1: Glossary of Basic Terms in Polymer Science

CONTENTS

PREAMBLE

In order to present clear concepts it is necessary that idealized definitions be adopted but it is recognized that the realities of polymer science must be faced. Deviations from ideality arise with polymers at both molecular and bulk levels in ways that have no parallel with the ordinary small molecules of organic or inorganic chemistry. Although such deviations are not explicitly taken into account in the definitions below, the terms recommended can usefully be applied to the *predominant* structural features of real polymer molecules, if necessary with self-explanatory, if imprecise, qualifications such as 'essentially….', 'almost completely….', or 'highly….'. Although such expressions lack the rigour beloved by the purist, every experienced polymer scientist knows that communication in this discipline is impossible without them.

Conventionally, the word *polymer* used as a noun is ambiguous; it is commonly employed to refer to both polymer substances and polymer molecules. Henceforth, *macromolecule* is used for individual molecules and *polymer* is used to denote a substance composed of *macromolecules*. *Polymer* may also be employed unambiguously as an adjective, according to accepted usage, e.g., *polymer blend*, *polymer molecule*.

1 MOLECULES AND MOLECULAR STRUCTURE

1.1 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.

Note 1: In many cases, especially for synthetic *polymers*, a molecule can be regarded as having a high relative molecular mass if the addition or removal of one or a few of the units has a negligible effect on the molecular properties. This statement fails in the case of certain properties of *macromolecules* which may be critically dependent on fine details of the molecular structure, e.g., the enzymatic properties of polypeptides.

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Note 2: If a part or the whole of the molecule has a high relative molecular mass and essentially comprises the multiple repetition of units derived, actually or conceptually, from molecules of low relative molecular mass, it may be described as either macromolecular or polymeric, or by polymer used adjectivally.
Note 3: In most cases, the polymer can actually be made by direct *polymerization* of its parent monomer but in other cases, e.g., poly(vinyl alcohol), the description 'conceptual' denotes that an indirect route is used because the nominal monomer does not exist.

1.2 oligomer 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.
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.

1.3 monomer molecule
Molecule which can undergo *polymerization*, thereby contributing *constitutional units* to the essential structure of a *macromolecule*.

1.4 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.

1.5 irregular macromolecule
Macromolecule, the structure of which essentially comprises the repetition of more than one type of *constitutional unit*, or a macromolecule the structure of which comprises *constitutional units* not all connected identically with respect to directional sense.

1.6 linear macromolecule
Macromolecule, the structure of which essentially comprises the multiple repetition in linear sequence of units derived, actually or conceptually, from molecules of low relative molecular mass.

1.7 regular oligomer molecule
Oligomer molecule, the structure of which essentially comprises the repetition of a single *constitutional unit* with all units connected identically with respect to directional sense.

1.8 monomeric unit
monomer unit
mer
Largest *constitutional unit* contributed by a single *monomer molecule* to the structure of a *macromolecule* or *oligomer molecule*.
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.

1.9 macromonomer molecule
Macromolecule or *oligomer molecule* that has one end-group which enables it to act as a *monomer molecule*, contributing only a single *monomeric unit* to a *chain* of the final *macromolecule*.

1.10 macroradical
Macromolecule which is also a radical.

1.11 prepolymer molecule
Macromolecule or *oligomer molecule* capable of entering, through reactive groups, into further *polymerization*, thereby contributing more than one *constitutional unit* to at least one type of *chain* of the final *macromolecules*.
Note: A prepolymer molecule capable of entering into further *polymerization* through reactive *end-groups*, often deliberately introduced, is known as a telechelic molecule.

1.12 macromonomeric unit
macromonomer unit
Largest *constitutional unit* contributed by a single *macromonomer molecule* to the structure of a *macromolecule*.

1.13 degree of polymerization
Number of *monomeric units* in a *macromolecule* an *oligomer molecule*, a *block*, or a *chain*.

1.14 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*.

1.15 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*.

1.16 configurational unit
Constitutional unit having at least one site of defined stereoisomerism.

1.17 configurational base unit
Constitutional repeating unit in a regular *macromolecule*, a regular *oligomer molecule*, a regular *block*, or a regular *chain*, the configuration of which is defined at least at one site of stereoisomerism in the *main chain*.

