

## 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 [H10](#)); **APPARATUS THEREFOR**

### Definition statement

*This place covers:*

Single crystals or homogeneous polycrystalline material with a defined structure; production thereof.

Processes and apparatus used in obtaining these crystals and materials.

Processes and apparatus for the after-treatment of single crystals or homogeneous polycrystalline material with a defined structure.

### Relationships with other classification places

Where there is a specific reference to a particular device or application using the crystal then the document should be classified in that field. For example, a document mentioning the fabrication of a particular type of transistor using the grown crystal, then the document should be classified in the semiconductor devices, i.e. class [H10](#).

Vapour phase epitaxial growth apparatus is similar to apparatus used for providing non-epitaxial coatings. Therefore, documents concerning apparatus features in these processes should also be classified in [C23C 14/00](#) and [C23C 16/00](#).

### References

#### Limiting references

*This place does not cover:*

Formation of diamonds using ultra-high pressure	<a href="#">B01J 3/06</a>
Casting of metals, casting of other substances by the same processes or devices	<a href="#">B22D</a>
Zone-refining of metals or alloys	<a href="#">C22B</a>
Changing the physical structure of non-ferrous metals or alloys by heat treatment or by hot or cold working	<a href="#">C22F</a>
Semiconductor devices; Electric solid-state devices not otherwise provided for	<a href="#">H10</a>

### Informative references

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

Separation by crystallisation in general	<a href="#">B01D 9/00</a>
Metallic nanometre sized particles	<a href="#">B22F 1/054</a>
Metallic nanotubes or nanofibres	<a href="#">B22F 1/0547</a>
Grinding or polishing of crystals	<a href="#">B24B</a>
Cleaving of stone or stone-like materials, e.g. brick or concrete, not provided for elsewhere	<a href="#">B28D 1/32</a>
Mechanical fine working of gems, jewels or crystals	<a href="#">B28D 5/00</a>
Working of plastics	<a href="#">B29</a>
Modifying the physical structure of ferrous metals	<a href="#">C21D</a>
Coating by vacuum evaporation, by sputtering or by ion implantation of the coating material	<a href="#">C23C 14/00</a>
Chemical coating by decomposition of gaseous compounds, without leaving reaction products of surface material in the coating	<a href="#">C23C 16/00</a>
Investigating or analysing biological crystals	<a href="#">G01N 33/48</a>
Photonic crystals	<a href="#">G02B</a> , <a href="#">G02F</a>
Fabrication of semiconductor wafers	<a href="#">H10P 95/02</a>

### Special rules of classification

Reference [B29](#) is non-limiting in the subclass [C30B](#). CPC will be updated/corrected once this inconsistency is resolved in IPC.

Looping references between [C30B](#) and [C21D](#) have been identified. Until this inconsistency is resolved in IPC, the current classification practice in CPC is as follows: [C30B](#) and [C21D](#) are considered as informative reference.

The preparation of single crystals or a homogeneous polycrystalline material with defined structure of particular materials or shapes is classified in the group for the process as well as in group [C30B 29/00](#).

Where a whole series is mentioned without emphasis on one particular material, for example GaAs, GaInAs, InAs, GaAlAs, GaN, InN, AlN, etc., it is classified in the groups covering the families of materials mentioned, in this case [C30B 29/40](#) and [C30B 29/403](#).

An apparatus specially adapted for a specific process is classified in the appropriate group for the process. Apparatus to be used in more than one kind of process is classified in group [C30B 35/00](#).

### Glossary of terms

In this place, the following terms or expressions are used with the meaning indicated:

amorphous	description of a solid material not having long-range crystalline lattice structure.
bulk/layer	bulk crystals have dimensions which are comparable in all three dimensions whereas layers have one dimension (thickness) significantly less than the other two dimensions (surface area). Often a bulk layer is grown from a discrete "seed" whereas a layer is grown epitaxially on a substrate.
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 crystallise from solution at this temperature.
grains	crystalline regions in a solid material, each grain generally being a single crystalline region.
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.
nanocrystals	single crystals having at least one dimension less than 100 nm. The term includes nanowires, nanotubes, nanorods etc.
oriented crystal	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 crystal growth proceeding by the alignment of atoms or molecules or clusters into a thermodynamically favoured arrangement determined by the nature of the seed.
single-crystal	description of a solid material having long-range order of atoms or molecules in a regularly-repeating lattice structure. 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.
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.)
zone melting	description of a process in which a crystallised 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 crystallised body.

