

C30B

SINGLE-CRYSTAL-GROWTH (by using ultra-high pressure, e.g. for the formation of diamonds [B01J 3/06](#)); UNIDIRECTIONAL SOLIDIFICATION OF EUTECTIC MATERIAL OR UNIDIRECTIONAL DEMIXING OF EUTECTOID MATERIAL; REFINING BY ZONE-MELTING OF MATERIAL (zone-refining of metals or alloys [C22B](#)); PRODUCTION OF A HOMOGENEOUS POLYCRYSTALLINE MATERIAL WITH DEFINED STRUCTURE (casting of metals, casting of other substances by the same processes or devices [B22D](#); working of plastics B29; modifying the physical structure of metals or alloys [C21D](#), [C22F](#)); SINGLE CRYSTALS OR HOMOGENEOUS POLYCRYSTALLINE MATERIAL WITH DEFINED STRUCTURE; AFTER-TREATMENT OF SINGLE CRYSTALS OR A HOMOGENEOUS POLYCRYSTALLINE MATERIAL WITH DEFINED STRUCTURE (for producing semiconductor devices or parts thereof [H01L](#)); APPARATUS THEREFOR

Definition statement

This subclass/group covers:

Single crystals or homogeneous polycrystalline material with a defined structure; production thereof. Included in this subclass are processes and apparatus used in obtaining these crystals and materials. Also included in this subclass are processes and apparatus for the after-treatment of single crystals or homogeneous polycrystalline material with a defined structure.

When apparatus features do not correspond to any of the subgroup headings, they are classified in the head group. For example particle filtration means for a Czochralski apparatus: [C30B 15/00](#).

References relevant to classification in this subclass

This subclass/group does not cover:

| | |
|---|---|
| Formation of diamonds using ultra-high pressure | B01J 3/06 |
| Casting of metals, casting of other substances by the same processes or devices | B22D |
| Modifying the physical structure of metals or alloys | C21D , C22F |
| Zone-refining of metals or alloys | C22B |

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| Production of semiconductor devices or parts thereof; semiconductor devices characterized by their crystalline structure or particular orientation of the crystalline planes | H01L |
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Informative references

Attention is drawn to the following places, which may be of interest for search:

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| Separation by crystallisation in general | B01D 9/00 |
| Metallic nanometer sized particles | B22F 1/0018 |
| Metallic nanotubes or nanofibres | B22F 1/0025 |
| Grinding, polishing of crystals | B24B |
| Cleaving of stone or stone-like materials, e.g., brick, concrete, not provided for elsewhere | B28D 1/32 |
| Mechanical fine working of gems, jewels, crystals | B28D 5/00 |
| Coating by vacuum evaporation, by sputtering or by ion implantation of the coating material | C23C 14/00 |
| Chemical coating by decomposition of gaseous compounds, without leaving reaction products of surface material in the coating | C23C 16/00 |
| Investigating or analysing biological crystals | G01N 33/48 |
| Photonic crystals | G02B , G02F |
| Fabrication of semiconductor wafers | H01L 21/02 |

Special rules of classification within this subclass

- Patent and non-patent documents describing the growth of single crystals/homogenous polycrystalline material with defined structure are classified according to the method/apparatus used and the chemical and physical nature of the grown crystal. Up to June 2006 combination classes (hybrid /ecc) were used, meaning for example that a combination classification symbol as [C30B 15/00](#)+ [C30B 29/06](#) was used in addition to any relevant subgroup for the Czochralski pulling of silicon single crystals. With the abandonment of the physical paper collection it was considered no longer necessary to use such combination classes. Work is still in progress to split these combination groups.
- Patent documents often lists whole series of materials which can be grown as crystals. The classifier should provide the appropriate classification symbol under **C30B29/00FOR** those materials grown as crystals in the examples and any mentioned in the claims. Where a whole series is mentioned without emphasis on one particular material, for example GaAs, GaInAs, InAs, GaAlAs, GaN, InN, AlN etc., the classifier should try to identify the most appropriate classification(s) covering the families of materials mentioned. In this case [C30B 29/40](#) and [C30B 29/403](#) would be appropriate and sufficient.
- Mere references to "crystals" or "single crystals" in a document in the absence of other details do not lead to a classification in [C30B](#). For example a reference to a "Czochralski grown silicon single crystal" in the description of a substrate used for a semiconductor device is not sufficient for requiring a classification in [C30B](#). If, however, the reference includes further details about the chemical/physical properties of the crystal and these do not seem trivial then the classifier should give the appropriate [C30B](#) classification. Documents referring to the synthesis of chemical compounds which also mention crystallographic results for the solid are not normally classified in [C30B](#) unless there is emphasis on the crystal growing technique.
- Concerning the circulation of documents to other fields by giving symbols of the other fields, most patents concerning crystal growth mention to different degrees of emphasis the applications where the grown crystal are to be used. Where there is a specific reference to a particular device or application using the crystal then the document should be circulated to that field. For example, a document mentioning the fabrication of a particular type of transistor using the grown crystal, then the document should be circulated to the semiconductor field ([H01L](#)).
- Concerning vapour phase epitaxial growth apparatus, the search should always consult the relevant groups in [C23C](#) where such apparatuses are also classified. Epitaxial growth is dependent primarily on process parameters and substrate, an apparatus used for "epitaxial growth" in the overwhelming majority of cases the same apparatus can be used for providing non-epitaxial coatings. Documents concerning apparatus features in these process should be also classified in [C23C](#)

