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## STRUCTURE-BASED NOMENCLATURE FOR CYCLIC ORGANIC MACROMOLECULES (IUPAC RECOMMENDATIONS 2008)

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# Structure-based nomenclature for cyclic organic macromolecules

## (IUPAC Recommendations 2008)

*Abstract:* A structure-based nomenclature system for monocyclic and polycyclic organic macromolecules is presented. Single-strand mono- and polycyclic macromolecules as well as spiro macrocyclic compounds are covered. However, rotaxanes and catenanes, which contain interlocked rings, and rings or ring systems formed by noncovalent bonds are excluded. Also, polypeptides and carbohydrate polymers are not included. The nomenclature of cyclic macromolecules is based on the existing nomenclature of regular and irregular macromolecules, which in turn is based on the nomenclature of organic chemistry also published by IUPAC. The procedure for naming a cyclic macromolecule consists of transforming it to an open-chain regular or irregular macromolecule in such a way that naming of units proceeds in descending order of seniority but otherwise follows the rules established for these types of macromolecules. For polycyclic macromolecules, the same principles are followed after the main ring, bridges, and branch units are identified and locants for branch units as well as bridges are assigned. The complete names are assembled by citing the component names and locants in the appropriate order according to the rules in this document. Wherever possible, examples for illustration of the naming procedure have been chosen from the literature.

*Keywords:* nomenclature; rules; structure-based nomenclature; monocyclic macromolecules; polycyclic macromolecules; spiro macromolecules; examples; IUPAC Chemical Nomenclature and Structure Representation Division; IUPAC Polymer Division.

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## CM-0 INTRODUCTION

This document on nomenclature of cyclic macromolecules is designed to provide unambiguous names through an extension of structure-based nomenclature for regular [1] and irregular [2] organic macromolecules. The document includes single-strand mono- and polycyclic macromolecules as well as spiro macrocyclic compounds. However, rotaxanes and catenanes, which contain interlocked rings, and rings or ring systems formed by noncovalent bonds are excluded. They will be dealt with in separate documents because of their specific structural features. Polypeptides and carbohydrate polymers are excluded. Cyclic polypeptides are the topic of a future document. Although the following recommendations and examples deal with organic cyclic macromolecules only, the general principles described in this document can similarly be applied to inorganic cyclic macromolecules and to hybrid organic/inorganic structures.

A first approach to naming macrocyclic compounds used IUPAC-approved names for bivalent units and concepts of structure-based polymer names [3]. The present document follows this basic principle and adjusts it to the specific requirements of macromolecular structures; at the same time, it is ex-

tended to more complex structures. The concept is based on transforming a cyclic macromolecule into an open-chain regular or irregular macromolecule by a conceptual scission of a ring bond and naming it according to the rules established for these types of macromolecules. The principles of nomenclature for regular and irregular polymers will not be repeated here. They will be used and explained only where necessary for a better understanding of examples.

Nomenclature of polycyclic macromolecules uses the same principles as that of monocyclic macromolecules. Polycyclic macromolecules are named by identifying the main ring, branch points, and bridges, and citing their names in the appropriate order.

To name cyclic macromolecules, knowledge of nomenclature of organic chemistry [4–6], at least to the extent it is explained and illustrated by examples in [1], is indispensable.

The intention of this document is to propose a nomenclature applicable to practically all cyclic organic macromolecules that can be imagined, e.g., by transformation of organic-chemical ring systems to macrocyclic ring systems. One should, however, also take into account the synthetic feasibility of macrocyclic molecules. Most of them will be monocyclic, bicyclic, or spiro. Polycyclic macromolecules beyond bicyclics are unsupported by convincing proof of structure and at present should be regarded as hypothetical.

Structure-based nomenclature unambiguously names a compound with respect to its constitution. Configurational aspects can be included in the name by means of stereodescriptors added to the structure-based name as affixes. Topology, in particular of polycyclic macromolecules, is not an explicit topic in structure-based nomenclature, although it is inherently contained in a structure-based name (see rule 21, last example, in [1]). The topology of polycyclic macromolecules has been discussed elsewhere in the literature [7,8].

To assist the reader, within the following glossary, cross-references to terms also defined in the glossary are denoted in italic typeface.

## CM-1 GLOSSARY

### CM-1.1 block

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

[9] and definition 1.62 in [10].

### CM-1.2 branch point

Point on a chain or a ring at which a branch or a *bridge* is attached.

Revision of definition in [9] and definition 1.54 in [10].

### CM-1.3 branch unit

*Constitutional unit* in a macromolecule to which a branch or *bridge* is attached.

Revision of definition in [9] and definition 1.55 in [10].

### CM-1.4 bridge

*Block*, constitutional unit, or bond, joining two *branch units* of a more senior *macrocycle*, i.e., the macrocycle containing units of higher *seniority*.

See also [5a,9] and VB-1 in [11].

**CM-1.5 constitutional unit (CU)**

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] and definition 1.14 in [10].

**CM-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] and definition 1.15 in [10].

**CM-1.7 cyclic macromolecule**

Macromolecule in which the termini of the backbone are connected to form a ring.

*Note:* Linear macromolecules comprising *constitutional units* that include small cyclic structures [e.g., the phenylene groups in poly(ethylene terephthalate)] are not cyclic macromolecules. However, a cyclic molecule comprising such *constitutional (repeating) units* is a cyclic macromolecule (see also example 1).

**CM-1.8 irregular monocyclic macromolecule**

*Cyclic macromolecule* that with a single conceptual scission of a chain bond is converted to an open-chain structure with an irregular distribution of *constitutional units*, i.e., a structure that cannot be described by a single *constitutional repeating unit*.  
See also [9] and definition 1.5 in [10].

**CM-1.9 macrocycle**

*Cyclic macromolecule* or macromolecular cyclic portion of a macromolecule.  
[9] and definition 1.57 in [10].

*Note 1:* A macrocycle is always monocyclic.

*Note 2:* Rings that can be named by rules of the nomenclature of organic chemistry are not considered as macrocycles according to the definition given above.

*Note 3:* Macrocycle is also used for molecules of low molar mass that would not be considered to be macromolecules as specified in the definition given above [12].

**CM-1.10 main ring**

*Macrocycle* in a bridged *polycyclic macromolecule* or polycyclic macromolecular portion that contains the *subunits* of highest *seniority*.

*Note:* In macrocyclic molecules with macrocyclic *substituents*, the ring that contains the subunits of highest seniority is called the parent macrocycle or macrocyclic system.

**CM-1.11 path length**

Number of polymer main-chain (backbone) atoms between two *subunits*.

*Note:* Where a ring or ring system constitutes all or part of a path between two subunits, the shortest continuous chain of atoms in the ring or ring system is selected.

See also Glossary in [1].

### CM-1.12 polycyclic macromolecule

Molecule that includes more than one *macrocycle*, all of which have at least one atom in common with another macrocycle.

*Note 1:* Molecules that have two rings without any common atom are not considered polycyclic, e.g., biphenyl. In general terminology, however, they are often regarded as polycyclic.

*Note 2:* “Multicyclic” or “pluricyclic” have been proposed as alternative terms for polycyclic. In accordance with nomenclature of organic chemistry, the term “polycyclic” is used here, since it does not lead to confusion with respect to “poly” in polymer. Therefore, the use of “multicyclic” or “pluricyclic” is discouraged as an alternative for “polycyclic”.

### CM-1.13 preferred constitutional repeating unit

*Constitutional repeating unit* that begins with the *subunit* of highest *seniority*.

Adopted from [1], p. 1925.

### CM-1.14 regular monocyclic macromolecule

*Cyclic macromolecule* that can be described by a single *constitutional repeating unit*.

See also [9] and definition 1.4 in [10].

### CM-1.15 seniority

Priority in a set of atoms or groups of atoms according to a prescribed order.

See also Glossary in [1,9].

### CM-1.16 spiro compound

Compound having one atom as the only common member of two rings.

See also [9,13].

### CM-1.17 spiro macromolecule

Macromolecule having one atom as the only common member of two *macrocycles*.

*Note:* Spiro macromolecule is also used for double-strand macromolecules in which case the definition is: Double-strand macromolecule consisting of an uninterrupted sequence of rings, with adjacent rings having only one atom in common. Alternatively, a spiro macromolecule is a double-strand macromolecule with adjacent *constitutional units* joined to each other through three atoms, two on one side and one on the other side of each constitutional unit. [9] and definition 1.43 in [10].

