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MACROMOLECULAR DIVISION
COMMISSION ON MACROMOLECULAR NOMENCLATURE*

**A CLASSIFICATION OF LINEAR
SINGLE-STRAND POLYMERS**

(Recommendations 1988)

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A classification of linear single-strand polymers (Recommendations 1988)

The polymer literature lacks, at present, a widely applicable, internally consistent, and easily recognizable system for classifying polymers. This situation prevails in spite of the large number of polymers that are already known or will be synthesized in the future. The classification scheme to be presented here facilitates logical indexing, including through the use of computer techniques, information storage and retrieval. At the present time, the scheme is limited to linear single-strand organic and inorganic polymers. It is consistent with previous IUPAC recommendations (References 1–5).

GENERAL PRINCIPLES

The classification consists of a hierarchical scheme for naming polymers according to the chemical constitution of the repeating units in the main chain (backbone). It can be applied to homopolymers, alternating copolymers, and other macromolecular substances in which the constitutional repeating units can be identified. All existing linear single-strand polymers are embraced by this classification, which has been designed so as to be capable of extension to include any new structures of this type. In view of the open-ended nature of the classification, the tables below can only be illustrative, not comprehensive.

Four hierarchical levels are used; in order of decreasing importance, they are: classes, subclasses, groups, and individual polymers.

CLASSES

Polymers are divided into two principal classes on the basis of the constitution of the main chain.

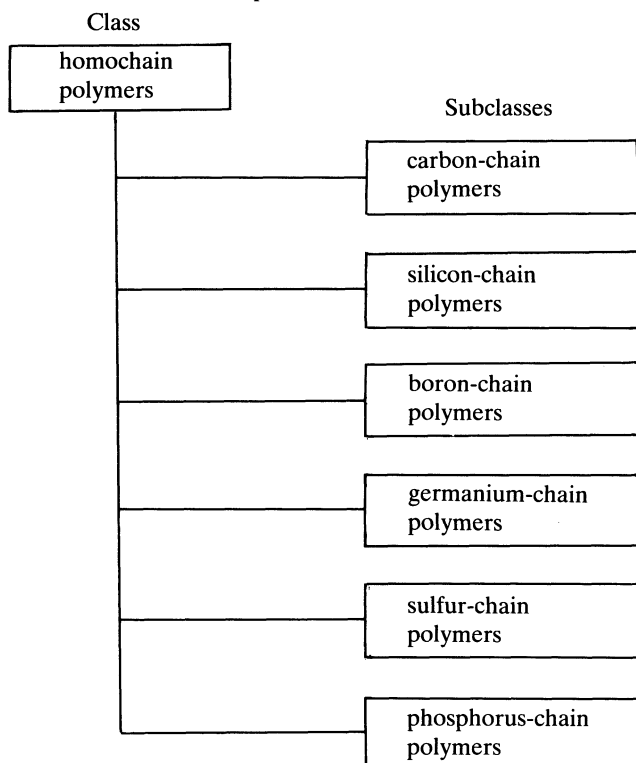
Homochain polymers are those in which the main chains are constructed from atoms of a single element.

Rule 1

Homochain polymers are named by placing the name or symbol of the element in the main chain immediately before the expression ‘-chain polymer’.

Examples (see also SUBCLASSES, below, and Table 1)
carbon-chain polymer or C-chain polymer;
sulfur-chain polymer or S-chain polymer.

Heterochain polymers are those in which the main chains are constructed from atoms of two or more elements.

Table 1. Examples of subclasses of homochain polymers**Rule 2.1**

Heterochain polymers are named by placing the names or symbols of all the elements in the main chain, in parentheses, immediately before the expression '-chain polymer'.