Glossary of terms

In this subclass/group, the following terms (or expressions) are used with the meaning indicated:

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| Amorphous | Description of a solid material not having long-range crystalline lattice structure. |
| Crystal | Description of a solid material having long-range order of atoms or molecules arranged in a regularly-repeating lattice structure. |
| Defined structure | The structure of a solid material with grains which are oriented in a preferential way or have larger dimensions than normally obtained. |
| Epitaxy | The formation of a crystalline layer on a substrate in such a manner that the formed crystal bears a definite crystallographic relationship to the substrate. |
| Eutectic | Description of a mixture or solution containing two or more phases at a composition that has the lowest melting point and where the phases simultaneously crystallize from solution at this temperature. |
| Homogeneous polycrystalline material | A solid material with crystal particles, all of which have the same chemical composition. |
| Lattice | An ordered arrangement of atoms or molecules within a solid material. |
| Oriented crystalline material | A polycrystalline structure in which the grains are generally aligned in a preferential direction such as obtained in columnar growth. |
| Seed | A material, usually itself a small single-crystal, upon which a single-crystal is grown, the seeded |

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| | crystal growth proceeding by the alignment of atoms or molecules or clusters into a thermodynamically favored arrangement determined by the nature of the seed. |
| Single-crystal | Description of a solid material having at least one long-range order of atoms or molecules in a regularly-repeating lattice structure throughout the body of material. Also includes twin crystals and a predominantly single crystal product. |
| Superlattice | A single-crystal having an internal structure of more than two layers, each layer having a composition different from the next adjacent layer. |
| Twin crystal | a crystalline material in which the adjoining crystalline lattices have a mirror-image symmetrical relationship, the interface between the adjoining crystals being termed the twin plane. |
| Zone melting | description of a process in which a crystallized body is formed by melting a zone of a starting material with subsequent cooling and crystallisation while either the zone or the starting product is displaced so that all or part of the starting material is converted into the crystallized body. |
| Grains | crystalline regions in a solid material, each grain generally being a single crystalline region. |
| Whiskers/needles | discrete solid crystalline particles of generally elongated shape. Dimensions are superior to 100 nm and are not considered as nanocrystals (nanowires, nanorods etc) |
| Bulk/layer | ulk crystals have dimensions which are comparable in all three dimensions whereas layers have one |

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| | dimension (thickness) significantly less than the other two dimensions (surface area). For thick layers the distinction may not be always evident and a certain degree of double classification is unavoidable. Often a bulk layer is grown from a discrete "seed" whereas a layer is grown epitaxially on a substrate. |
| Nanocrystals | single crystals having at least one dimension less than 100 nm. The term includes nanowires, nanotubes, nanorods etc. |

Synonyms and Keywords

In patent documents the following abbreviations are often used:

| | |
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| SSR | Solid state re-crystallization |
| FZ | floating zone |
| SOI | silicon on insulator |
| SOS | silicon on sapphire |
| LHPG | laser heated pedestal growth |
| SLS | sequential lateral solidification |
| CZ or Cz | Czochralski |
| MCZ or MCz | Czochralski method with applied magnetic field |
| LEC | liquid encapsulated Czochralski |
| EFG | Edge defined film-fed growth |
| TSSG | Top-seeded solution growth |
| MBE | molecular beam epitaxy |
| PVD | physical vapour deposition |

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| CVD | Chemical vapour deposition |
| MBA | molecular beam allotaxy |
| MCE | microchannel epitaxy |
| GSMBE | gas source molecular beam epitaxy |
| MOCVD | metalorganic chemical vapour deposition |
| OMVPE | organometallic vapour phase epitaxy |
| CBE | chemical beam epitaxy |
| HVPE | hydride vapour phase epitaxy |
| ALE | atomic layer epitaxy |
| MLE | molecular layer epitaxy |
| ELO/ELOG | epitaxial lateral overgrowth, pendeo epitaxy |

C30B 1/00

**Single-crystal growth directly from the solid state
(unidirectional demixing of eutectoid materials [C30B 3/00](#);
under a protective fluid [C30B 27/00](#))**

Definition statement

This subclass/group covers:

Particular attention is paid to documents where crystal growth is induced by e.g. scanning zones of a material to be crystallized with e.g. a laser beam. If the material to be crystallized becomes molten prior to cooling and crystallization then the document is not classified here but is allocated a classification under [C30B 13/00](#).