**CM-1.18 spiro union**

Linkage between two rings consisting of a single atom common to both rings.

*Note:* A “free spiro union” is a linkage which constitutes the only union direct or indirect between the two rings. The common atom is designated as the “spiro atom”.

[5b]; see also [4a,9] and rule SP-0 in [13].

**CM-1.19 substituent**

An atom or a group of atoms that replaces one or more hydrogen atoms attached to a backbone atom. See also definition in [5c].

**CM-1.20 subunit**

Largest segment named as a single unit under nomenclature of organic chemistry rules (refs. [4–6] at the date of publication of this document).

*Note:* A subunit may be a ring or ring system, a heteroatom or a heteroatom chain, or a carbon chain.

See also Glossary in [1].

**CM-2 GENERAL PRINCIPLES****CM-2.1 Seniority**

Nomenclature of cyclic macromolecules like that of open-chain macromolecules [1,2] is based on the seniority of constitutional units and constitutional repeating units that are part of the macromolecule. The constitutional units, constitutional repeating units, and subunits are named according to the IUPAC nomenclature of organic chemistry [4–6] and IUPAC polymer nomenclature [1,2].

Seniority depends on the atoms, rings, bonds, and substituents in a cyclic macromolecule. The order of seniority of subunits is adopted from organic and polymer nomenclature; it is defined in detail elsewhere [1,2,4–6]. The basic order of seniority of subunits is:

heterocyclic units > heteroatoms (according to their position in the periodic table  $O > S > N > P > Si > B$ , etc. [4b,5d,14]) > carbocyclic units > acyclic carbon units.

Rings for the purpose of determining seniority are those that can be named by conventional nomenclature [4–6,15] and that do not contain polymeric units.

Seniority among subunits will be evident from examples that follow. For a concise overview of the principles of seniority of subunits, see [1].

There is a difference between structure-based nomenclature of irregular polymers as described in [2] and in the present document. In [2], p. 880, it is explicitly stated that seniority of blocks, which are comprised of constitutional repeating units in terms of nomenclature, has not been defined. In the present document, the seniority of a block is that of the constitutional repeating unit. If the most senior unit in a cyclic macromolecule is a constitutional repeating unit that has a direction from the subunit of highest seniority to that of second highest seniority within the constitutional repeating unit, e.g.,  $-[O-CH_2-CH_2]-$ , this direction automatically defines the direction of citation unless there are two identical blocks in the cyclic macromolecule (cf. examples 28, 34, 38, and 39).

### CM-2.2 Conceptual scission

For nomenclature purposes, polycyclic macromolecules are broken down to monocyclic structures (cf. CM-4.1 and CM-5.2). By analogy with open-chain macromolecules, the structure of a monocyclic macromolecule is described by citing consecutively the names of the subunits as one proceeds around the cycle. In contrast to open-chain macromolecules, where naming has to begin at one terminus, in macrocycles the sequence of subunits could theoretically begin at any point and it is possible to proceed in either direction from that point. Here, rules are provided, which, on the basis of seniority, allow unambiguous selection of the correct starting point and identification of the direction to take in the sequence around the cycle. To aid this, conceptual scission is introduced. A conceptual scission of a cyclic macromolecule transforms it to an open-chain macromolecule that has the most senior subunit or constitutional repeating unit at the terminus from which naming begins.

### CM-2.3 Naming of a cyclic macromolecule or macrocycle

When naming a cyclic macromolecule or a macrocycle, the steps to be followed in order are:

- CM-2.3.1 Draw the structure of the cyclic macromolecule. Identify the constitutional repeating units and minimize the number of subunits outside of them (see CM-3.3.1) wherever there is a choice.  
*Note:* Minimization of the number of subunits outside the constitutional repeating unit in the cyclic macromolecule prevails over citation of a constitutional repeating unit beginning with the subunit of highest seniority within that constitutional repeating unit (see also examples 8, 10, and 11).
- CM-2.3.2 Identify the main ring and the bridges or macrocyclic substituent (if present) by applying the rules of seniority and conceptual scission.
- CM-2.3.3 Name the cyclic macromolecule or macrocycle according to the rules given in the following sections.

## CM-3 MONOCYCLIC MACROMOLECULES

### CM-3.1 Naming of a monocyclic macromolecule

For naming a monocyclic macromolecule, the steps to be followed in order are:

- CM-3.1.1 Draw the structure of the monocyclic macromolecule. Identify the constitutional repeating units and minimize the number of subunits outside them wherever there is a choice.
- CM-3.1.2 Irrespective of its location within or outside a constitutional repeating unit, identify the most senior subunit in the macrocycle according to rules of organic-chemical [4–6] and structure-based polymer nomenclature [1,2].
- CM-3.1.3 If the most senior subunit is contained in the cyclic macromolecule more than once, the shortest path to the subunit of identical or next lower seniority determines the direction of citation. For equivalent path lengths, the atoms or units within a block (constitutional repeating unit) are senior to the same atoms or units outside the block.
- CM-3.1.4 If the most senior unit is part of a preferred constitutional repeating unit, the direction within this constitutional repeating unit determines the direction of citation.
- CM-3.1.5 Make a conceptual scission of the macrocycle such that the resulting open-chain macromolecule begins with the constitutional repeating unit containing the subunit of highest seniority, or with the subunit of highest seniority if that is not part of a constitutional repeating unit, and proceed in the direction determined in CM-3.1.3 or in CM-3.1.4.



- CM-3.1.6 Name the resulting open-chain macromolecule according to the rules established for regular and irregular, single-strand macromolecules [1,2] citing the names of individual subunits reading from left to right, beginning with the most senior constitutional unit or constitutional repeating unit and proceeding in the direction of the subunit next in seniority.
- CM-3.1.7 Name the monocyclic macromolecule by adding the prefix “cyclo-” to the structure-based name created in CM-3.1.6 and enclosed within parentheses or square or curly brackets as appropriate.

### CM-3.2 Regular monocyclic macromolecules

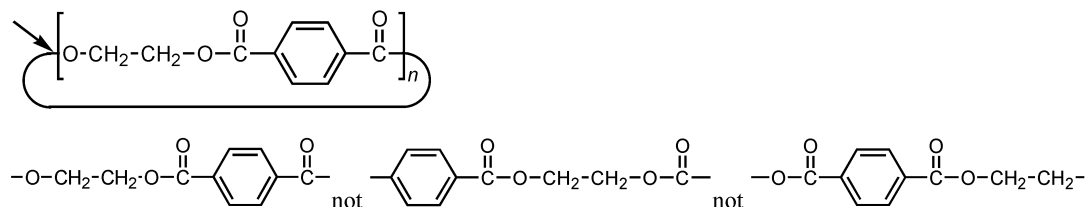
Regular, single-strand, monocyclic macromolecules have a structure such that with a single conceptual scission of the macrocycle they are converted to an open-chain, regular macromolecule consisting of one constitutional repeating unit [1].

The general format for the name of a regular monocyclic macromolecule is **cyclo[poly(constitutional repeating unit)]**.

*Note 1:* The same format can be used for oligomer nomenclature, e.g., cyclo[tetra(constitutional repeating unit)]. Thus, for  $n = 4$  in example 1, the name would be cyclo[tetra(oxyethyleneoxyterephthaloyl)].

*Note 2:* In all of the following examples, the open-chain structures are those that result from conceptual scission if not stated otherwise.

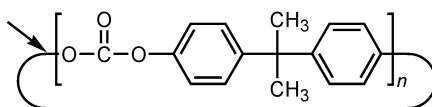
#### Example 1



Name: cyclo[poly(oxyethyleneoxyterephthaloyl)]

*Note:* A semi-systematic name for this polymer is cyclo[poly(ethylene terephthalate)].

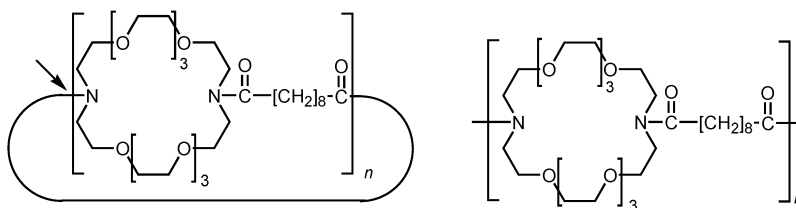
#### Example 2 (taken from [16])



Name: cyclo{poly[oxycarbonyloxy-1,4-phenylene(dimethylmethylene)-1,4-phenylene]}

Alternative correct name: cyclo[poly(oxycarbonyloxy-1,4-phenylenepropane-2,2-diyl-1,4-phenylene)]

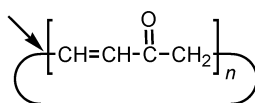
## Example 3



Name: cyclo{poly[(1,4,7,10,16,19,22,25-octaoxa-13,28-diazatriacontan-13,28-diyl)(1,10-dioxodecane-1,10-diyl)]}

*Note:* The ring containing the nitrogen atoms is not a macrocycle in the sense of this document, as it can be named by nomenclature of organic chemistry. The cyclic polymer (left) is a monocyclic macromolecule, while the structure at the right represents a linear macro-molecule (see CM-1.9, note 2).