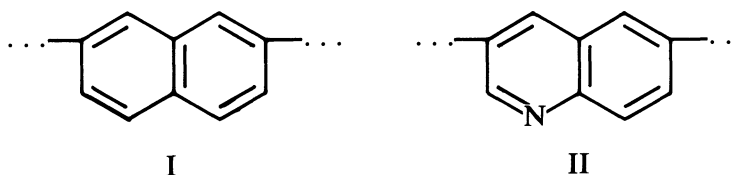
Examples (see also SUBCLASSES, below, and Table 2)

(oxygen,carbon)-chain polymer or (O,C)-chain polymer;

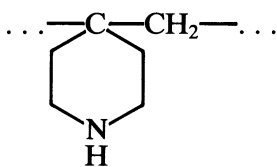
(oxygen,nitrogen,carbon)-chain polymer or (O,N,C)-chain polymer.

Rule 2.2

The order of citation of the elements in heterochain polymers is that conventionally used in inorganic nomenclature (Reference 6). For the common elements, the order of citation is as follows: O, S, N, P, C, Si, B. Note that in those cases where the main chain has bonds in common with cyclic structures, *all* atoms in the rings must be considered for classification purposes. Thus I is a homochain polymer, whereas II is a heterochain polymer.



On the other hand, a polymer such as III, in which the main chain has no bonds in common with the cyclic structure, is classified as a homochain polymer.

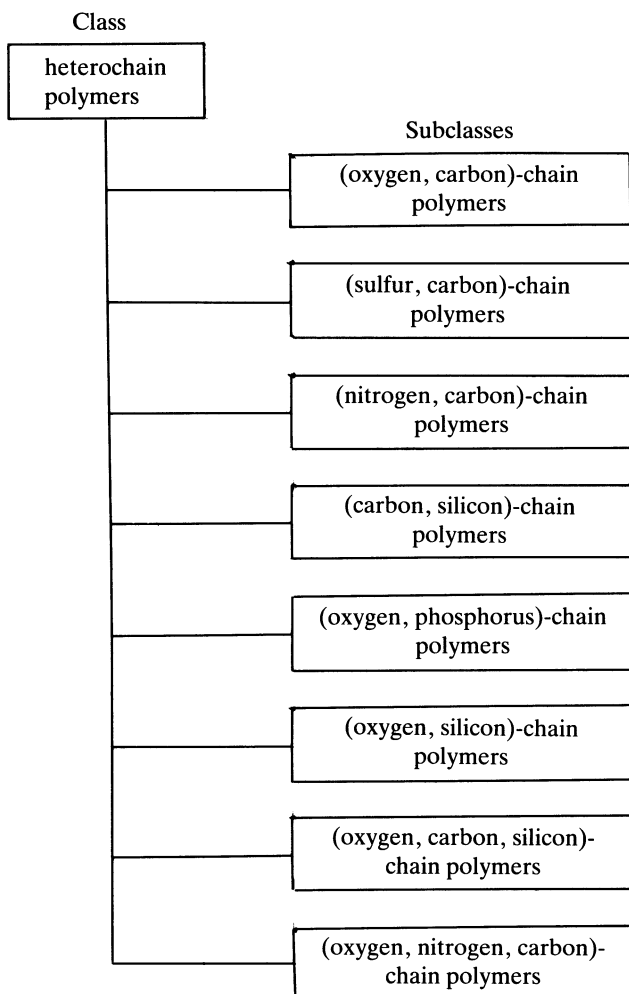


III

Rule 3.1

The presence of specific sidegroups, or specific elements in sidegroups, is indicated by placing the name of the sidegroup, or of the element in the sidegroup, immediately before the expression ‘-sidegroup polymer’.

Table 2. Examples of subclasses of heterochain polymers



Rule 3.2

Where more than one element, or more than one sidegroup, is to be specified, the names of the elements or sidegroups are placed in parentheses.

Examples

oxygen-sidegroup polymer;

hydroxyl-sidegroup polymer [for poly(1-hydroxyethylene), etc.];

ether-sidegroup polymer [for poly(1-methoxyethylene), etc.];

(O,N,P)-sidegroup polymer;

(ether,amide)-sidegroup polymer.

SUBCLASSES

Each class of polymers can be divided into various subclasses, according to the nature of the elements in the main chain. Examples are given in Rules 1, 2.1, as well as in Tables 1 and 2.

