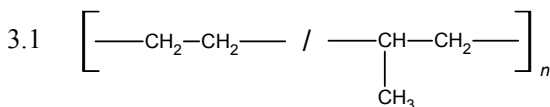
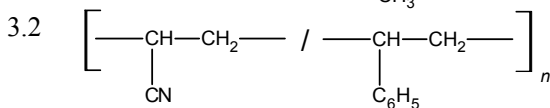
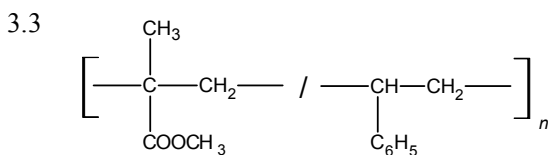
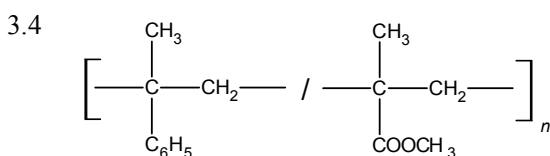
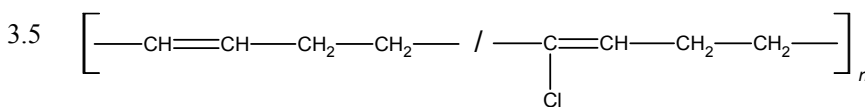
- 1) copolymers with an unspecified sequential arrangement of monomer units;
- 2) linear copolymers with random, statistical, alternating, or periodic distributions of monomer units;
- 3) block and graft polymers.

SB-3.1 Copolymers with an unspecified sequential arrangement of monomer units

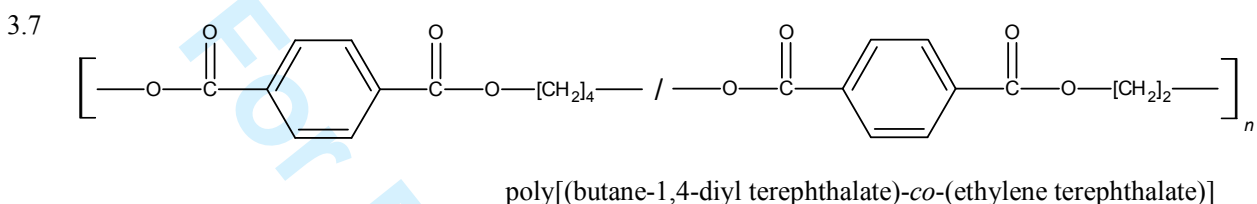
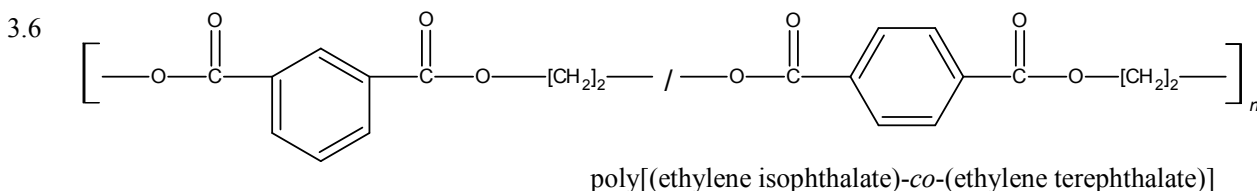
Rule 4

If the sequential arrangement of monomer units in a copolymer is not known, the source-based name of the copolymer is made by combining the prefix 'poly' and, in parentheses, the monomer or apparent monomer names (A, B, etc.), in alphabetical order, separated by the italic connective *-co-*.

Examples

poly(ethene-*co*-propene)poly(acrylonitrile-*co*-styrene)poly[(methyl methacrylate)-*co*-styrene]poly[(isopropenylbenzene)-*co*-(methyl methacrylate)]poly[(buta-1,3-diene)-*co*-(2-chlorobuta-1,3-diene)]

Note: Concerning the graphic representation, see the note to Example 2.5.



SB-3.2 Random, statistical, alternating and periodic copolymers

Rule 5

If the sequential arrangement of monomer units in a copolymer is known to be random, statistical, alternating, or periodic, the source-based name of the copolymer is made by combining the prefix ‘poly’ and, in parentheses, the monomer or apparent monomer names (A, B, etc.), separated by the italic connectives *-ran-*, *-stat-*, *-alt-*, or *-per-*, respectively. The order of citation of the monomer names should be alphabetical except in the case of periodic copolymers for which it must agree with the sequence distribution of monomer units in the copolymer.

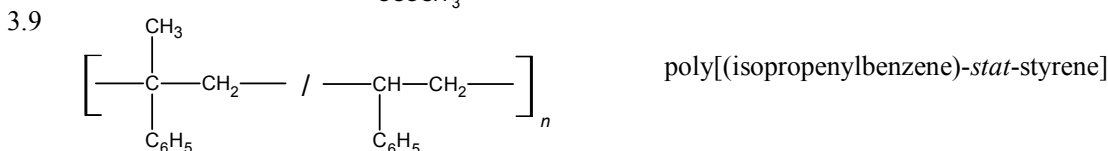
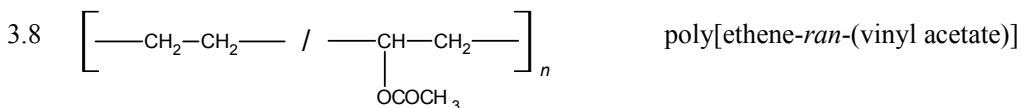
Note 1: The source-based names of random, statistical, alternating and periodic copolymers would typically be represented as poly(A-*ran*-B), poly(A-*stat*-B), poly(A-*alt*-B) and poly(A-*per*-B-*per*-C).