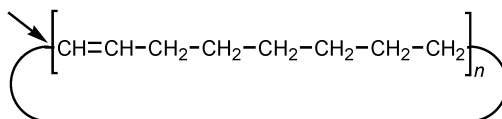
## Example 4



Name: cyclo[poly(3-oxobut-1-ene-1,4-diyl)]

*Note:* The lower locant for the double bond is preferred to the lower locant for the oxo substituent according to seniority rules (p. 1929 in [1]).

## Example 5 (taken from [17])



Name: cyclo[poly(oct-1-ene-1,8-diyl)]

*Note:* The name polyoctenamer for the open-chain polymer of this example is obsolete and should not be used.

### CM-3.3 Irregular monocyclic macromolecules

Single-strand, irregular monocyclic macromolecules have a structure such that with one conceptual scission of the macrocycle they are converted to an irregular, open-chain macromolecule.

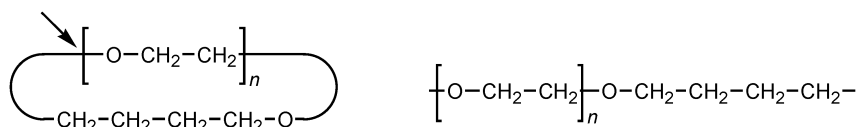
Irregular monocyclic macromolecules are named by prefixing “cyclo-” to the name, in parentheses or square or curly brackets, of the open-chain structure in accordance with the principles of structure-based nomenclature of irregular polymers [2] and the conventions and principles described in CM-2.1 and CM-3.1.

A name of a block and names of constitutional units outside the block in the sequence are separated by hyphens in the name of the macrocycle.

An irregular polymer or a block with unknown distribution of units is written to place its units, separated from each other by a solidus without space before and after it [2], in alphabetical order.

*Note:* In [2], a dash is used to separate a name of a block from names of constitutional units outside the block. In the present document, a hyphen is recommended since hyphens result in more concise names and fulfill the same function. A dash as a special symbol should be reserved for specific cases where a hyphen is inappropriate such as that described in CM-4.7.

Example 6 (taken from [18])



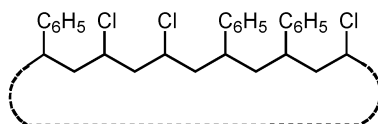
Name: cyclo[poly(oxyethylene)-oxybutane-1,4-diyl]

*Note 1:* The oxygen atom within the constitutional repeating unit is senior to the oxygen atom outside the constitutional repeating unit because the shortest path from one oxygen atom to the next is via the ethylene group within the block.

*Note 2:* If in example 6 the oxybutane-1,4-diyl unit is replaced by an oxymethylene unit, the name is cyclo[oxymethylene-poly(oxyethylene)]; the shortest path from one oxygen to the next is now via the methylene group.

Example 7

A cyclic statistical copolymer of styrene and vinyl chloride joined head-to-tail (a cyclic version of example 1.1 from [2]).



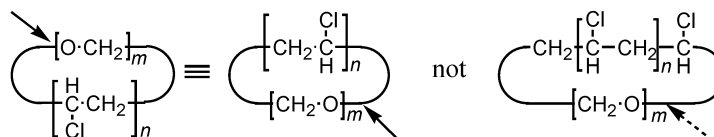
Name: cyclo{poly[(1-chloroethylene)/(1-phenylethylene)]} (according to rule 18 in [1])  
cyclo[poly(1-chloroethylene/1-phenylethylene)] (following [2])

*Note:* Rule 18 in [1] requires that substituted subunits are parenthesized or bracketed; [2] cites these subunits without parentheses or brackets. Following rule 18 in [1] is more uniform and systematic.

### CM-3.3.1 Minimization of the number of individual subunits

Monocyclic macromolecules are written in such a way that the number of individual subunits outside the constitutional repeating units is minimized. This requires in some cases that the senior subunit in a constitutional repeating unit will be located other than at the starting point of the constitutional repeating unit [2].

## Example 8



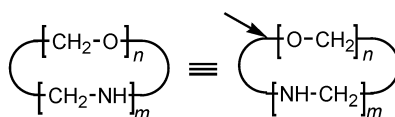
Name: cyclo[poly(oxymethylene)-poly(2-chloroethylene)]

not cyclo[poly(oxymethylene)-methylene-poly(1-chloroethylene)-(chloromethylene)]

*Note 1:* Since  $-\text{O}-\text{CH}_2-$  is the preferred constitutional repeating unit representing a regular block in this example, it automatically determines the direction of citation.

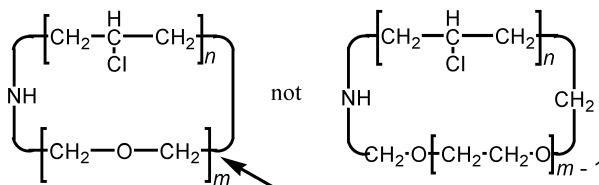
*Note 2:* Because cyclic macromolecules are ring structures, it does not matter which unit is written in the upper left corner of the graphical representation. For naming purposes, it may be convenient to write the unit of highest seniority in the upper left corner and proceed clockwise in the order of decreasing seniority.

## Example 9



Name: cyclo[poly(oxymethylene)-poly(methyleneimino)]

## Example 10



Name: cyclo[poly(methyleneoxymethylene)-imino-poly(2-chloropropane-1,3-diyl)]

*Note:* This example illustrates that minimization of the number of constitutional units takes preference over the order of subunits within a constitutional repeating unit, i.e., it can (and often will) prevent the conceptual scission being made at the most senior subunit (for the direction of citation, see also CM-3.3.2).

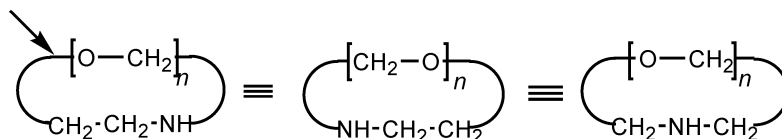
### CM-3.3.2 Direction of citation

If the most senior unit is a preferred constitutional repeating unit, the direction within this unit determines the direction of citation (see example 8). If the most senior unit is not a preferred constitutional repeating unit, the direction for citation of the units is determined by the shortest path length (see CM-1.11) between the most senior unit in a monocyclic macromolecule and the next senior units.

For the case of equal path lengths between the unit of highest seniority and that with the next highest seniority, the path selected is the one with a unit of third highest seniority nearest to the unit of highest seniority.

For equivalent path lengths, the atoms or units inside a constitutional repeating unit are senior to the same atoms or units outside (see also CM-2.1).

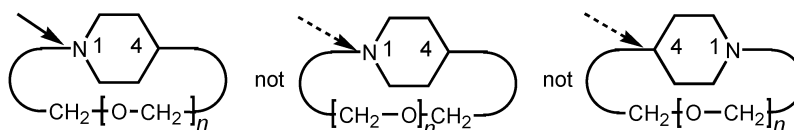
#### Example 11



Name: cyclo[poly(oxymethylene)-iminoethylene]  
not cyclo[poly(oxymethylene)-methyleneiminomethylene]

*Note:* Regrouping of the constitutional repeating unit of the rightmost structure reduces the number of subunits outside the constitutional repeating unit from three to two.

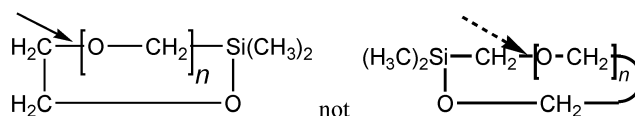
#### Example 12



Name: cyclo[piperidine-1,4-diyl-poly(methyleneoxy)-methylene]  
not cyclo[piperidine-1,4-diyl-methylene-poly(oxymethylene)]  
not cyclo[piperidine-4,1-diyl-poly(methyleneoxy)-methylene]

*Note:* The piperidine ring is the most senior constitutional unit. Because of its fixed numbering and in order to retain the lowest set of locants, the piperidine ring determines the direction of citation.