C30B 1/026

[N: Solid phase epitaxial growth through a disordered intermediate layer]

Definition statement

This subclass/group covers:

Growth methods where for example the crystallographic structure of a substrate is transferred via e.g. an intermediate amorphous layer to an overlying layer during a heat treatment below the melting point of the different layers.

C30B 3/00

Unidirectional demixing of eutectoid materials

Definition statement

This subclass/group covers:

Method (and specific apparatus) for the growth of single crystals and homogenous polycrystalline materials from a eutectic mixture wherein on a unidirectional cooling a distinct composite structure forms. For example, aligned fibres of one phase form in a matrix of another phase when a eutectic mixture is directionally cooled. This transformation or demixing may occur when the material is cooled from the solid state. Most frequently this growth method concerns metallic eutectic alloys. This group has not been frequently used in recent years.

C30B 5/00

Single-crystal growth from gels (under a protective fluid [C30B 27/00](#))

Definition statement

This subclass/group covers:

Growth from colloidal systems is also classified here. Growth of larger crystals from ordering of macromolecules can be classified here. Periodic 2D and 3D structures formed by self assembly from colloidal systems of particles/nanospheres/microspheres to form photonic "crystals" have been classified here. This is subject to some discussion. In principle 2D or 3D structures called "photonic crystals" but made by the assembly of macroscale structures are not classified in [C30B](#).

References relevant to classification in this group

This subclass/group does not cover:

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|---------------------------------------|-----------------------------|
| Macroscale photonic band gap crystals | G02B 6/1225 |
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C30B 7/00

Single-crystal growth from solutions using solvents which are liquid at normal temperature, e.g. aqueous solutions (from molten solvents [C30B 9/00](#); by normal or gradient freezing [C30B 11/00](#); under a protective fluid [C30B 27/00](#))

C30B 9/00

Single-crystal growth from melt solutions using molten solvents (by normal or gradient freezing [C30B 11/00](#); by zone-melting [C30B 13/00](#); by crystal pulling [C30B 15/00](#); on immersed seed crystal [C30B 17/00](#); by liquid phase epitaxial growth [C30B 19/00](#); under a protective fluid [C30B 27/00](#))

Definition statement

This subclass/group covers:

The growth of bulk crystal are classified here whereas epitaxial layer growth from the melt (with and without solvents/flux) are classified in [C30B 19/00](#). Some double classification is unavoidable.

C30B 11/00

Single-crystal growth by normal freezing or freezing under temperature gradient, e.g. Bridgman-Stockbarger method ([C30B 13/00](#), [C30B 15/00](#), [C30B 17/00](#), [C30B 19/00](#) take precedence; under a protective fluid [C30B 27/00](#))

C30B 13/00

Single-crystal growth by zone-melting; Refining by zone-melting ([C30B 17/00](#) takes precedence; by changing the cross-section of the treated solid [C30B 15/00](#); under a protective fluid [C30B 27/00](#) ; zone-refining of specific materials, see the relevant subclasses for the materials)

C30B 15/00

Single-crystal growth by pulling from a melt, e.g. Czochralski method (under a protective fluid [C30B 27/00](#))

C30B 17/00

Single-crystal growth onto a seed which remains in the melt during growth, e.g. Nacken-Kyropoulos method ([C30B 15/00](#) takes precedence)

C30B 19/00

Liquid-phase epitaxial-layer growth

C30B 21/00

Unidirectional solidification of eutectic materials

C30B 23/00

Single-crystal growth by condensing evaporated or sublimed material

Definition statement

This subclass/group covers:

The growth of bulk crystals, as opposed to layers, from vapours produced by physical processes such as sublimation is classified here.

C30B 23/02

Epitaxial-layer growth

Definition statement

This subclass/group covers:

Epitaxial layer growth from vapours produced by physical processes, e.g. molecular beam epitaxy (MBE), sputtering, sublimation etc.

References relevant to classification in this group

This subclass/group does not cover:

| | |
|---|---|
| Physical vapour deposition wherein generally unstructured polycrystalline or amorphous coatings are produced. | C23C 14/00 and sub-groups |
|---|---|

Informative references

Attention is drawn to the following places, which may be of interest for search:

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|----------------------------|--|
| General apparatus features | C23C 14/00 and subgroups pertaining to apparatus features, e.g. C23C 14/50 : substrate holders |
|----------------------------|--|

C30B 25/00

Single-crystal growth by chemical reaction of reactive gases, e.g. chemical vapour-deposition growth

Definition statement

This subclass/group covers:

The growth of bulk crystals by chemical vapour phase deposition (CVD, MOCVD etc) is classified here.