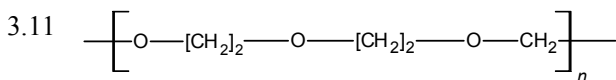
Note 2: The adjective ‘periodic’ should not be used for copolymers consisting of only two types of alternating monomer units; these should be treated as alternating copolymers.

Note 3: A random copolymer is a special case of a statistical copolymer in which the probability of finding a given monomer unit at any given site in the chain is independent of the nature of the neighbouring units at that position (Bernoullian distribution).

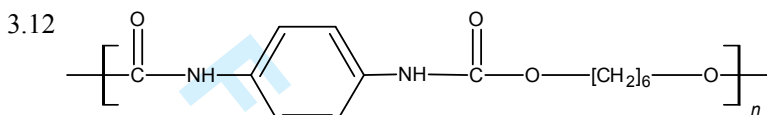
Note 4: The alternative nomenclature for copolymers, outlined in the Appendix to Ref. 5, which gave rise to such names as *alt*-copoly(A/B), has long been abandoned and is no longer acceptable.

Examples





poly[(oxirane)-*per*-(oxirane)-*per*-formaldehyde]



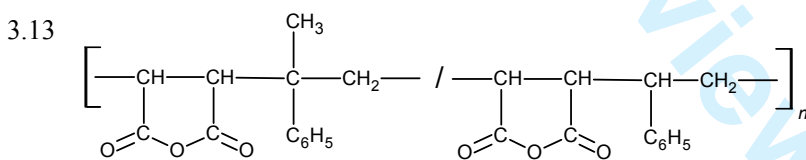
poly[(1,4-diisocyanatobenzene)-*alt*-(hexane-1,6-diol)]

Rule 6

If copolymer structures comprise several types of periodicity, some of which are always characterized by the regular sequencing of particular monomer units (A, B, ...), and others of which are always characterized by the sequencing of two or more other monomer units (U, V, ...) in irregular arrangement, the polymers are considered as extended alternating or periodic copolymers and the names of the monomers of the latter periodicity (U, V, ...) are embraced by parentheses and separated by semicolon(s).

Note: The source-based name of the copolymer with the sequence arrangement -AUAVAVAUAVAU- would typically be represented as poly[A-*alt*-(U;V)].

Example:



poly[(maleic anhydride)-*alt*-(isopropenylbenzene;styrene)]

SB-3.3 Block polymers

The names of block polymers differ from the names of the copolymers described in **SB-2.1** and **SB-2.2**. Every block is named as if it were an individual polymer, i.e., polyA, polyB, etc., for a homopolymer block, or poly(A-*co*-B), etc., for a copolymer block; the name of the block copolymer is then made by arranging the names of the blocks in the appropriate order and with the appropriate connective, -*block*- between pairs of names.

Rule 7

A block polymer or copolymer consisting of several blocks is named by arranging the names of the blocks, separated by the connective -*block*-, in the order of their sequence in the copolymer chain, but when two or more blocks are repeated in the same sequence two or more times in a polymer chain the name should be shortened by using the appropriate prefix – bis, tris, tetrakis, etc. The order of citation of the monomer names

should be alphabetical except in cases where the sequence distribution of monomer units in the copolymer dictates otherwise.

Note 1: Both sides of the connective *-block-* must be attached to the names of the blocks (polyA, polyB, etc.) and not to the names of the monomers. Thus, the following names are wrong: poly[(methyl methacrylate)-*block*-styrene] and poly[(buta-1,3-diene)-*block*-styrene-*block*-(buta-1,3-diene-*stat*-styrene)]; the correct names are given in examples 3.14 and 3.18 respectively.

Note 2: The following are typical representations:

polyA-*block*-polyB (a di-block copolymer)

bis(polyA-*block*-polyB) (a tetra-block copolymer of alternating blocks)

poly(polyA-*block*-polyB) (a multi-block copolymer of alternating blocks)

poly(A-*stat*-B)-*block*-polyA-*block*-polyB (a tri-block copolymer in which one of the blocks is a statistical copolymer)

Note 3: Tris(polyA-*block*-polyB) is a shorter representation of polyA-*block*-polyB-*block*-polyA-*block*-polyB-*block*-polyA-*block*-polyB, and bis(polyA-*block*-polyB-*block*-polyC) of polyA-*block*-polyB-*block*-polyC-*block*-polyA-*block*-polyB-*block*-polyC.

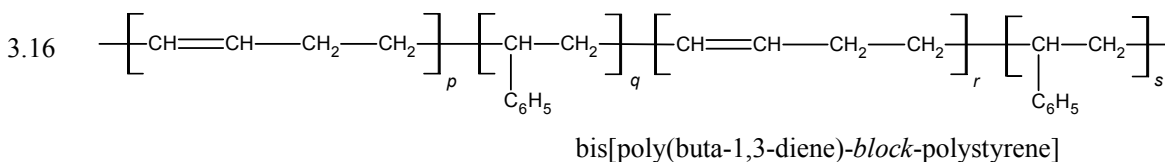
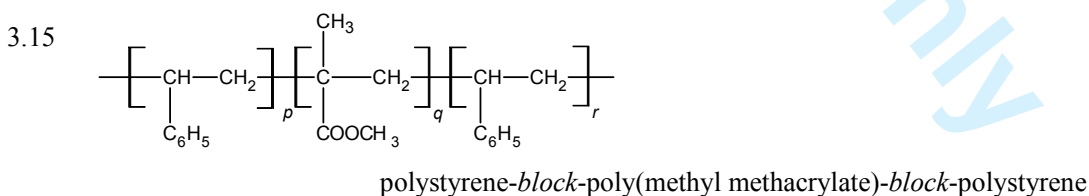
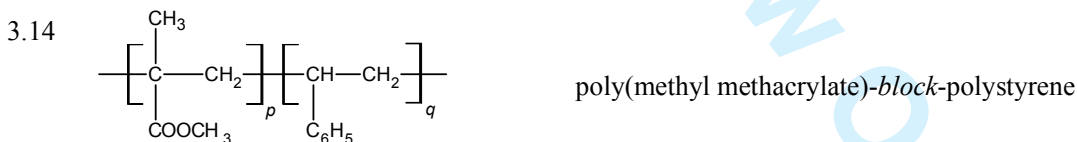
Note 4: For short blocks the prefix ‘oligo’ may be used in place of ‘poly’.