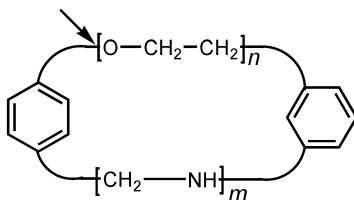
#### Example 13



Name: cyclo[poly(oxymethylene)-(dimethylsilanediyloxy)ethylene]  
not cyclo[poly(oxymethylene)-methyleneoxy(dimethylsilanediyloxy)methylene]

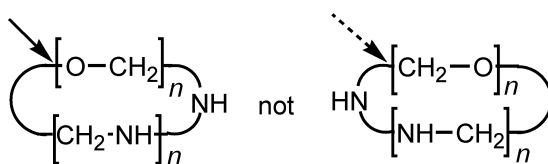
*Note:* Although oxygen has the highest seniority, followed by silicon, the direction of citation is determined by the smallest number of subunits outside of the constitutional repeating unit.

## Example 14



Name: cyclo[poly(oxyethylene)-1,3-phenylene-poly(iminomethylene)-1,4-phenylene]

## Example 15



Name: cyclo[poly(oxymethylene)-imino-poly(iminomethylene)]

not cyclo[poly(methyleneoxy)-poly(methyleneimino)-imino]

*Note:* The direction of the preferred constitutional repeating unit determines the direction of citation.

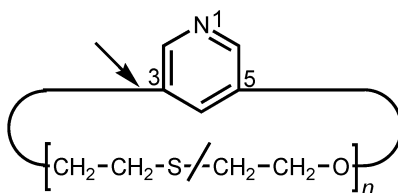
**CM-3.3.3 Substituents and locants**

Constitutional units containing substituted chain atoms are named as described in detail in [1,4–6] and according to the preceding rules.

The name of each substituent together with its locant is prefixed to the name of the appropriate subunit of the macrocycle.

Polyatomic chain or ring units named by nomenclature of organic chemistry such as ethylene, 1,4-phenylene, or pyridine-2,6-diyl retain their own numbering for substitution (see rule 12, p. 1930 [1]). See also examples 12 and 19.

## Example 16



Name: cyclo{pyridine-3,5-diyl-poly[(oxyethylene)/(sulfanediylethylene)]} (according to rule 18 in [1])

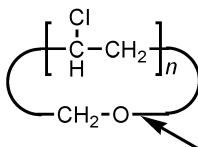
cyclo[pyridine-3,5-diyl-poly(oxyethylene/sulfanediylethylene)] (following [2])

*Note 1:* Citation of the name begins with the locant of the atom attached to the point of conceptual scission. In this case, the lower locant is cited first.

*Note 2:* Although citation of irregular block constitutional units seems to be according to seniority, citation follows alphabetical order according to [2].

*Note 3:* Cf. note at example 7.

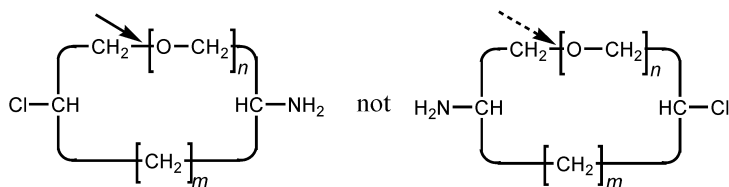
#### Example 17



Name: cyclo[oxy-poly(2-chloroethylene)-methylene]  
not cyclo[oxy-methylene-poly(1-chloroethylene)]

*Note:* Since the path from oxygen to the chloromethylene group is equal in either direction, the path from oxygen via the methylene group within the constitutional repeating unit is preferred. See CM-3.1.3.

#### Example 18

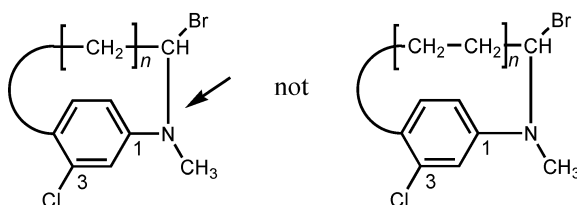


Name: cyclo[poly(oxymethylene)-(aminomethylene)-poly(methylene)-(1-chloroethylene)]  
not cyclo[poly(oxymethylene)-(chloromethylene)-poly(methylene)-(1-aminoethylene)]

*Note 1:* According to rule 10, criterion (e) in [1] (aminomethylene) is senior to (chloromethylene).

*Note 2:* The unsubstituted version of this example would be named cyclo[poly(oxymethylene)-poly(methylene)].

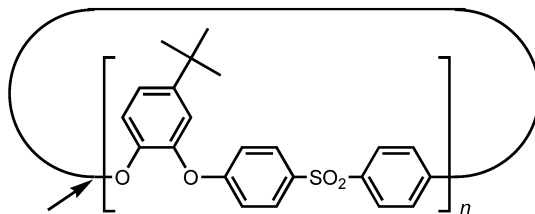
#### Example 19



Name: cyclo[(methylimino)(3-chloro-1,4-phenylene)-poly(methylene)-(bromomethylene)]

*Note:* The name cyclo[(methylimino)(3-chloro-1,4-phenylene)-poly(ethylene)-(bromomethylene)] must not be used since in structure-based nomenclature the preferred constitutional repeating unit is methylene. (See also footnote, p. 1956 in [1].)

Example 20 (taken from [19])



Name: cyclo{poly[oxy(4-*tert*-butyl-1,2-phenylene)oxy-1,4-phenylenesulfonyl-1,4-phenylene]}

#### CM-3.3.4 Macrocyclic substituents

A monocyclic macromolecule containing a macrocyclic substituent requires the determination of the senior macrocycle.

The macrocycle containing the constitutional (repeating) units of highest seniority is the senior ring, and other macrocycles are the substituents (see also CM-4 and CM-5 for polycyclic macromolecules). On this basis, there are two different ways of naming such polymers.

Parent ring nomenclature:

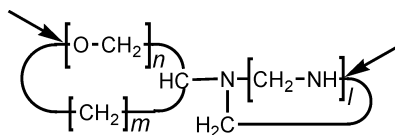
The parent (senior) macrocycle is named as described above where the substituents are included in the names of the respective branch units. The substituents are named starting from the side of the branch unit having units of highest seniority (in alphabetical order in irregular macromolecules with unknown sequence of constitutional units); name 1 in the following examples.

Ring assembly nomenclature:

Each ring is named separately. Branch points are identified for each ring separately as described in CM-4.3, where the branch point of the senior terminal ring has a plain (i.e., unprimed) number, and that of the next ring a primed number. Finally, the bond between two rings is specified by the appropriate symbol, i.e., – for a single or = for a double bond between the respective branch point locants, all included in square brackets and placed in front of the name, e.g., [B1–B1'] or [B1=B1'], cf., the valence bond bridge description in CM-4.7; name 2 in the following examples.

The general format for the name according to the alternative nomenclature is [B1–B1']-cyclo[[B1]ring name 1]-cyclo[[B1']ring name 2].

Example 21

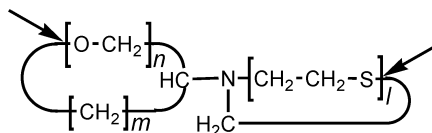


Name 1: cyclo[poly(oxymethylene)-({cyclo[poly(iminomethylene)-nitrilomethylene]}methylene)-poly(methylene)]

Name 2: [B1–B1']-cyclo[poly(oxymethylene)-[B1]methylene-poly(methylene)]-cyclo[poly(iminomethylene)-[B1']iminomethylene]



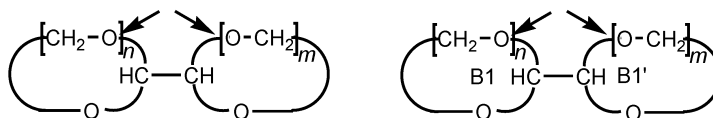
## Example 22



Name 1: cyclo[poly(oxymethylene)-({cyclo[poly(sulfanediylethylene)-nitrilomethylene]}methylene)-poly(methylene)]

Name 2: [B1-B1']-cyclo[poly(oxymethylene)-[B1]methylene-poly(methylene)]-cyclo[poly(sulfanediylethylene)-[B1']iminomethylene]

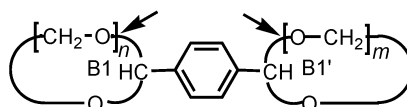
## Example 23



Name 1: cyclo[poly(oxymethylene)-oxy({cyclo[poly(oxymethylene)-oxymethanetriyl]}methylene)]

Name 2: [B1-B1']-bis{cyclo[poly(oxymethylene)-oxy[B1]methylene]}

## Example 24



Name 1: cyclo{poly(oxymethylene)-oxy[(4-{cyclo[poly(oxymethylene)-oxymethanetriyl]}phenyl)methylene]}

Name 2: [B1],[B1']-(1,4-phenylene)-bis{cyclo[poly(oxymethylene)-oxy[B1]methylene]}

## CM-4 BRIDGED POLYCYCLIC MACROMOLECULES

## CM-4.1 Overview

Polycyclic macromolecules (see CM-1.12) are considered to comprise a main ring and at least one bridge between two atoms of this ring. This section provides rules for the identification of the main ring, of bridges, branch points, and branch units, and their locants, and how to name each component or segment. Spiro macromolecules with a free spiro union [5b,6,13] (see CM-1.18) are not included but will be dealt with in CM-5.