C30B 25/02

Epitaxial-layer growth

Definition statement

This subclass/group covers:

Epitaxial layer growth by chemical vapour phase deposition (CVD, MOCVD, MOVPE, HVPE etc). Also classified here is gas source molecular beam epitaxy (GSMBE) wherein a hybrid process CVD-MBE is involved.

References relevant to classification in this group

This subclass/group does not cover:

| | |
|--|---|
| Production of polycrystalline products such as silicon and germanium by the so-called Siemen's process from the vapour phase | C01B 33/035 |
| Chemical vapour deposition wherein generally unstructured polycrystalline or amorphous coatings are produced | C23C 16/00 and sub-groups |

Informative references

Attention is drawn to the following places, which may be of interest for search:

| | |
|------------------------|--|
| CVD apparatus features | C23C 16/00 and sub-groups pertaining to apparatus features |
|------------------------|--|

C30B 25/105

[N: by irradiation or electric discharge]

Definition statement

This subclass/group covers:

Heating by irradiation or electric discharge includes plasma assisted methods
[C30B 28/00](#)

classified here are documents in which there is a particular emphasis on a feature relating to the polycrystallinity of the product (grain size, orientation). Crystal growing methods and apparatus should receive the usual classifications irrespective of whether polycrystalline, multi-crystalline or monocrystalline products are formed.

C30B 27/00

Single-crystal growth under a protective fluid

C30B 28/00

Production of homogeneous polycrystalline material with defined structure

C30B 29/00

Single crystals or homogeneous polycrystalline material with defined structure characterised by the material or by their shape (alloys [C22C](#))

Definition statement

This subclass/group covers:

Classified here are single crystals or homogenous polycrystalline material with defined structure according to their chemical composition or shape.

C30B 29/02

Elements

Definition statement

This subclass/group covers:

In addition to other elements, non-diamond forms of carbon are classified here.

References relevant to classification in this group

This subclass/group does not cover:

| | |
|-----------|------------------------------|
| Graphene | C01B 31/0438 |
| Fullerene | C01B 31/0213 |

C30B 29/38

Nitrides

References relevant to classification in this group

This subclass/group does not cover:

| | |
|---------------------------------------|---|
| All-nitrides (including born nitride) | C30B 29/403 , C30B 29/406 |
|---------------------------------------|---|

C30B 29/58

Macromolecular compounds

Definition statement

This subclass/group covers:

Macromolecular compounds including biological compounds such as proteins and enzymes.

C30B 29/60

characterised by shape

Definition statement

This subclass/group covers:

Classified here are discrete single crystals characterized by shape as opposed to products containing multiple oriented crystalline material ([C30B 29/605](#)).

C30B 29/602

[N: Nanotubes]

References relevant to classification in this group

This subclass/group does not cover:

| | |
|----------------------|-----------------------------|
| CNT carbon nanotubes | C01B 31/022 |
|----------------------|-----------------------------|

C30B 29/605

[N: Products containing multiple oriented crystallites, e.g. columnar crystallites]

Definition statement

This subclass/group covers:

Also nanomaterials, nanocrystalline materials which have a uniform i.e. homogeneous, oriented structure

C30B 29/607

[N: Crystals of complex geometrical shape, e.g. tubes, cylinders (nanotubes [C30B 29/602](#))

Definition statement

This subclass/group covers:

No longer to be used but cannot be deleted until splitting of combination groups is completed. Use [C30B 29/66](#)

C30B 30/00

Production of single crystals or homogeneous polycrystalline material with defined structure characterised by the action of electric or magnetic fields, wave energy or other specific physical conditions

C30B 31/00

Diffusion or doping processes for single crystals or homogeneous polycrystalline material with defined structure; Apparatus therefor

Relationship between large subject matter areas

Apparatus for diffusion or doping processes for single crystals or homogeneous polycrystalline material with defined structure can also be classified in [C23C](#) if the apparatus is used for surface treatment of metallic material by diffusion into the surface or for coating metallic material

C30B 33/00

After-treatment of single crystals or homogeneous polycrystalline material with defined structure ([C30B 31/00](#) takes precedence; grinding, polishing B24; mechanical fine working of gems, jewels, crystals [B28D 5/00](#))

C30B 35/00

Apparatus for a specific growth method to be classified under the classification for the growth method. In this group only apparatus which can be used for more than one method is classified. Also special materials or a particular apparatus accessory which can be of general use in crystal growth can be classified here.

C30B 35/007

[N: Apparatus for preparing, pre-treating the source material to be used for crystal growth]

Definition statement

This subclass/group covers:

This group also covers methods for preparing , pre-treating the source material to be used for crystal growth.