Note 5: For blocks of a defined length a numerical prefix should be used in place of ‘poly’.

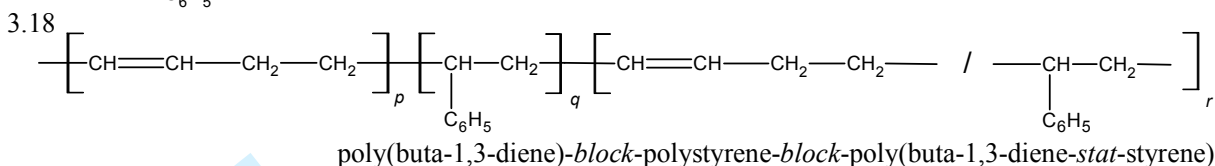
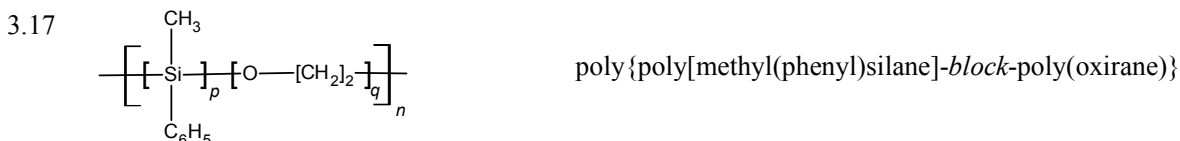
Note 6: Retained traditional polymer names as defined in Section SB-5 are allowed for blocks.

Note 7: The alternative nomenclature for block copolymers, outlined in the Appendix to Ref. 5, which gave rise to such names as *block*-copoly(A/B), has long been abandoned and its use is no longer acceptable.

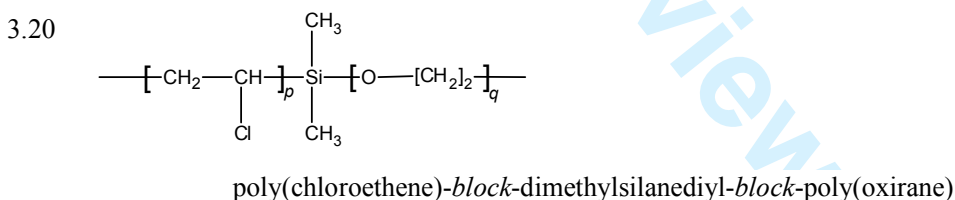
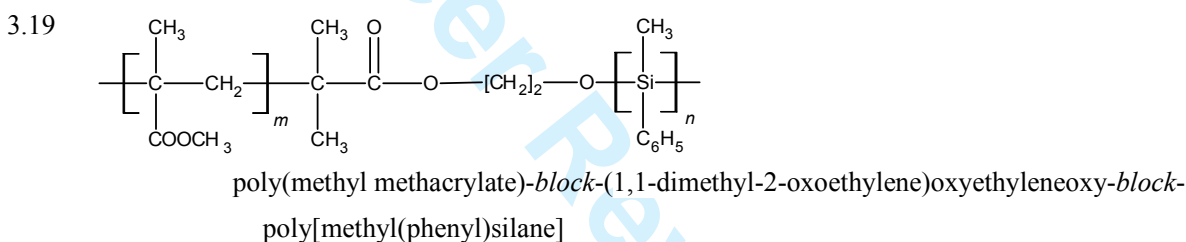
Examples



Note: This is a shorter representation of poly(buta-1,3-diene)-*block*-polystyrene-*block*-poly(buta-1,3-diene)-*block*-polystyrene.

**Rule 8**

A block polymer or copolymer in which the blocks are connected through a link unit, X, is named by arranging the names of the blocks, in alphabetical order, separated by the compound connective *-block-X-block-* in which X is named as a constitutional unit [1] in accordance with IUPAC nomenclature rules [8, 11].

Examples**SB-3.4 Graft polymers****Rule 9**

The names of graft homopolymers and copolymers are formed by citing the name(s) of the main-chain polymer or block(s), followed by the connective *-graft-*, and then the name of the side chain; this order of citation is important. If two or more different chains are randomly grafted onto the main chain, semicolons are used to separate the names of the grafts and the plurality of the names of the side chains is parenthesized (cf. Rule 6). If the numbers of graft chains per molecule are known then they are named using prefixes (bis, tris, etc.).