The general format of the name for bridged polycyclic macromolecules is

**Bridge(s)-cyclo(main ring).**

*Note:* Treating a polycyclic macromolecule in the above manner reduces it to a monocycle, which is why cyclo and not bicyclo or a higher-order cyclo notation appears in the name.

### CM-4.2 Selection of the main ring and bridges

The main ring is the ring that contains the constitutional units of highest seniority [1,2,5,6]. The remaining parts of the structure are bridges connected to the main ring with branch units.

The main ring is named according to the rules described in CM-3. This means that each constitutional unit of the main ring is named as if no bridge were present.

*Note:* Only bridges connecting two branch points are allowed. Any connection to an additional branch point is considered as a separate bridge.

### CM-4.3 Locants for branch units

Each branch unit in the main ring, to which a bridge is attached, is identified by the letter “B” to indicate a branch point, and by an integer “*n*”. Branch units are numbered with “*n*” in the order in which they appear in the naming sequence of the main ring. This *Bn* expression is preceded, if necessary, by a locant “*l*” that specifies the position within the constitutional unit the branch point is part of, and a colon.

The representation of these symbols, i.e., the sequence of branch point locant *l*, a colon, and the *Bn* expression all enclosed within square brackets: [*l*:*Bn*] is the locant for the branch unit.

In a name, each [*l*:*Bn*] expression directly precedes the name of the constitutional unit to which the branch point belongs without hyphen. The square brackets of the representation of this locant do not affect the nesting order of enclosing marks.

*Note:* Because of the frequent occurrence of letters and numbers that precede ring systems, the use of square brackets and a colon is essential to maintain clarity; compare ...[3:*B1*]1*H*-pyrrole-2,5-diyl... with ...3-*B1*-1*H*-pyrrole-2,5-diyl... (cf. example 26).

### CM-4.4 Locants for bridges

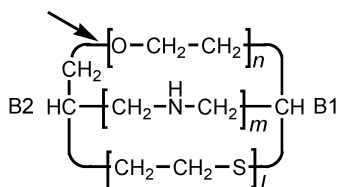
In the name of a bridge, both *Bn* expressions for the corresponding branch units created during the naming of the macrocyclic main ring are cited as locants in ascending order in square brackets **before** the name of the bridge. The complete name of a bridge thus comprises two *Bn* expressions followed by name(s) of the subunit(s) within the bridge. When a locant is required to indicate the attachment position within a bridge, the locant and a colon precede the corresponding *Bn* expression (see example 27).

### CM-4.5 Naming a bridge

In bridge names, constitutional (repeating) units are cited in the order in which they appear, beginning at the lower numbered branch point and proceeding to the higher numbered branch point.

*Note:* For example, although seniority rules dictate that (iminoethylene) be cited in preference to (ethyleneimino), in bridge names, [*B1*],[*B2*]- (ethyleneimino) takes precedence over [*B2*],[*B1*]- (iminoethylene). See example 29.

Example 25



Main ring: contains the *O*- and *S*-containing constitutional repeating unit

Bridge: *N*-containing block

Branch point 1: [B1]methylene

Branch point 2: carbon-1 in an ethylene unit ...[1:B2]ethylene...

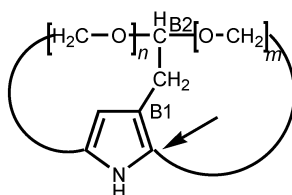
Name for main ring: cyclo[poly(oxyethylene)-[B1]methylene-poly(sulfanediylethylene)-[1:B2]ethylene]

Name for the bridge: [poly(methyleneiminomethylene)]

Locants for the bridge: [B1],[B2]

Name for the polymer: [B1],[B2]-[poly(methyleneiminomethylene)]-cyclo[poly(oxyethylene)-[B1]methylene-poly(sulfanediylethylene)-[1:B2]ethylene]

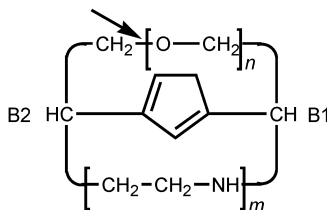
#### Example 26



Name: [B1],[B2]-(methylene)-cyclo[[3:B1]1*H*-pyrrole-2,5-diyl-poly(methyleneoxy)-[B2]methylene-poly(oxyethylene)]

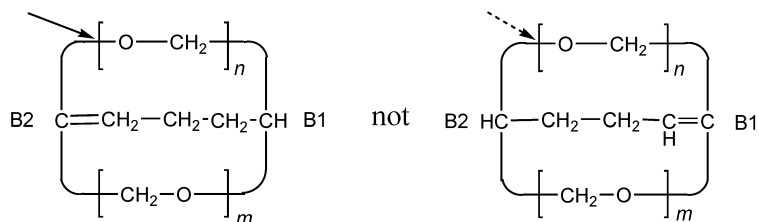
*Note:* The first branch point is at position 3 within a 1*H*-pyrrole-2,5-diyl unit of the main ring.

#### Example 27



Name: [1:B1],[3:B2]-(cyclopenta-1,3-diene-1,3-diyl)-cyclo[poly(oxyethylene)-[B1]methylene-poly(iminoethylene)-[1:B2]ethylene]

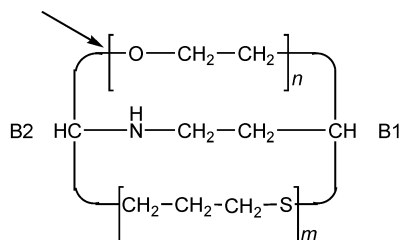
#### Example 28



Name: [B1],[B2]-(propan-1-yl-3-ylidene)-cyclo[poly(oxyethylene)-[B1]methylene-poly(oxyethylene)-[B2]methylene]

*Note:* Since in nomenclature of organic chemistry -yl is senior to -ylidene, a lower locant for -yl is preferred if the same locant set would result when both suffixes are considered together. As a result, the first branch point should be the one with the single bond, which in turn determines that naming begins with the oxygen atom marked with an arrow.

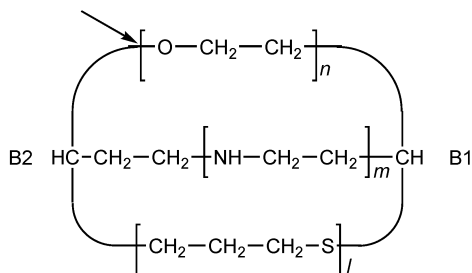
## Example 29



Name: [B1],[B2]-(ethyleneimino)-cyclo[poly(oxyethylene)-[B1]methylene-poly(sulfanediylpropane-1,3-diyl)-[B2]methylene]

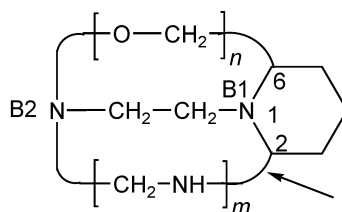
*Note:* Bridge names used in nomenclature of organic chemistry such as epiminoethano are not used in polymer nomenclature.