GROUPS

Each subclass can be further divided into groups having similar chemical structures. Examples of carbon-chain polymers are polyalkylenes, polyarylenes, etc. (Table 3A).

Table 3A. Examples of groups of carbon-chain polymers

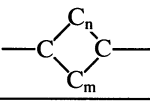
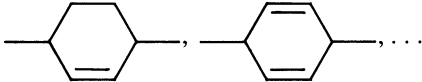
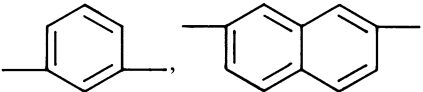
| Subclass | Groups |
|--------------------------|--|
| carbon-chain polymers | polyalkylenes and polyalkylidenes -(C-C-C)- |
| | polyalkenylenes -(C=C)- |
| | polyalkynylenes $\text{-(C}\equiv\text{C)-}$ |
| | polycycloalkylenes  |
| | polycycloalkenylenes  |
| | polyarylenes  |

Table 3B. Examples of groups of (oxygen,carbon)-chain polymers

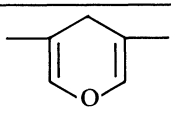
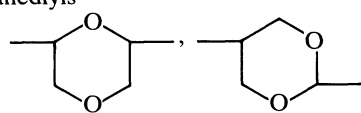
| Subclass (oxygen, carbon)- chain polymers | Groups |
|---|--|
| | polyethers —O—C— |
| | polyesters of carboxylic acids —O—C(=O)— |
| | polyanhydrides of carboxylic acids —C(=O)—O—C(=O)— |
| | polycarbonates —O—C(=O)—O— |
| | polypyrandiyls  |
| | polydioxanediyls  |

Table 3C. Examples of groups of (sulfur,carbon)-chain polymers

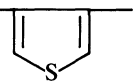
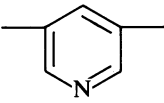
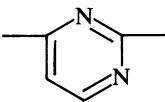
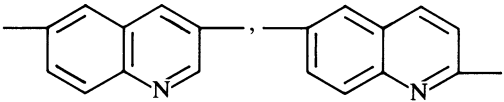
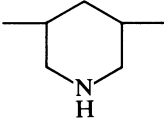
| Subclass (sulfur, carbon)- chain polymers | Groups |
|---|--|
| | polythioethers —S—C— |
| | polysulfones —S(=O)(=O)—C— |
| | polythiophenediyls  |

Table 3D. Examples of groups of (nitrogen,carbon)-chain polymers

| Subclass | Groups |
|--------------------------------------|--|
| (nitrogen,carbon)- chain polymers | polyamines —N—C— |
| | polyimines —N=C— |
| | polyamides —N—C— O |
| | polyureas —N—C—N— O |
| | polymeric quaternized ammonium salts —N [⊕] —C— |
| | polypyridinediyls  |
| | polypyrimidinediyls  |
| | polyquinolinediyls  |
| | polypiperidinediyls  |

Examples of (oxygen,carbon)-chain polymers are polyethers, polycarbonates, etc. (Table 3B). Examples of other types can be found in Tables 3C and 3D.

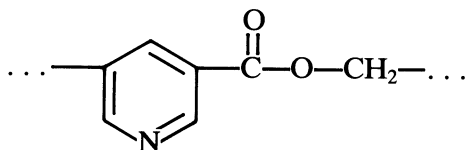
It is convenient to retain such widely accepted terminology as polyacetals, polycarbonates, polyamides, polyesters, nucleic acids, etc., for naming the groups of polymers.

INDIVIDUAL POLYMERS

The lowest hierarchical ranking is given to the individual polymers, which are named in accordance with accepted IUPAC nomenclature practice. The reader is referred

to References 2 and 3 for recommendations for naming organic and inorganic single-strand polymers, respectively.

It is to be noted that, for polymers of complex structure, assignment to more than one subclass and/or group is sometimes possible. For example, the polymer



may be classified as follows:

class: heterochain

subclass: (O,N,C)-chain polymer

groups: polycarboxylate and/or pyridine-chain polymer

Additional examples are given in Table 4 and the Appendix.