Note 1: The following are typical representations:

polyA-*graft*-polyU

poly(A-*co*-B)-*graft*-polyU

poly(A-*alt*-B)-*graft*-polyU

(polyA-*block*-polyB)-*graft*-(polyU-*block*-polyV)

(a graft copolymer in which the chains of one block copolymer are grafted onto unspecified main-chain blocks of another)

polyA-*graft*-(polyU;polyV)

(a graft copolymer in which polyU and polyV chains are grafted to a main chain)

(polyA-*graft*-polyU)-*block*-(polyB-*graft*-polyV)

(a diblock copolymer in which polyU chains are grafted to one block and polyV chains to the other)

(polyA-*block*-polyB-*block*-polyC)-*graft*-polyU

(a graft copolymer in which polyU chains are grafted at unspecified main-chain blocks)

polyA-*block*-[polyB-*graft*-polyU]-*block*-polyC

(a graft copolymer in which polyU chains are grafted at main-chain block polyB)

polyA-*tris*(*graft*-polyB)

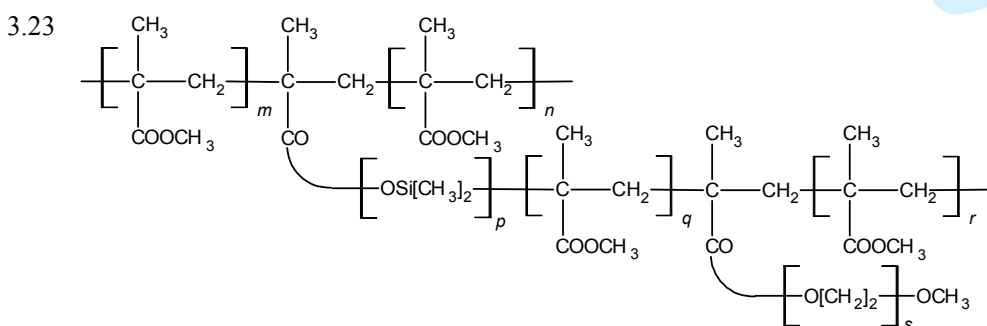
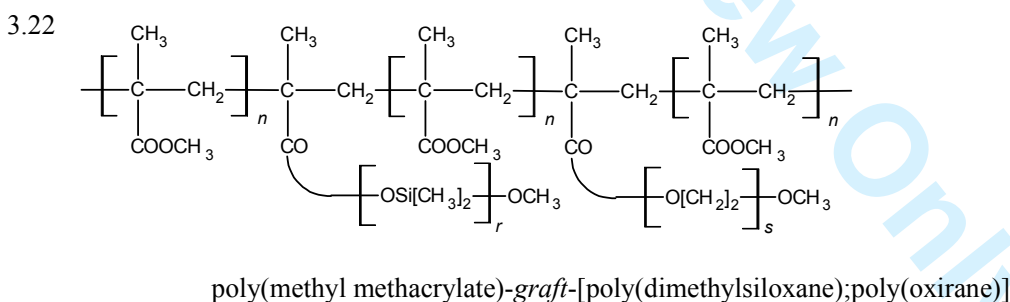
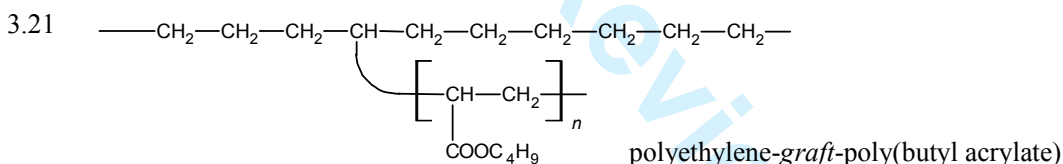
(a graft copolymer in which three polyB chains are grafted to a main-chain polyA)

Note 2: For short blocks or grafts the prefix 'oligo' may be used in place of 'poly'.

Note 3: For blocks or grafts of a defined length a numerical prefix should be used in place of 'poly'.

Note 4: Retained traditional polymer names as defined in Section SB-5 are allowed for blocks and grafts.

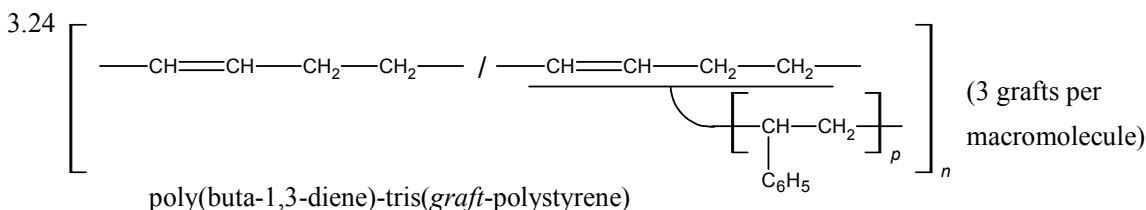
Examples



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poly(methyl methacrylate)-*graft*-{poly(dimethylsiloxane)-*block*-[poly(methyl methacrylate)-*graft*-
poly(oxirane)]}

For Peer Review Only

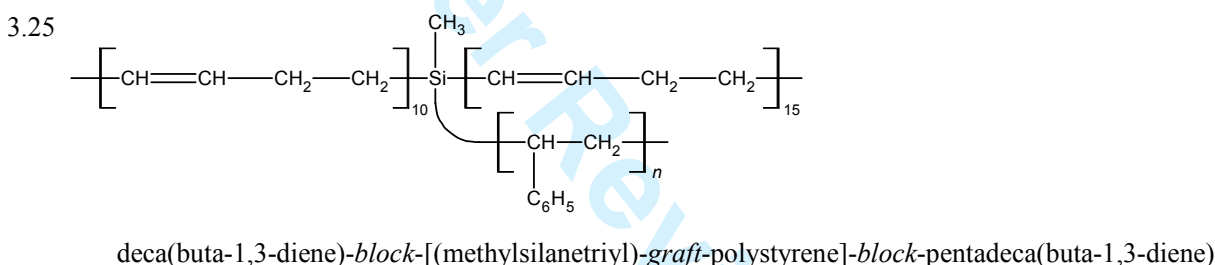


Note: In the above graphical representation, the horizontal line indicates grafting at unknown positions in the main-chain units.