## Example 30



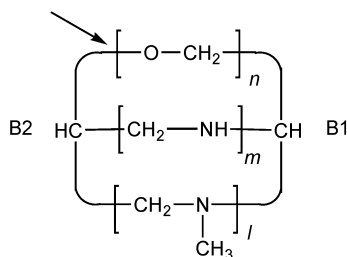
Name: [B1],[B2]-[poly(ethyleneimino)-ethylene]-cyclo[poly(oxyethylene)-[B1]methylene-poly(sulfanediylpropane-1,3-diyl)-[B2]methylene]

## Example 31



Name: [B1],[B2]-(ethylene)-cyclo[[1:B1]piperidine-2,6-diyl-poly(methyleneoxy)-[B2]imino-poly(methyleneimino)]

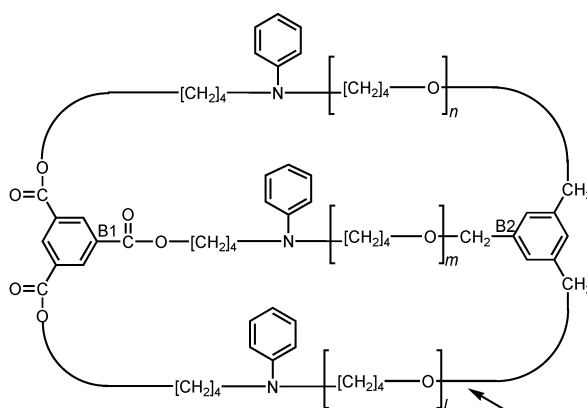
## Example 32



Name: [B1],[B2]-[poly(iminomethylene)]-cyclo{poly(oxymethylene)-[B1]methylene-poly[(methylimino)methylene]-[B2]methylene}

*Note:* A substituted subunit in a backbone is senior to the same subunit when unsubstituted; thus,  $-\text{N}(\text{Me})-$  is senior to  $-\text{NH}-$ , and  $-\text{N}(\text{Me})-\text{CH}_2-$  is senior to  $-\text{NH}-\text{CH}_2-$ .

## Example 33 (taken from [20])

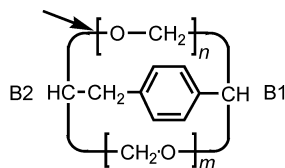


Name: [B1],[B2]-[carbonyloxybutane-1,4-diyl(phenylimino)-poly(butane-1,4-dioxy)-methylene]-cyclo[poly(oxybutane-1,4-diyl)-(phenylimino)butane-1,4-dioxy[5:B1]isophthaloyloxybutane-1,4-diyl(phenylimino)-poly(butane-1,4-dioxy)-methylene[5:B2]1,3-phenylenemethylene]

**CM-4.6 Influence of a bridge on the conceptual scission of the main ring**

For polycyclic macromolecules having a type of symmetry such that the name of the main ring is identical regardless of the direction taken around the ring, path lengths from each senior unit to the senior constitutional unit in the bridge **must** be considered; the shortest path determines from which main ring senior unit the naming starts. See also example 28.

## Example 34



Name: [B1],[B2]-(1,4-phenylenemethylene)-cyclo[poly(oxymethylene)-[B1]methylene-poly(oxy-methylene)-[B2]methylene]

*Note 1:* The ethylene two-carbon sequence (with one atom in the bridge and the other in the main ring) must be broken in order to separate the main ring atoms from the bridge atoms.

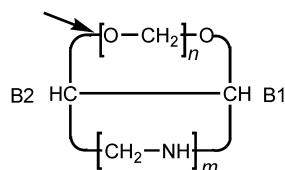
*Note 2:* The name of the main ring, whether it begins from the oxygen atom with the arrow or the oxygen atom of the other block, is cyclo[poly(oxymethylene)-[B1]methylene-poly(oxy-methylene)-[B2]methylene]. The main ring structure, therefore, cannot be used to determine from which oxygen atom to begin. Starting from the oxygen atom with the arrow results in the bridge name including locants [B1],[B2]-(1,4-phenylenemethylene); starting from the oxygen atom of the other block results in the bridge name including locants [B1],[B2]-(methylene-1,4-phenylene). Since a carbocyclic constitutional unit is senior to an acyclic constitutional unit [1,2,5,6], the preferred bridge name including locants is [B1],[B2]-(1,4-phenylenemethylene). This, in turn, determines that naming of the main ring begins at the oxygen atom with the arrow.

## CM-4.7 Valence bond bridges

A bridge consisting only of a single, double, or (theoretically) triple bond is denoted in square brackets by [B<sub>n</sub>] expressions as locants, between which the appropriate symbol is placed, i.e., [B1–B2], [B1=B2], or [B1≡B2], cited in front of the name of the main ring in which the branch points are identified as usual (see CM-4.3).

*Note:* A triple bond as a bridge is highly unlikely in a real polycyclic macromolecule.

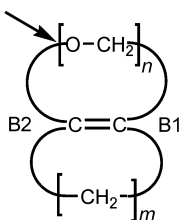
## Example 35



Name: [B1–B2]-cyclo[poly(oxymethylene)-oxy-[B1]methylene-poly(iminomethylene)-[B2]methylene]

*Note:* This example illustrates application of seniority rules [1,2,4]; the O–C–O–C–N sequence (clockwise from O with arrow) is preferred to the O–C–O–C–C–N sequence (counter-clockwise from the O not marked with an arrow). Naming therefore proceeds clockwise from the O marked with an arrow.

## Example 36

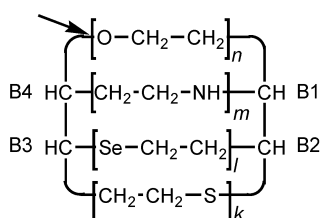


Name: [B1=B2]-cyclo[poly(oxymethylene)-[B1]methylene-poly(methylene)-[B2]methylene]

**CM-4.8 Multiple bridges**

Multiple bridges are named in the order in which the branch points, each identified by the respective [B*n*] expression, were assigned during the naming of the main ring.

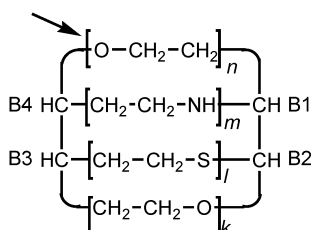
## Example 37



Name: [B1],[B4]-[poly(iminoethylene)]-[B2],[B3]-[poly(ethyleneselanediy)]-cyclo[poly(oxyethylene)-[1:B1][2:B2]ethylene-poly(sulfanediylethylene)-[1:B3][2:B4]ethylene]

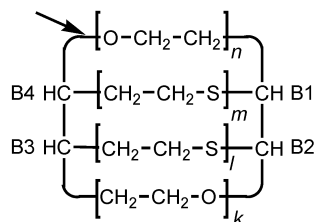
If more than one constitutional unit in the main ring can be chosen as the senior unit and the names of the main ring thus generated are identical with each other, path lengths from each main ring senior unit to the senior constitutional unit in each bridge must be considered.

## Example 38



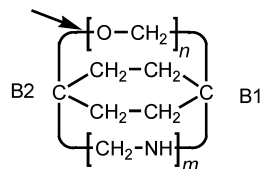
Name: [B1],[B4]-[poly(iminoethylene)]-[B2],[B3]-[poly(sulfanediylethylene)]-cyclo[poly(oxyethylene)-[1:B1][2:B2]ethylene-poly(oxyethylene)-[1:B3][2:B4]ethylene]

## Example 39



Name: [B1],[B4]-[poly(sulfanediylethylene)]-[B2],[B3]-[poly(sulfanediylethylene)]-cyclo[poly(oxyethylene)-[1:B1][2:B2]ethylene-poly(oxyethylene)-[1:B3][2:B4]ethylene]  
 or [B1],[B4]:[B2],[B3]-bis[poly(sulfanediylethylene)]-cyclo[poly(oxyethylene)-[1:B1][2:B2]ethylene-poly(oxyethylene)-[1:B3][2:B4]ethylene]

## Example 40



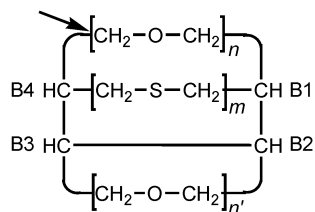
Name: [B1],[B2]-(ethylene)-[B1],[B2]-(ethylene)-cyclo[poly(oxymethylene)-[B1]methylene-poly(iminomethylene)-[B2]methylene]  
 or [B1]<sub>2</sub>,[B2]<sub>2</sub>: [B1],[B2]-bis(ethylene)-cyclo[poly(oxymethylene)-[B1]methylene-poly(iminomethylene)-[B2]methylene]

*Note:* The ring system of this example contains two spiro atoms, which are the branch points. Since none of these is a free spiro union, the substance must be named as bridged polycyclic macromolecule.