1.18 configurational repeating unit
Smallest set of successive *configurational base units* that prescribes configurational repetition at one or more sites of stereoisomerism in the *main chain* of a regular *macromolecule*, a regular *oligomer molecule*, a regular *block*, or a regular *chain*.

1.19 stereorepeating unit
Configurational repeating unit having defined configurations at all sites of stereoisomerism in the *main chain* of a regular *macromolecule*, a regular *oligomer molecule*, a regular *block*, or a regular *chain*.

1.20 tacticity
Orderliness of the succession of *configurational repeating units* in the *main chain* of a regular *macromolecule*, a regular *oligomer molecule*, a regular *block*, or a regular *chain*.

1.21 tactic macromolecule
Regular *macromolecule* in which essentially all the *configurational (repeating) units* are identical.

1.22 stereoregular macromolecule
Regular *macromolecule* essentially comprising only one species of *stereorepeating unit*.

1.23 isotactic macromolecule
Tactic *macromolecule*, essentially comprising only one species of *configurational base unit*, which has chiral or prochiral atoms in the *main chain* in a unique arrangement with respect to its adjacent *constitutional units*.
Note: In an isotactic *macromolecule*, the *configurational repeating unit* is identical with the *configurational base unit*.

1.24 syndiotactic macromolecule
Tactic *macromolecule*, essentially comprising alternating enantiomeric *configurational base units*, which have chiral or prochiral atoms in the *main chain* in a unique arrangement with respect to their adjacent *constitutional units*.
Note: In a syndiotactic *macromolecule*, the *configurational repeating unit* consists of two *configurational base units* that are enantiomeric.

1.25 atactic macromolecule
Regular *macromolecule* that has an equal number of the possible *configurational base units* in a random sequence distribution.

1.26 block macromolecule
Macromolecule which is composed of *blocks* in linear sequence.

1.27 junction unit
Non-repeating atom or non-repeating group of atoms between *blocks* in a *block macromolecule*.

1.28 graft macromolecule
Macromolecule 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*.

1.29 stereoblock macromolecule
Block macromolecule composed of stereoregular, and possibly some non-stereoregular, *blocks*.

1.30 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*.
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*.

1.31 subchain
Arbitrarily chosen contiguous sequence of *constitutional units*, in a *chain*.
Note: The term *subchain* may be used to define designated subsets of the *constitutional units* in a *chain*.

1.32 linear chain
Chain with no *branch points* between the boundary units.

1.33 branched chain
Chain with at least one *branch point* between the boundary units.

1.34 main chain
backbone
That linear *chain* to which all other *chains*, *long* or *short* or both, may be regarded as being pendant.
Note: Where two or more *chains* could equally be considered to be the *main chain*, that one is selected which leads to the simplest representation of the molecule.

1.35 end-group
Constitutional unit that is an extremity of a *macromolecule* or *oligomer molecule*.
Note: An *end-group* is attached to only one *constitutional unit* of a *macromolecule* or *oligomer molecule*.

1.36 long chain
Chain of high relative molecular mass.
Note: See Note 1 to Definition 1.1.

1.37 short chain
Chain of low relative molecular mass.
Note: See Note 1 to Definition 1.2.

1.38 single-strand chain
Chain that comprises *constitutional units* connected in such a way that adjacent *constitutional units* are joined to each other through two atoms, one on each *constitutional unit*.

1.39 single-strand macromolecule
Macromolecule that comprises *constitutional units* connected in such a way that adjacent *constitutional units* are joined to each other through two atoms, one on each *constitutional unit*.

1.40 double-strand chain
Chain consisting of an uninterrupted sequence of rings with adjacent rings having one atom in common (spiro chain) or two or more atoms in common (ladder chain).

1.41 double-strand macromolecule
Macromolecule consisting of an uninterrupted sequence of rings with adjacent rings having one atom in common (spiro macromolecule) or two or more atoms in common (ladder macromolecule).

1.42 spiro chain
Double-strand chain consisting of an uninterrupted sequence of rings, with adjacent rings having only one atom in common.
Note: A spiro chain is a *double-strand chain* 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*.