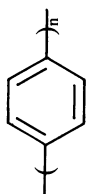
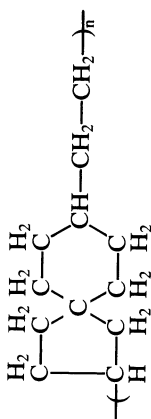
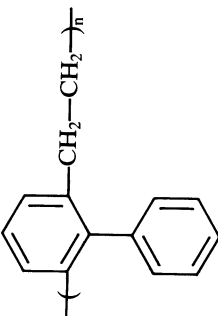

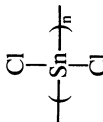
Table 4. Examples of individual polymers

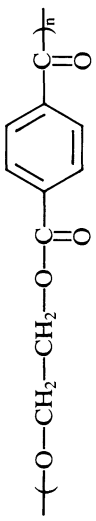
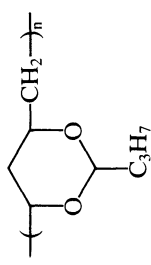
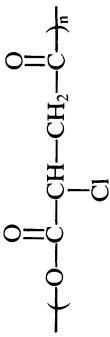
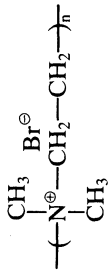
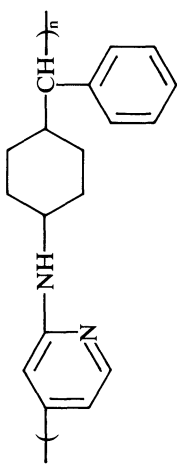
| Group | (Structure) | Individual polymers (Name) |
|-----------------|--|---|
| Polyalkylenes | $\left(\begin{array}{c} \text{CH}_3 \\ \\ \text{---C---CH}_2\text{---} \\ \\ \text{CH}_3 \end{array} \right)_n$ | Poly(1,1-dimethylethylene) Polyisobutylene |
| Polyalkenylenes | $\left(\begin{array}{c} \text{---C=CHCH}_2\text{CH}_2\text{---} \\ \\ \text{Cl} \end{array} \right)_n$ | Poly(1-chloro-1-butenylene) Polychloroprene |
| Polyethers | | Poly(oxy-1,4-phenylene) Poly(phenylene oxide) |
| Polyamides | $\left[\text{---NH---C(=O)---(CH}_2\text{)}_4\text{---C(=O)---NH---(CH}_2\text{)}_6\text{---} \right]_n$ | Poly(iminoadipoyliminohexamethylene) Poly(hexamethylene adipamide) |

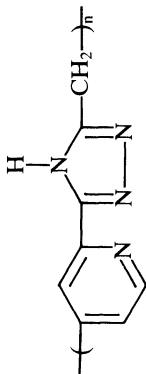
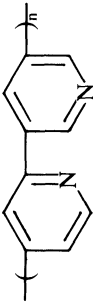
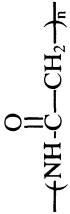
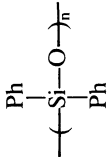

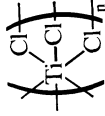
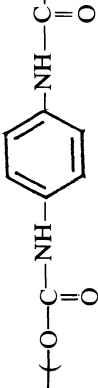
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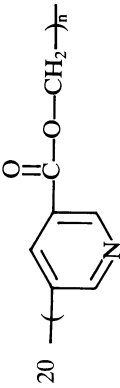
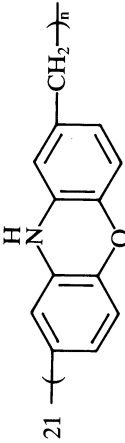
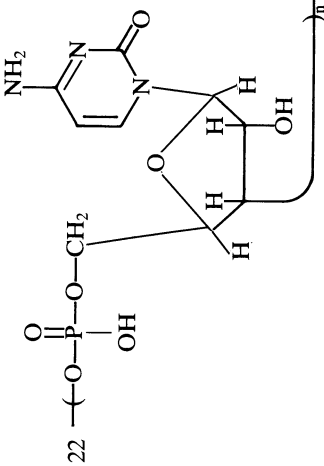