**CM-4.9 Seniority of a constitutional unit over a valence bond bridge**

In polycyclic macromolecules containing at least one bridge comprising one or more constitutional units and at least one bridge comprising a valence bond, when more than one constitutional unit in the main ring can be chosen as the senior unit and the names of the main ring thus generated are identical to each other, bridges containing constitutional units are senior to valence bond bridges.

## Example 41





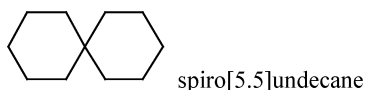
Name: [B1],[B4]-[poly(methylenesulfanediy)methylene]-[B2-B3]-cyclo[poly(methyleneoxymethylene)-[1:B1][2:B2]ethylene-poly(methyleneoxymethylene)-[1:B3][2:B4]ethylene]

*Note:* In cyclic macromolecules with more than one valence-bond bridge, the order of decreasing seniority is triple bond > double bond > single bond.

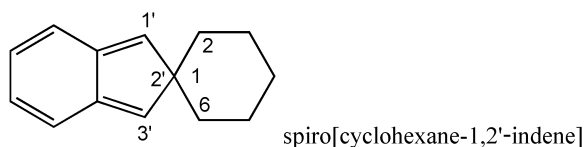
## CM-5 SPIRO MACROMOLECULES

### CM-5.1 Introduction

Spiro molecules have a single atom common to two ring systems. In some non-polymeric spiro compounds such as spiro[5.5]undecane and others in which all component rings could be named by an established “cyclo...” name, the shared atom is not cited (rule SP-1.1 [13] and R-2.4.3.1 [5,6]).



In other cases, in which at least one of the rings (or ring systems) has a name not beginning with “cyclo...”, e.g., spiro[cyclohexane-1,2'-indene], the “shared” atom of each spiro union is cited twice (rules SP-4.1 [13] and R-2.4.3.3 [5]).



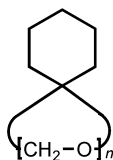
For naming spiro macromolecules, the second of these methods is recommended as the more general method.

The method described in CM-4 for bridged polycyclic macromolecules could also be adapted for spiro macromolecules. This leads to shorter and often easier names for monospiro macromolecules, but much more complicated names result for more complex structures when using this method. Both methods are described below. The method using the prefix “spiro” is generally the preferred method.

Only macrocyclic substances containing a free spiro union, i.e., those in which the two rings or ring systems sharing the spiro atom are not interconnected by additional bridges, such as in example 40, are named as described in the following sections.

Substances with spiro unions to non-macromolecular rings such as cyclohexane, e.g., cyclo[poly(oxymethylene)-cyclohexane-1,1-diyl], example 42, are not regarded as spiro macromolecules. They are cyclic macromolecules and named according to the recommendations in CM-3.

Example 42



Name: cyclo[poly(oxymethylene)-cyclohexane-1,1-diyl]

### CM-5.2 Bicyclic monospiro macromolecules

#### Spiro-name:

Both rings of a spiro macromolecule containing only two macrocycles are named independently according to the recommendations in CM-3. The spiro atom is regarded as a branch point in each ring, and a prime is added to the branch point expression referring to the less senior ring. The prefix “spiro” is placed in front of the names of the components, which are cited in order of seniority, enclosed in square brackets regardless of the nesting order. The locants for the spiro atom expressed by the respective branch point expression of each of the individual macrocycles are placed between the names of the components.

The general format for the name is

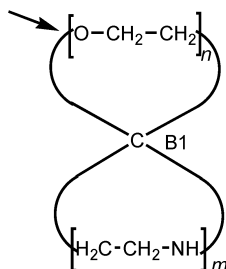
**spiro[cyclo(ring name 1)-[B $n$ ],[B $n'$ ]-cyclo(ring name 2)],**

in which [B $n$ ] and [B $n'$ ] are the locants for the spiro atom.

#### Alternative polycyclic macromolecule name:

Alternatively, the most senior macrocycle may be named according to the recommendations in CM-3. The other ring is then regarded as a bridge and named according to the recommendations for naming bridges in CM-4 and cited in front of the name of the main ring. The same locant is cited twice before the name of the bridge in order to indicate that both of its ends are attached to the same branch point of the main ring.

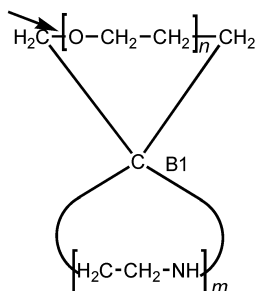
#### Example 43



Name: spiro[cyclo[poly(oxyethylene)-[B1]methylene]-[B1],[B1']-cyclo[poly(iminoethylene)-[B1']methylene]]

Alternative name: [B1],[B1]-[poly(iminoethylene)]-cyclo[poly(oxyethylene)-[B1]methylene]

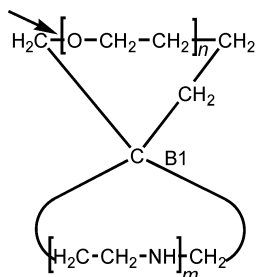
#### Example 44



Name: spiro[cyclo[poly(oxyethylene)-[2:B1]propane-1,3-diyl]-[B1],[B1']-cyclo[poly(iminoethylene)-[B1']methylene]]

Alternative name: [B1],[B1]-[poly(iminoethylene)]-cyclo[poly(oxyethylene)-[2:B1]propane-1,3-diyl]

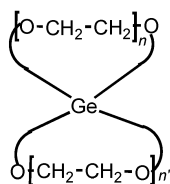
## Example 45



Name: spiro[cyclo[poly(oxyethylene)-[3:B1]butane-1,4-diyl]-[B1],[B1']-cyclo[poly(iminoethylene)-[1:B1']ethylene]]

Alternative name: [B1],[B1']-[poly(methyleneiminomethylene)-methylene]-cyclo[poly(oxyethylene)-[3:B1]butane-1,4-diyl]

## Example 46 (taken from [21])



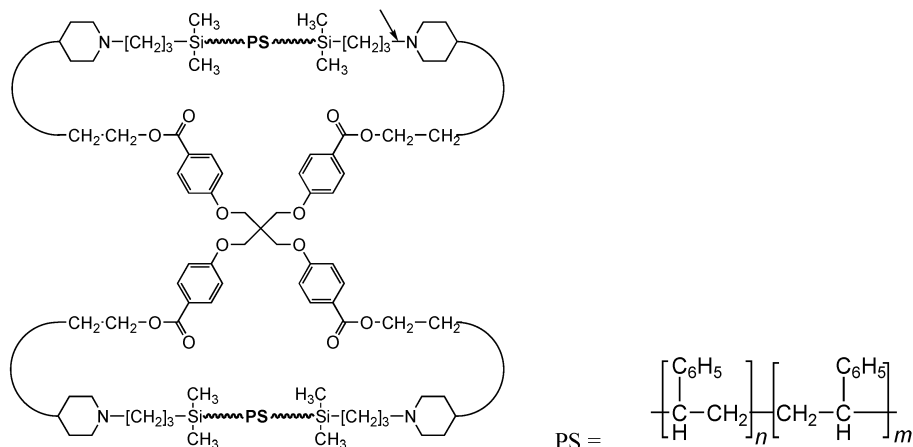
Name: spiro[cyclo[oxy[B1]germanediyl-poly(oxyethylene)]-[B1],[B1']-cyclo[oxy[B1']germanediyl-poly(oxyethylene)]]

or [B1],[B1']-spirobi[cyclo[oxy[B1]germanediyl-poly(oxyethylene)]]

Alternative name: [B1],[B1']-[poly(oxyethylene)-oxy]-cyclo[oxy[B1]germanediyl-poly(oxyethylene)]

*Note:* The spirobi[...] method described in SP-2.1 [13] for spiro compounds with two identical spiro-fused rings may also be used, even though the two rings in a spiro macromolecule are most likely of different size.