1.43 spiro macromolecule
Double-strand macromolecule consisting of an uninterrupted sequence of rings, with adjacent rings having only one atom in common.
Note: 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*.

1.44 ladder chain
Double-strand chain consisting of an uninterrupted sequence of rings, with adjacent rings having two or more atoms in common.
Note: A ladder chain is a *double-strand chain* with adjacent *constitutional units* joined to each other through four atoms, two on one side and two on the other side of each *constitutional unit*.

1.45 ladder macromolecule
Double-strand macromolecule consisting of an uninterrupted sequence of rings, with adjacent rings having two or more atoms in common.
Note: A ladder macromolecule is a *double-strand macromolecule* with adjacent *constitutional units* joined to each other through four atoms, two on one side and two on the other side of each *constitutional unit*.

1.46 multi-strand chain
Chain that comprises *constitutional units* connected in such a way that adjacent *constitutional units* are joined to each other through more than four atoms, more than two on at least one side of each *constitutional unit*.
Note: A *chain* that comprises *constitutional units* joined to each other through *n* atoms on at least one side of each *constitutional unit* is termed an *n*-strand *chain*, e.g., three-strand *chain*. If an uncertainty exists in defining *n*, the highest possible number is selected.

1.47 multi-strand macromolecule
Macromolecule that comprises *constitutional units* connected in such a way that adjacent *constitutional units* are joined to each other through more than four atoms, more than two on at least one side of each *constitutional unit*.
Note: A *macromolecule* that comprises *constitutional units* joined to each other through *n* atoms on at least one side of each *constitutional unit* is termed an *n*-strand *macromolecule*, e.g., three-strand *macromolecule*. If an ambiguity exists in defining *n*, the highest possible number is selected.

1.48 skeletal structure
Sequence of atoms in the *constitutional unit(s)* of a *macromolecule*, an *oligomer molecule*, a *block*, or a *chain*, which defines the essential topological representation.

1.49 skeletal atom
Atom in a *skeletal structure*.

1.50 skeletal bond
Bond connecting two *skeletal atoms*.

1.51 star macromolecule
Macromolecule containing a single *branch point* from which linear *chains* (arms) emanate.
Note 1: A star macromolecule with n linear *chains* (arms) attached to the *branch point* is termed an n-star macromolecule, e.g., five-star macromolecule.
Note 2: If the arms of a star macromolecule are identical with respect to constitution and *degree of polymerization*, the *macromolecule* is termed a regular star macromolecule.
Note 3: If different arms of a star macromolecule are composed of different *monomeric units*, the *macromolecule* is termed a variegated star macromolecule.

1.52 comb macromolecule
Macromolecule comprising a *main chain* with multiple trifunctional *branch points* from each of which a linear side-*chain* emanates.
Note 1: If the sub*chains* between the *branch points* of the *main chain* and the terminal sub*chains* of the *main chain* are identical with respect to constitution and *degree of polymerization*, and the side-*chains* are identical with respect to constitution and *degree of polymerization*, the *macromolecule* is termed a regular comb macromolecule.
Note 2: If at least some of the *branch points* are of functionality greater than three, the *macromolecule* may be termed a brush *macromolecule*.

1.53 branch
side-chain
pendant chain
Oligomeric or polymeric offshoot from a macromolecular *chain*.
Note 1: An oligomeric branch may be termed a short-chain branch.
Note 2: A polymeric branch may be termed a long-chain branch.

1.54 branch point
Point on a *chain* at which a *branch* is attached.
Note 1: A *branch point* from which *f* linear *chains* emanate may be termed an *f*-functional *branch point*, e.g., five-functional *branch point*. Alternatively, the terms trifunctional, tetrafunctional, pentafunctional, etc. may be used, e.g., pentafunctional *branch point*.

Note 2: A *branch point* in a *network* may be termed a junction point.

1.55 branch unit
Constitutional unit containing a *branch point*.
Note: A *branch* unit from which *f* linear *chains* emanate may be termed an *f*-functional *branch* unit, e.g., five-functional *branch* unit. Alternatively, the terms trifunctional, tetrafunctional, pentafunctional, etc. may be used, e.g., pentafunctional *branch* unit.

1.56 pendant group
side-group
Offshoot, neither oligomeric nor polymeric, from a *chain*.