Rule 10

A graft homopolymer or copolymer in which the main-chain blocks are connected through a link unit, X, to which a graft, polyY, is attached is named by arranging the names of the blocks, separated by the compound connective *-block-(X-graft-polyY)-block-* in which X is named as a constitutional unit [1] in accordance with the IUPAC Rules of Organic or Inorganic Nomenclature [8, 11].

Example



SB-4 NAMING END-GROUPS

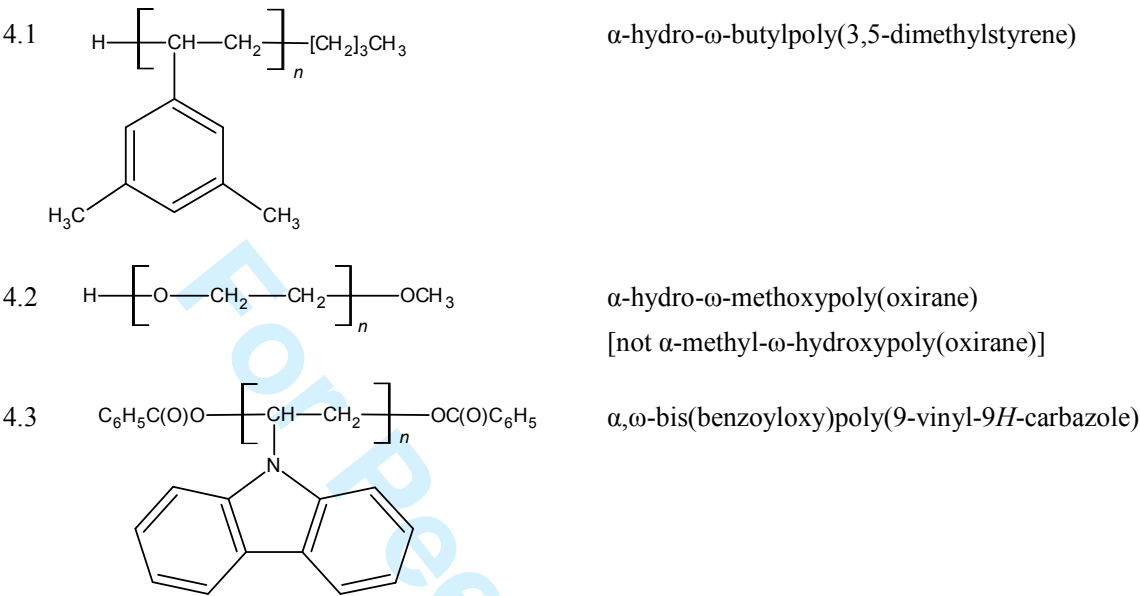
Rule 11

When the end groups of a polymer are to be specified, the name of the polymer is preceded by the systematic names of the end groups prefixed by α and ω , typically as α -X- ω -YpolyA.

Note 1: In general, the source-based naming of a polymer with end groups takes no account of the orientation of the monomer units in the polymer chain and therefore no specification of which end group is at the beginning of the chain and which at the end of the chain. If, however, the mechanism of the polymer formation is known and the graphical representation of the structure [13] depicts the correct orientation of the monomer unit then, in many instances, it will be clear as to which end group is better associated with α and which with ω .

Note 2: For those polymers in which the structures of the monomer units and end groups allow for the reversal of the orientation of the monomer unit, the chosen orientation is that for which the end groups can be cited in alphabetical order.

Examples:



SB-5 TRADITIONAL NAMES OF HOMOPOLYMERS

Because of their widespread use within industry and academia (see Appendix SB-7), a limited number of well-established traditional names of homopolymers are retained. In most cases these were derived from now obsolete names of their corresponding monomers. If the monomer names are not retained in IUPAC nomenclature it is no longer acceptable to use them regardless of the prevalence of their appearance in scientific, technical and commercial literature. Thus, even though retained traditional polymer names based on obsolete monomer names have every appearance of being source-based polymer names they are no longer so and should be replaced by their proper source-based polymer names as IUPAC nomenclature becomes used more widely in polymer science. Appendix SB-7 contains a comprehensive listing of which the following are some of the more important examples:

Examples

<u>retained traditional polymer name</u>	<u>source-based name</u>
5.1 polyethylene	polyethene
5.2 polypropylene	polypropene
5.3 polyisobutene	poly(2-methylpropene)
5.4 polytetrafluoroethylene	poly(tetrafluoroethene)

Note 1: In general, a traditional name of a polymer is a source-based name if it is based on a retained IUPAC name of the monomer. In such an instance, the name is listed in column 1 in Appendix SB-7.

Note 2: Notwithstanding the retention of the corresponding monomer name in IUPAC nomenclature, some traditional polymer names are not retained and are no longer acceptable, for example, poly(ethylene glycol).

Note 3: In some instances for which the monomer name is not retained in organic or inorganic nomenclature, neither is the traditional polymer name. Typically, polybutylene, for which the corresponding monomer is

but-1-ene, the obsolete name, butylene, which is not retained in IUPAC nomenclature, being easily confused with butane-1,4-diyl.

Rule 12

The retained traditional polymer names as listed in Appendix SB-7 are also retained for use as components in block and graft polymer names and the names of modified polymers [15].