- 1 'Basic Definitions of Terms Relating to Polymers 1974'. *Pure Appl. Chem.* **40**, 477-491 (1974).
- 2 'Nomenclature of Regular Single-Strand Organic Polymers (Rules Approved 1975)'. *Pure Appl. Chem.* **48**, 373-385 (1976).
- 3 'Nomenclature for Regular Single-Strand and Quasi-Single-Strand Inorganic and Coordination Polymers (Recommendations 1984)'. *Pure Appl. Chem.* **57**, 149-168 (1985).
- 4 'Stereochemical Definitions and Notations Relating to Polymers (Recommendations 1980)' *Pure Appl. Chem.* **53**, 733-752 (1981).
- 5 'Report on Nomenclature in the Field of Macromolecules'. *J. Polym. Sci.* **8**, 257-277 (1952).
- 6 Rule IP-2.1 in Ref. 3.

APPENDIX

| Individual polymer | | Groups | Subclass | Class |
|--------------------|---|--------------------|----------|-----------|
| 1 | $\text{---}(\text{S})_n\text{---}$ | — | S-chain | homochain |
| 2 |  | polyarylenes | C-chain | homochain |
| 3 |  | polycycloalkylenes | C-chain | homochain |
| 4 |  | polyarylenes | C-chain | homochain |
| 5 |  | polyalkylenes | C-chain | homochain |
| 6 |  | — | Sn-chain | homochain |

| Individual polymer | | Groups | Subclass | Class |
|--------------------|--|--------------------------------------|--------------|-------------|
| 7 | $\begin{array}{c} \text{F} \quad \text{CH}_3 \\ \quad \\ \text{---}(\text{---Si---})_n\text{---} \\ \quad \\ \text{F} \quad \text{CH}_3 \end{array}$ | — | Si-chain | homochain |
| 8 |  | polyesters of carboxylic acids | (O, C)-chain | heterochain |
| 9 |  | polydioxanediyls, polyacetals | (O, C)-chain | heterochain |
| 10 |  | polyanhydrides of carboxylic acids | (O, C)-chain | heterochain |
| 11 |  | polymeric quaternized ammonium salts | (N, C)-chain | heterochain |
| 12 |  | polyamines and/or polypyridinediyls | (N, C)-chain | heterochain |

| Individual polymer | | Groups | Subclass | Class |
|--------------------|---|---|--|------------------------------|
| 13 |  | poly(4,2-pyridinediyl-4H-1,2,4-triazole-3,5-diylmethylen) | polypyridinediyls and/or polytriazolediyls | (N,C)-chain heterochain |
| 14 |  | poly([2,3'-bipyridine]-4,5'-diyl) | polypyridinediyls | (N,C)-chain heterochain |
| 15 |  | poly[imino(1-oxoethylene)] | polyamides (or polypeptides) | (N,C)-chain heterochain |
| 16 |  | catena-poly[(diphenylsilicon)- μ -oxo] polydiphenylsiloxane | polysiloxanes | (O,Si)-chain heterochain |
| 17 |  | catena-poly[(hydridoaluminum)- μ -phenylimido] | — | (N,Al)-chain heterochain |
| 18 |  | catena-poly[titaniumtri- μ -chloro] | — | (Cl,Ti)-chain heterochain |
| 19 |  | poly(oxycarbonylimino-1,4-phenylene-iminocarbonyloxyethylene) | polyurethanes | (O,N,C)-chain heterochain |

| Individual polymer | Groups | Subclass | Class |
|---|---|----------------|-------------|
| <p>20</p>  | polyesters of carboxylic acids and/or polypyridinediyls | (O,N,C)-chain | heterochain |
| <p>21</p>  | poly(2,8-phenoxazinediylmethylene) | (O,N,C)-chain | heterochain |
| <p>22</p>  | poly(riboctyidylic acid) | (O,P,C)-chain | heterochain |
| <p>23</p>  | — | (N,C,Ag)-chain | heterochain |