1.57 macrocycle
Cyclic *macromolecule* or a macromolecular cyclic portion of a *macromolecule*.
Note 1: See Note 2 to Definition 1.30.
Note 2: In the literature, the term macrocycle is sometimes used for molecules of low relative molecular mass that would not be considered *macromolecules* as specified in Definition 1.1.

1.58 network
Highly ramified *macromolecule* in which essentially each *constitutional unit* is connected to each other *constitutional unit* and to the macroscopic phase boundary by many permanent paths through the *macromolecule*, the number of such paths increasing with the average number of intervening bonds; the paths must on the average be co-extensive with the *macromolecule*.
Note 1: Usually, and in all systems that exhibit rubber elasticity, the number of distinct paths is very high, but, in most cases, some *constitutional units* exist which are connected by a single path only.
Note 2: If the permanent paths through the structure of a network are all formed by covalent bonds, the term covalent network may be used.
Note 3: The term physical network may be used if the permanent paths through the structure of a network are not all formed by covalent bonds but, at least in part, by physical interactions, such that removal of the interactions leaves individual *macromolecules* or a *macromolecule* that is not a network.

1.59 crosslink
Small region in a *macromolecule* from which at least four *chains* emanate, and formed by reactions involving sites or groups on existing *macromolecules* or by interactions between existing *macromolecules*.
Note 1: The small region may be an atom, a group of atoms, or a number of *branch points* connected by bonds, groups of atoms, or oligomeric *chains*.
Note 2: In the majority of cases, a crosslink is a covalent structure but the term is also used to describe sites of weaker chemical interactions, portions of crystallites, and even physical interactions and entanglements.

1.60 micronetwork
Polymer network that has dimensions of the order 1 nm to 1 μm.

1.61 loose end
Polymer chain within a *network* which is connected by a *junction point* at one end only.

1.62 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.
Note: Where appropriate, definitions relating to *macromolecule* may also be applied to *block*.

1.63 constitutional sequence
Whole or part of a *chain* comprising one or more species of *constitutional unit(s)* in defined sequence.
Note: Constitutional sequences comprising two *constitutional units* are termed diads, those comprising three *constitutional units* triads, and so on. In order of increasing sequence lengths they are called tetrads, pentads, hexads, heptads, octads, nonads, decads, undecads, etc.

1.64 configurational sequence
Whole or part of a *chain* comprising one or more species of *configurational unit(s)* in defined sequence.
Note: Configurational sequences comprising two configurational units are termed diads, those with three such configurational units triads, and so on. In order of increasing sequence lengths they are called tetrads, pentads, hexads, heptads, octads, nonads, decads, undecads, etc.

1.65 polyelectrolyte molecule
Macromolecule in which a substantial portion of the *constitutional units* has ionizable or ionic groups, or both.

1.66 ionomer molecule
Macromolecule in which a small but significant proportion of the *constitutional units* has ionizable or ionic groups, or both.
Note: Some protein molecules may be classified as ionomer molecules

2 SUBSTANCES

2.1 monomer
Substance composed of *monomer molecules*.

2.2 polymer
Substance composed of *macromolecules*.

2.3 oligomer
Substance composed of *oligomer molecules*.
Note: An oligomer obtained by telomerization is often termed a telomer.

2.4 homopolymer
Polymer derived from one species of (real, implicit or hypothetical) *monomer*.
Note 1: Many *polymer*s are made by the mutual reaction of complementary *monomers*. These *monomers* can readily be visualized as reacting to give an ‘implicit monomer’ or ‘hypothetical monomer’, the homo*polymerization* of which would give the actual product,

which can be regarded as a homopolymer. Well-known examples are poly(ethylene terephthalate) and poly(*N*,*N*'-hexane-1,6-diyladipamide).
Note 2: Some *polymer*s are obtained by the chemical modification of other *polymer*s such that the structure of the *macromolecules* that constitute the resulting *polymer* can be thought of as having been formed by the homo*polymerization* of a hypothetical *monomer*. These *polymer*s can be regarded as homopolymers. A well-known example is poly(vinyl alcohol).

2.5 copolymer
Polymer derived from more than one species of *monomer*.
Note: 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.