Example 47 (taken from [22])



Name: spiro[cyclo[piperidine-1,4-diylethyleneoxycarbonyl-1,4-phenyleneoxy[2:B1]propane-1,3-diyloxy-1,4-phenylenecarbonyloxyethylenepiperidine-4,1-diylpropane-1,3-diyl(dimethylsilanediyl)-poly(1-phenylethylene)-poly(2-phenylethylene)-(dimethylsilanediyl)propane-1,3-diyl]-[B1],[B1']-cyclo[piperidine-1,4-diylethyleneoxycarbonyl-1,4-phenyleneoxy[2:B1']propane-1,3-diyloxy-1,4-phenylenecarbonyloxyethylenepiperidine-4,1-diylpropane-1,3-diyl(dimethylsilanediyl)-poly(1-phenylethylene)-poly(2-phenylethylene)-(dimethylsilanediyl)propane-1,3-diyl]]

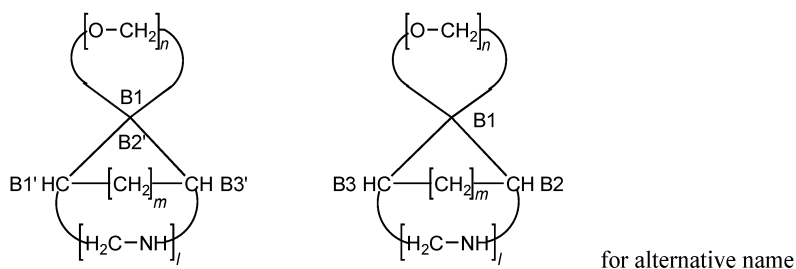
or [B1],[B1']-spirobi[cyclo[piperidine-1,4-diylethyleneoxycarbonyl-1,4-phenyleneoxy[2:B1]propane-1,3-diyloxy-1,4-phenylenecarbonyloxyethylenepiperidine-4,1-diylpropane-1,3-diyl(dimethylsilanediyl)-poly(1-phenylethylene)-poly(2-phenylethylene)-(dimethylsilanediyl)propane-1,3-diyl]]

Alternative name: [B1],[B1']-[methyleneoxy-1,4-phenylenecarbonyloxyethylenepiperidine-4,1-diylpropane-1,3-diyl(dimethylsilanediyl)-poly(1-phenylethylene)-poly(2-phenylethylene)-(dimethylsilanediyl)propane-1,3-diyl]piperidine-1,4-diylethyleneoxycarbonyl-1,4-phenyleneoxymethylene]-cyclo[piperidine-1,4-diylethyleneoxycarbonyl-1,4-phenyleneoxy[2:B1]propane-1,3-diyloxy-1,4-phenylenecarbonyloxyethylenepiperidine-4,1-diylpropane-1,3-diyl(dimethylsilanediyl)-poly(1-phenylethylene)-poly(2-phenylethylene)-(dimethylsilanediyl)propane-1,3-diyl]]

### CM-5.3 Spiro macromolecules with additional bridges

If there are additional bridges present in a spiro macromolecule with a free spiro union, the most senior spiro macromolecule that can be named according to CM-5.2 is selected and named accordingly. Branch point expressions are added as appropriate, and finally the names of the bridges are placed in front of the name as described in CM-4.1.

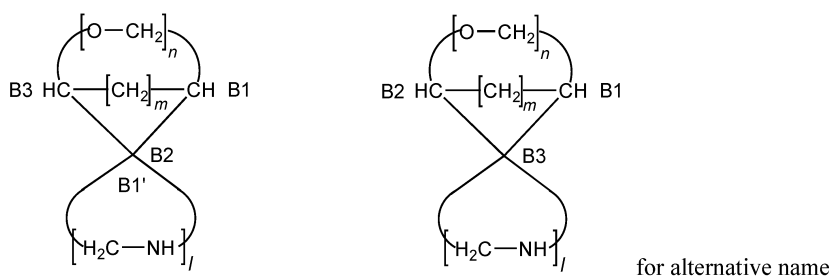
## Example 48



Name: [B1'],[B3']-[poly(methylene)]-spiro[cyclo[poly(oxymethylene)-[B1]methylene]-[B1],[B2']-cyclo[poly(iminomethylene)-[1:B1',2:B2',3:B3']propane-1,3-diyl]]

Alternative name: [B1],[B1']-[B2],[B3]-[poly(methylene)]-[B2]methylene-poly(iminomethylene)-[B3]methylene]-cyclo[poly(oxymethylene)-[B1]methylene]

## Example 49



Name: [B1],[B3]-[poly(methylene)]-spiro[cyclo[poly(oxymethylene)-[1:B1,2:B2,3:B3]propane-1,3-diyl]-[B2],[B1']-cyclo[poly(iminomethylene)-[B1']methylene]]

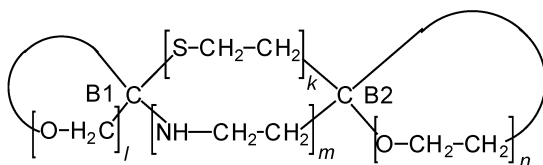
Alternative name: [B1],[B2]-[B3],[B3]-[poly(iminomethylene)]-[B3]methylene]-cyclo[poly(oxymethylene)-[B1]methylene-poly(methylene)-[B2]methylene]

## CM-5.4 Polyspiro macromolecules

For polyspiro macromolecules, the principles of CM-5.2 and CM-5.3 are extended in a similar fashion to those published in [13] for non-macromolecular spiro compounds. Briefly, if more than one spiro atom is present in a polymacrocyclic substance, a numerical prefix (e.g., di, tri, etc.) in front of the prefix “spiro” indicates the number of spiro atoms shared by two macromolecular rings. The component macromolecular rings are cited in order of occurrence beginning with the most senior terminal component. The locants for the spiro atoms expressed by the respective branch point expression of each of the individual macrocycles are placed between the names of the respective components, with a prime added to the branch point expression referring to the second and two primes to those referring to the third component ring, etc.

*Note:* Polyspiro macromolecules with only macrocycles and bridges are rather theoretical. Apart from the difficulty of synthesizing such molecules, unambiguous proof of the polyspiro structure would be difficult or even impossible to obtain.

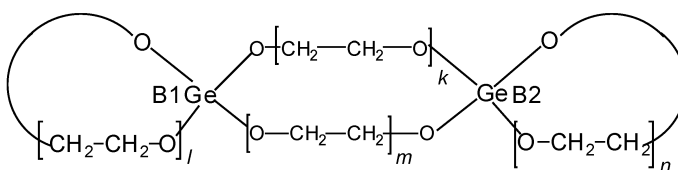
## Example 50



Name: dispiro[cyclo[poly(oxyethylene)-[B1]methylene]-[B1],[B2']-cyclo[poly(sulfanediylethylene)-[B1']methylene-poly(ethyleneimino)-[B2']methylene]-[B1'],[B1'']-cyclo[poly(oxyethylene)-[B1'']methylene]]

Alternative name: [B1],[B1]-{[B2],[B2]-[poly(oxyethylene)]-poly(sulfanediylethylene)-[B2]methylene-poly(ethyleneimino)}-cyclo[poly(oxyethylene)-[B1]methylene]

## Example 51 (taken from [23])



Name: dispiro[cyclo[poly(oxyethylene)-oxy[B1]germanediyl]-[B1],[B1']-cyclo[poly(oxyethylene)-oxy[B1']germanediyl-poly(oxyethylene)-oxy[B2']germanediyl]-[B2'],[B1'']-cyclo[poly(oxyethylene)-oxy[B1'']germanediyl]]

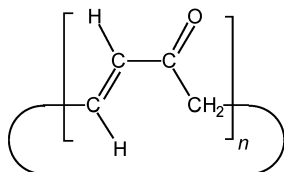
Alternative name: [B1],[B1]-[poly(oxyethylene)-oxy]-[B2],[B2]-[poly(oxyethylene)-oxy]-cyclo[poly(oxyethylene)-oxy[B1]germanediyl-poly(oxyethylene)-oxy[B2]germanediyl]

or [B1],[B1]:[B2],[B2]-bis[poly(oxyethylene)-oxy]-cyclo[poly(oxyethylene)-oxy[B1]germanediyl-poly(oxyethylene)-oxy[B2]germanediyl]

**CM-6 STEREOISOMERISM**

Configuration of stereogenic units in cyclic macromolecules is denoted by conventional stereodescriptors. A more detailed description of possible forms of stereoisomerism will be covered in a future document.

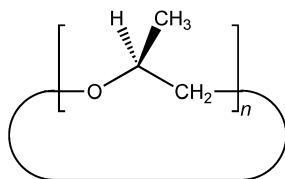
## Example 52

*E/Z* isomerism

Name: cyclo{poly[(*E*)-3-oxobut-1-ene-1,4-diyl]}

## Example 53

Chiral constitutional repeating unit



Name: cyclo(poly{oxy[(1S)-1-methylethylene]})

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