SB-6 SUMMARY

SB-6.1 General

- a) Source-based nomenclature of single-strand polymers is an accepted IUPAC nomenclature. It is a convenient alternative to structure-based nomenclature.
- b) IUPAC uses the general term 'preferred name' to recommend a single name from amongst several possible variants for a given monomer. This approach helps to remove one of the shortcomings of source-based nomenclature by reducing the number of names used for a given polymer when rigour is essential.

SB-6.2 Naming homopolymers made by chain polymerization, ring-opening polymerization or polyaddition

- a) The names of the monomers to be used in source-based nomenclature should conform to the IUPAC recommendations concerning organic and inorganic chemical nomenclature.
- b) The concept of apparent monomer is introduced.
- c) In developing source-based names of homopolymers formed by chain polymerization, ring-opening polymerization or polyaddition the monomer names following 'poly' should be parenthesized for those with locants or stereodescriptors, and for names consisting of two or more words.

SB-6.3 Polymers made by polycondensation

For the polycondensation products of a single monomer of the type x-A-y or of two monomers of the types x-A-x and y-B-y, a name based on an apparent monomer such as (cyclic) ethylene terephthalate is recommended.

SB-6.4 Copolymers

- a) The names of copolymers with an unspecified distribution of monomer units are based on names of the monomers or apparent monomers separated by the connective *-co-*.
- b) The names of linear copolymers with random, statistical, alternating, or periodic distributions of monomer units are based on the names of the monomers separated by the connectives *-ran-*, *-stat-*, *-alt-* and *-per-*, respectively.
- c) The names of block and graft polymers (homopolymers and copolymers) are based on the homopolymer names separated by the connectives *-block-* or *-graft-*, respectively.

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- d) The nomenclature for graft polymers allows for the naming of polymers with graft chains distributed onto all types or selected types of constitutional units of the main chain.
- e) The formerly used nomenclature system using the prefix ‘copoly’ for copolymers has been abandoned and is no longer acceptable.

SB-6.5 Naming end groups

A method for inclusion of end-group names where required is elaborated.

SB-6.6 Traditional polymer names

Because of their widespread use within industry and academia, a limited number of well-established traditional names of homopolymers are retained for use beside or in place of source-based names.

SB-7 APPENDIX**SOURCE-BASED, STRUCTURE-BASED AND RETAINED TRADITIONAL NAMES OF COMMON POLYMERS**

Entries are listed in alphabetical order of source-based names

P = preferred name from amongst alternative source-based names;

R = retained traditional polymer name;

NR = non-retained traditional polymer name.

source-based name(s) of the polymer	structure-based name(s) of the polymer ¹	traditional polymer name(s)
polyacetaldehyde ^P , polyethanal	poly[oxy(methylmethylene)]	
poly(acetaldehyde divinyl acetal)	poly[(2-methyl-1,3-dioxane-4,6-diyl)methylene]	poly(vinyl acetal) ^{2 R}
polyacetylene ^P , polyethyne	poly(ethene-1,2-diyl)	
polyacrylamide, poly(prop-2-enamide)	poly(1-carbamoylethylene)	
polyacrylonitrile, poly(prop-2-enenitrile)	poly(1-cyanoethylene)	
poly(allyl alcohol), poly(prop-2-en-1-ol)	poly[(1-(hydroxymethyl)ethylene]	
poly(azepan-2-one) ^P , poly(hexano-6-lactam)	poly[azanediyl(1-oxohexane-1,6-diyl)]	poly(ε-caprolactam) ^R , polycaprolactam ^{NR}
poly(aziridine)	poly(azanediylethylene)	polyethyleneimine ^R
poly(bicyclo[2.2.1]hepta-2,5-diene)	poly(cyclopent-4-ene-1,3-diylethene-1,2-diyl)	poly(norbornadiene) ^R
poly(bicyclo[2.2.1]hept-2-ene)	poly[(cyclopentane-1,3-diyl)ethene-1,2-diyl], poly(bicyclo[2.2.1]heptane-2,3-diyl)	poly(norbornene) ^R
poly(butanal divinyl acetal)	poly[(2-propyl-1,3-dioxane-4,6-diyl)methylene]	poly(vinyl butyral) ^R
poly(buta-1,3-diene)	poly[(but-1-ene-1,4-diyl)/(1-vinylethylene)]	polybutadiene ^{3 R}
poly[(butane-1,4-diol)- <i>alt</i> -(1,3-diisocyanato-2-methylbenzene)], poly[(butane-1,4-diol)- <i>alt</i> -(2,6-diisocyanatotoluene)]	poly[oxycarbonylazanediyl(2-methyl-1,3-phenylene)azanediylcarbonyloxybutane-1,4-diyl]	
poly(butane-1,4-diyl terephthalate)	poly(oxybutane-1,4-diyl-oxyterephthaloyl)	poly(butylene terephthalate) ^{NR}
poly(but-1-ene)	poly(1-ethylethylene)	polybutylene ^{NR}
poly(2-chlorobuta-1,3-diene)	poly{[(1-chlorobut-1-ene-1,4-diyl)/(1-chloro-1-vinylethylene)/[1-(1-chlorovinyl)ethylene]}	polychloroprene ^R
poly(chlorotrifluoroethene)	poly(1-chloro-1,2,2-trifluoroethylene)	polychlorotrifluoroethylene ^{NR}
poly(1,1-dichloroethene)	poly(1,1-dichloroethylene)	poly(vinylidenechloride) ^{NR}
poly(1,1-difluoroethene)	poly(1,1-difluoroethylene)	poly(vinylidene fluoride) ^{NR}