2.6 pseudo-copolymer
Irregular *polymer*, the molecules of which are derived from only one species of *monomer* but which display a variety of structural features more appropriate for description in *copolymer* terms.
Note: Where appropriate, adjectives specifying the types of *copolymer* may be applied to *pseudo-copolymer*. The term statistical pseudo-*copolymer*, for instance, may be used to describe an irregular *polymer* in the molecules of which the sequential distribution of configurational units obeys known statistical laws.

2.7 co-oligomer
Oligomer derived from more than one species of *monomer*.

2.8 pseudo-co-oligomer
Irregular *oligomer*, the molecules of which are derived from only one species of *monomer* but which display a variety of structural features more appropriate for description in co-oligomer terms.

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

2.10 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.
Note: In a random *copolymer*, the sequence distribution of *monomeric units* follows Bernoullian statistics.

2.11 alternating copolymer
Copolymer consisting of *macromolecules* comprising two species of *monomeric units* in alternating sequence.
Note: An alternating *copolymer* may be considered as a *homopolymer* derived from an implicit or hypothetical *monomer*; see Note 1 to Definition 2.4.

2.12 periodic copolymer
Copolymer consisting of *macromolecules* comprising more than two species of *monomeric units* in regular sequence.

2.13 uniform polymer
monodisperse polymer
Polymer composed of molecules uniform with respect to relative molecular mass and constitution.
Note 1: A *polymer* comprising a mixture of *linear* and *branched chains*, all of uniform relative molecular mass, is not uniform.
Note 2: A *copolymer* comprising linear molecules of uniform relative molecular mass and uniform elemental composition but different sequential arrangements of the various types of *monomeric units*, is not uniform (e.g., a *copolymer* comprising molecules with a random arrangement as well as a *block* arrangement of *monomeric units*).
Note 3: A *polymer* uniform with respect only to either relative molecular mass or constitution may be termed uniform, provided a suitable qualifier is used (e.g., 'a *polymer* uniform with respect to relative molecular mass').
Note 4: The adjectives monodisperse and polydisperse are deeply rooted in the literature, despite the former being non-descriptive and self-contradictory. They are in common usage and it is recognized that they will continue to be used for some time; nevertheless, more satisfactory terms are clearly desirable. After an extensive search for possible replacements, the terms uniform and non-uniform have been selected and they are now the preferred adjectives.

2.14 non-uniform polymer
polydisperse polymer
Polymer comprising molecules non-uniform with respect to relative molecular mass or constitution or both.
Note: See notes 2 and 4 to Definition 2.13.

2.15 regular polymer
Polymer composed of regular *macromolecules*, regular *star macromolecules*, or regular *comb macromolecules*.
Note: A *polymer* consisting of *star macromolecules* with arms identical with respect to constitution and *degree of polymerization* is considered to be regular; see Note 2 to Definition 1.51. Analogously, a *polymer* consisting of *comb macromolecules* with the sub-*chains* between the *branch points* of the *main chain* and the terminal subchain*s* of the *main chain* identical with respect to constitution and *degree of polymerization* and the side-*chains* identical with respect to constitution and *degree of polymerization* is considered to be regular; see Note 1 to Definition 1.52.

2.16 irregular polymer
Polymer composed of irregular *macromolecules*.

2.17 tactic polymer
Polymer composed of tactic *macromolecules*.

2.18 isotactic polymer
Polymer composed of isotactic *macromolecules*.

2.19 syndiotactic polymer
Polymer composed of syndiotactic *macromolecules*.

2.20 stereoregular polymer
Polymer composed of *stereoregular macromolecules*.

2.21 atactic polymer
Polymer composed of *atactic macromolecules*.

2.22 block polymer
Polymer composed of *block macromolecules*.

2.23 graft polymer
Polymer composed of *graft macromolecules*.

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

2.25 graft copolymer
Copolymer that is a *graft polymer*.
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*.

2.26 stereoblock polymer
Polymer composed of *stereoblock macromolecules*.

2.27 linear polymer
Polymer composed of linear *macromolecules*.

2.28 linear copolymer
Copolymer composed of linear *macromolecules*.

2.29 single-strand polymer
Polymer, the *macromolecules* of which are single-strand *macromolecules*.