poly[(1,4-diisocyanatobenzene)- <i>alt</i> -(hexane-1,6-diol)], poly[hexane-1,6-diyl <i>N,N'</i> -(1,4-phenylene)dicarbamate]	poly(oxyhexane-1,6-diylloxycarbonylazanediy-1,4-phenyleneazanediyloxycarbonyl)	
poly[(dimethylmethylene)bis(4,1-phenylene) carbonate]	poly[oxy(oxycarbonyloxy-1,4-phenylene(dimethylmethylene)-1,4-phenylene)]	
poly(2,6-dimethyl-1,4-phenylene oxide)	poly[oxy(2,6-dimethyl-1,4-phenylene)]	poly(phenylene oxide) ⁴ ^{NR}
	poly[oxy(dimethylsilanediy)], <i>catena</i> -poly[(dimethylsilicon)-μ-oxido] ⁵	poly(dimethylsiloxane) ^R
polyethene	poly(methylene)	polyethylene ^R
poly(ethylene terephthalate)	poly(oxyethyleneoxyterephthaloyl)	
polyformaldehyde ^P , polymethanal	poly(oxymethylene)	
poly(formaldehyde divinyl acetal)	poly(1,3-dioxane-4,6-diylmethylene)	poly(vinyl formal) ^R
poly[<i>N,N'</i> -(hexane-1,6-diyl)hexane-diamide], poly[<i>N,N'</i> -(hexane-1,6-diyl)adipamide]	poly(azanediyladipoylazanediyhexane-1,6-diyl)	poly(hexamethylene adipamide) ^{NR}
polyisoprene ⁶ ^P , poly(2-methylbuta-1,3-diene)	poly{(1-methylbut-1-ene-1,4-diyl)/ (1-ethenyl-1-methylethylene)/ [1-(1-methylethenyl)ethylene]}	
poly[(maleic anhydride)- <i>alt</i> -styrene]	poly[(2,5-dioxotetrahydrofurn-3,4-diyl)(1-phenylethylene)]	
polymethacrylamide, poly(2-methylprop-2-enamide)	poly(1-carbamoyl-1-methylethylene)	
poly(3-methyloxiran-2-one), poly(lactic acid)	poly[oxy(1-methyl-2-oxoethylene)]	
poly(3-methylaziridin-2-one), polyalanine	poly[azanediyl(1-methyl-2-oxoethylene)]	
poly(methyl acrylate)	poly[1-(methoxycarbonyl)ethylene]	
poly(methyl methacrylate)	poly[1-(methoxycarbonyl)-1-methylethylene]	
poly[methyl(phenyl)silane]	poly[methyl(phenyl)silanediy], <i>catena</i> -poly[methyl(phenyl)silicon] ⁵	
poly(2-methyloxirane) ^P , poly(propene oxide)	poly[oxy(1-methylethylene)]	poly(propylene oxide) ^R , poly(propylene glycol) ⁷ ^{NR} , polypropylene oxide ^{NR} , polypropylene glycol ^{NR2}
poly(2-methylpropene)	poly(1,1-dimethylethylene)	polyisobutene ^R , polyisobutylene ^{NR}
poly(oxolane) ^P , polytetrahydrofuran	poly(oxybutane-1,4-diyl)	poly(tetramethylene ether glycol) ^{NR}
poly(oxepan-2-one) ^P , poly(hexano-6-lactone)	poly[oxy(1-oxohexane-1,6-diyl)]	poly(ε-caprolactone) ^R , polycaprolactone ^{NR}
poly(oxetane)	poly(oxypropane-1,3-diyl)	poly(trimethylene ether glycol) ^{NR}
poly(oxirane) ^P , poly(ethene oxide)	poly(oxyethylene)	poly(ethylene oxide) ^R , poly(ethylene glycol) ⁷ ^{NR} , polyethylene oxide ^{NR} , polyethylene glycol ^{NR2}
poly(oxolan-2-one) ^P , poly(butano-4-lactone)	poly[oxy(1-oxobutane-1,4-diyl)]	poly(γ-butyrolactone) ^{NR}

poly(2-phenyloxirane) ^P , poly(styrene oxide)	poly[oxy(1-phenylethylene)]	
poly[<i>N,N'</i> -(1,4-phenylene)terephthalamide]	poly(azanediyl-1,4-phenyleneazanediylterephthaloyl)	
poly(propane-1,3-diyl terephthalate)	poly(oxypropane-1,3-diyl-oxyterephthaloyl)	poly(trimethylene terephthalate) ^{NR}
polypropene	poly(1-methylethylene)	polypropylene ^R
poly[(prop-1-en-2-yl)benzene], poly[(isopropenyl)benzene]	poly(1-methyl-1-phenylethylene)	poly(α -methylstyrene) ^{NR}
polypropyne	poly(1-methylethene-1,2-diyl)	polymethylacetylene ^{NR}
poly(pyrrolidin-2-one) ^P , poly(butano-4-lactam)	poly[azanediyl(1-oxobutane-1,4-diyl)]	poly(γ -butyrolactam) ^{NR}
polystyrene ^P , poly(vinylbenzene)	poly(1-phenylethylene)	
	poly(sulfanediyl-1,4-phenylene)	poly(1,4-phenylene sulfide) ^R
poly(tetrafluoroethene)	poly(difluoromethylene)	polytetrafluoroethylene ^R
poly(trichloroacetaldehyde)	poly{oxy[(trichloromethyl)methylene]}	polychloral ^{NR}
poly(tricyclo[5.2.1.0 ^{2,6}]deca-3,8-diene)	-	polydicyclopentadiene ^R
poly(vinyl acetate)	poly(1-acetoxyethylene)	
poly(vinyl alcohol) ^P , poly(ethanol)	poly(1-hydroxyethylene)	
poly(9-vinyl-9 <i>H</i> -carbazole)	poly[1-(9 <i>H</i> -carbazol-9-yl)ethylene]	poly(9-vinylcarbazole) ^R , poly(<i>N</i> -vinylcarbazole) ^{NR} , poly(vinylcarbazole) ^{NR}
poly(vinyl chloride) ^P , poly(ethenyl chloride), poly(chloroethene)	poly(1-chloroethylene)	

¹. All structure-based polymer names based on 'ethylene' are preferred to names based on 'ethane-1,2-diyl'.