2.30 double-strand polymer
Polymer, the *macromolecules* of which are *double-strand macromolecules*.
Note 1: A *polymer*, the *macromolecules* of which are *spiro macromolecules*, is termed a spiro polymer.
Note 2: A *polymer*, the *macromolecules* of which are *ladder macromolecules*, is termed a ladder polymer.

2.31 double-strand copolymer
Copolymer, the *macromolecules* of which are *double-strand macromolecules*.

2.32 star polymer
Polymer composed of *star macromolecules*.

2.33 comb polymer
Polymer composed of *comb macromolecules*.
Note: See the Notes to Definitions 1.52 and 2.15.

2.34 branched polymer
Polymer, the molecules of which are *branched chains*.

2.35 macromonomer
Polymer or *oligomer* composed of *macromonomer molecules*.

2.36 mesogenic monomer
Monomer which can impart the properties of liquid crystals to the *polymer*s formed by its *polymerization*.

2.37 prepolymer
Polymer or *oligomer* composed of *prepolymer molecules*.

2.38 polyelectrolyte
Polymer composed of *polyelectrolyte molecules*.

2.39 ionomer
Polymer composed of *ionomer molecules*.

2.40 polymer blend
Macroscopically homogeneous mixture of two or more different species of *polymer*.
Note 1: In most cases, blends are homogeneous on scales smaller than several times visual optical wavelengths.
Note 2: For polymer blends, no account is taken of the miscibility or immiscibility of the constituent *polymer*s, i.e., no assumption is made regarding the number of phases present.
Note 3: The use of the term polymer alloy for a polymer blend is discouraged.

2.41 network polymer
polymer network
Polymer composed of one or more *networks*.

2.42 semi-interpenetrating polymer network (SIPN)
Polymer comprising one or more *networks* and one or more *linear* or *branched polymer*(s) characterized by the penetration on a molecular scale of at least one of the *networks* by at least some of the linear or *branched macromolecules*.
Note: Semi-interpenetrating polymer *networks* are distinguished from interpenetrating polymer *networks* because the constituent *linear* or *branched polymer*s can, in principle, be separated from the constituent *polymer network(s)* without breaking chemical bonds; they are *polymer blends*.

2.43 interpenetrating polymer network (IPN)
Polymer comprising two or more *networks* which are at least partially interlaced on a molecular scale but not covalently bonded to each other and cannot be separated unless chemical bonds are broken.
Note: A mixture of two or more pre-formed *polymer networks* is not an IPN.

2.44 polymer-polymer complex
Complex, at least two components of which are different *polymer*s.

3 REACTIONS

3.1 polymerization
Process of converting a *monomer* or a mixture of *monomers* into a *polymer*.

3.2 oligomerization
Process of converting a *monomer* or a mixture of *monomers* into an *oligomer*.
Note: An oligomerization by chain reaction carried out in the presence of a large amount of chain-transfer agent, so that the *end-groups* are essentially fragments of the chain-transfer agent, is termed telomerization.

3.3 homopolymerization
Polymerization in which a *homopolymer* is formed.

3.4 copolymerization
Polymerization in which a *copolymer* is formed.

3.5 co-oligomerization
Oligomerization in which a co-*oligomer* is formed.

3.6 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.
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: Propagation in chain polymerization usually occurs without the formation of small molecules. However, cases exist where a low molar-mass by-product is formed, as in the *polymerization* of oxazolidine-2,5-diones derived from amino acids (commonly termed amino acid *N*-carboxy anhydrides). When a low-molar-mass by-product is formed, the adjective *condensative* is recommended to give the term condensative chain polymerization.
Note 4: The growth steps are expressed by

$$P_x + M \rightarrow P_{x+1} (+ L) \; \{x\} \in \{1, 2, ...\infty\}$$

where P_x denotes the growing *chain* of *degree of polymerization x*, M a *monomer*, and L a low-molar-mass by-product formed in the case of condensative chain polymerization.
Note 5: The term chain polymerization may be qualified further, if necessary, to specify the type of chemical reactions involved in the growth step, e.g., ring-opening chain polymerization, cationic chain polymerization.
Note 6: There exist, exceptionally, some *polymerizations* that proceed *via* chain reactions that, according to the definition, are not chain polymerizations. For example, the *polymerization*

$$HS–X–SH + CH_2=CH–Y–CH=CH_2 \rightarrow –(S–X–S–CH_2–CH_2–Y–CH_2–CH_2)_n–$$

proceeds *via* a radical *chain* reaction with intermolecular transfer of the radical center. The growth step, however, involves reactions between molecules of all *degrees of polymerization* and, hence, the *polymerization* is classified as a polyaddition. If required, the classification can be made more precise and the *polymerization* described as a chain-reaction polyaddition.

3.7 polycondensation

Polymerization in which the growth of *polymer chains* proceeds by condensation reactions between molecules of all *degrees of polymerization*.
Note 1: The growth steps are expressed by

$$P_x + P_y \rightarrow P_{x+y} + L \qquad \{x\} \in \{1, 2, ...\infty\}; \{y\} \in \{1, 2, ...\infty\}$$

where P_x and P_y denote *chains* of *degree of polymerization x* and *y*, respectively, and L denotes a low-molar- mass by-product.
Note 2: The earlier term polycondensation was synonymous with condensation polymerization. It should be noted that the current definitions of polycondensation and condensative *chain polymerization* were both embraced by the earlier term polycondensation.

3.8 polyaddition

Polymerization in which the growth of *polymer chains* proceeds by addition reactions between molecules of all *degrees of polymerization*.
Note 1: The growth steps are expressed by

$$P_x + P_y \rightarrow P_{x+y} \qquad \{x\} \in \{1, 2, ...\infty\}; \{y\} \in \{1, 2, ...\infty\}$$

where P_x and P_y denote *chains* of *degrees of polymerization x* and *y*, respectively.
Note 2: The earlier term addition polymerization embraced both the current concepts of polyaddition and *chain polymerization*, but did not include *condensative chain polymerization*.

3.9 statistical copolymerization

Copolymerization in which a *statistical copolymer* is formed.

3.10 random copolymerization

Copolymerization in which a *random copolymer* is formed.

3.11 alternating copolymerization

Copolymerization in which an *alternating copolymer* is formed.

3.12 periodic copolymerization
Copolymerization in which a *periodic copolymer* is formed.

3.13 ring-opening polymerization
Polymerization in which a cyclic *monomer* yields a *monomeric unit* which is acyclic or contains fewer cycles than the *monomer*.
Note: If the *monomer* is polycyclic, the opening of a single ring is sufficient to classify the reaction as a ring-opening polymerization.

3.14 ring-opening copolymerization
Copolymerization which is a *ring-opening polymerization* with respect to at least one *monomer*.

3.15 radical polymerization
Chain polymerization in which the kinetic-chain carriers are radicals.
Note: Usually, the growing *chain* end bears an unpaired electron.

3.16 radical copolymerization
Copolymerization which is a radical *polymerization*.

3.17 ionic polymerization
Chain polymerization in which the kinetic-chain carriers are ions or ion-pairs.
Note: Usually, the growing *chain ends* are ions.

3.18 ionic copolymerization
Copolymerization which is an ionic *polymerization*.

3.19 anionic polymerization
Ionic polymerization in which the kinetic-chain carriers are anions.

3.20 cationic polymerization
Ionic polymerization in which the kinetic-chain carriers are cations.

3.21 living polymerization
Chain polymerization from which chain transfer and chain termination are absent.
Note: In many cases, the rate of chain initiation is fast compared with the rate of chain propagation, so that the number of kinetic-chain carriers is essentially constant throughout the *polymerization*.

3.22 living copolymerization
Copolymerization which is a living *polymerization*.

3.23 cyclopolymerization
Polymerization in which the number of cyclic structures in the *constitutional units* of the resulting *macromolecules* is larger than in the *monomer molecules*.

3.24 chain scission
Chemical reaction resulting in the breaking of skeletal bonds.

3.25 depolymerization
Process of converting a *polymer* into its *monomer* or a mixture of *monomers*.
Note: Unzipping is depolymerization occurring by a sequence of reactions, progressing along a *macromolecule* and yielding products, usually *monomer molecules*, at each reaction step, from which *macromolecules* similar to the original can be regenerated.

ALPHABETICAL INDEX OF TERMS