². Polyvinyl acetal is also a class name for polymers derived from divinyl acetals [16].

³. The traditional name polybutadiene should not be used if the structure of the polymer is known. In such circumstances the structure-based name should be used.

⁴. Poly(phenylene oxide) was originally a trade name for poly(2,6-dimethyl-1,4-phenylene oxide) that was accepted into common usage. As it indicates a non-substituted ring system it is a misnomer. Not only is it not retained but its use is deprecated.

⁵. Name according to the rules for linear inorganic polymers. Similar names are adopted for other polysiloxanes, polysilanes and their analogues.

⁶. The source-based name polyisoprene should not be used if the structure of the polymer is known. In such circumstances the structure-based name should be used.

⁷. The names poly(ethylene *or* propylene glycol) and poly(ethylene *or* propylene oxide) have been used to distinguish poly(oxirane)s of $M_{r,w}$ less than and greater than 100,000 respectively. Using nomenclature to distinguish polymers that differ only in the molecular mass range into which they fall is not acceptable. When the distinction is necessary it should be made in accordance with Note 4 to Rule 2.

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SB-9 REFERENCES

- 1) IUPAC. 'Nomenclature of regular single-strand organic polymers (IUPAC Recommendations 2002)', *Pure Appl. Chem.*, **74**, 1921-1956 (2002). (Ref. 14, chapter 15)
- 2) IUPAC. 'Nomenclature of regular double-strand (ladder and spiro) organic polymers (IUPAC Recommendations 2002)', *Pure Appl. Chem.*, **65**, 1561-1580 (1993). (Ref. 14, chapter 16)
- 3) IUPAC. 'Structure-based nomenclature for irregular single-strand organic polymers (IUPAC Recommendations 1994)', *Pure Appl. Chem.*, **66**, 873-889 (1994). (Ref. 14, chapter 17)
- 4) IUPAC. 'Structure-based nomenclature for cyclic organic macromolecules (IUPAC Recommendations 2008)', *Pure Appl. Chem.*, **80**, 201-232 (2008).
- 5) IUPAC. 'Source-based nomenclature for copolymers (IUPAC Recommendations 1985)', *Pure Appl. Chem.* **57**, 1427-1440 (1985). (Ref. 14, chapter 19)
- 6) IUPAC. 'Source-based nomenclature for non-linear macromolecules and macromolecular assemblies (IUPAC Recommendations 1997)', *Pure Appl. Chem.* **69**, 2511-2521 (1997). (Ref. 14, chapter 20)
- 7) IUPAC. 'Generic source-based nomenclature for polymers (IUPAC Recommendations 2001)', *Pure Appl. Chem.* **73**, 1511-1519 (2001). (Ref. 14, chapter 21)
- 8) IUPAC. 'Nomenclature of Organic Chemistry' (IUPAC Recommendations and Preferred Names 2013). Prepared for publication by H. A. Favre and W. H. Powell, RSC Publishing, Cambridge, UK (2013).
- 9) IUPAC. 'Glossary of basic terms in polymer science (IUPAC Recommendations 1996)', *Pure Appl. Chem.* **68**, 2287-2311 (1996). (Ref. 14, chapter 1)
- 10) IUPAC. 'Basic terminology of stereochemistry (IUPAC Recommendations 1996)', *Pure Appl. Chem.* **68**, 2193-2222 (1996).
- 11) IUPAC. 'Nomenclature of Inorganic Chemistry' (IUPAC Recommendations and Preferred Names 2005). Prepared for publication by N. G Connelly, T. Danhus, R. M. Hartshorn and A. T. Hutton, RSC Publishing, Cambridge, UK (2005).
- 12) B. M. Novak, A. K. Cederstav, 'The Polymerization of Free Enols with Electron-Deficient Comonomers', *J. Macromol. Sci. – Part A*, **A34**, 1815-1825 (1997).
- 13) IUPAC. 'Graphic representations (chemical formulae) of macromolecules (IUPAC Recommendations 1994)', *Pure Appl. Chem.*, **66**, 2469-2482 (1994). (Ref. 14, chapter 18)
- 14) IUPAC Recommendations 2008. *Compendium of Polymer Terminology and Nomenclature*. Prepared for publication by R. G. Jones, J. Kahovec, R. Stepto, E. S. Wilks, M. Hess, T. Kitayama,

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48
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60

W. V. Metanowski, with advice from A. Jenkins and P. Kratochvíl, RSC Publishing, Cambridge, UK (2008).

15) IUPAC. ‘Nomenclature and graphic representations for chemically modified polymers (IUPAC Recommendations 2014)’, *Pure Appl. Chem.*, **87**, 307-319 (2015)

16) IUPAC. ‘Glossary of class names of polymers based on chemical structure and molecular architecture (IUPAC Recommendations 2009)’, *Pure Appl. Chem.* **81**, 1131-1186 (2009).

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