## Synonyms and Keywords

*In patent documents, the following abbreviations are often used:*

SSR	solid state re-crystallisation
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
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 place 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

**{Solid phase epitaxial growth through a disordered intermediate layer}**

### Definition statement

*This place 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 place 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 place 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****Limiting references**

*This place does not cover:*

Macroscale photonic band gap crystals	<a href="#">G02B 6/1225</a>
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**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 place 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 13/20**

by induction, e.g. hot wire technique ([C30B 13/18](#) takes precedence)

**References****Limiting references**

*This place does not cover:*

The heating element being in contact with, or immersed in, the molten zone	<a href="#">C30B 13/18</a>
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**Informative references**

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

Induction coils	<a href="#">H05B 6/36</a>
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**C30B 13/28**

Controlling or regulating

**References****Informative references**

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

Controlling or regulating in general	<a href="#">G05</a>
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**C30B 23/00**

Single-crystal growth by condensing evaporated or sublimed materials

**Definition statement**

*This place 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 place covers:*

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

## References

### Limiting references

*This place does not cover:*

Physical vapour deposition wherein generally unstructured polycrystalline or amorphous coatings are produced.	<a href="#">C23C 14/00</a> and sub-groups
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### Informative references

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

General apparatus features	<a href="#">C23C 14/00</a> and subgroups pertaining to apparatus features, e.g. <a href="#">C23C 14/50</a> : substrate holders
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## C30B 25/00

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

#### Definition statement

*This place 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 place 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

### Limiting references

*This place does not cover:*

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

**Informative references**

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

CVD apparatus features	<a href="#">C23C 16/00</a> and sub-groups pertaining to apparatus features
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**C30B 25/105**

{by irradiation or electric discharge}

**Definition statement**

*This place 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 29/00**

**Single crystals or homogeneous polycrystalline material with defined structure characterised by the material or by their shape**

**Definition statement**

*This place covers:*

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

**References****Informative references**

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

Alloys	<a href="#">C22C</a>
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**C30B 29/02**

**Elements**

**Definition statement**

*This place covers:*

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

**References****Limiting references**

*This place does not cover:*

Fullerene	<a href="#">C01B 32/152</a>
Graphene	<a href="#">C01B 32/182</a>



**C30B 29/38****Nitrides****References****Limiting references**

*This place does not cover:*

All-nitrides (including born nitride)	<a href="#">C30B 29/403</a> , <a href="#">C30B 29/406</a>
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**C30B 29/58****Macromolecular compounds****Definition statement**

*This place covers:*

Macromolecular compounds including biological compounds such as proteins and enzymes.

**C30B 29/60****characterised by shape****Definition statement**

*This place 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****{Nanotubes}****References****Limiting references**

*This place does not cover:*

CNT carbon nanotubes	<a href="#">C01B 32/158</a>
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**C30B 29/605****{Products containing multiple oriented crystallites, e.g. columnar crystallites}****Definition statement**

*This place covers:*

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

**C30B 31/00**

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

**Relationships with other classification places**

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 31/18**

**Controlling or regulating**

**References****Informative references**

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

Controlling or regulating in general	<a href="#">G05</a>
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**C30B 33/00**

**After-treatment of single crystals or homogeneous polycrystalline material with defined structure ([C30B 31/00](#) takes precedence)**

**References****Limiting references**

This place does not cover:

Diffusion or doping processes for single crystals or homogeneous polycrystalline material with defined structure; Apparatus therefor	<a href="#">C30B 31/00</a>
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**Informative references**

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

Grinding, polishing	<a href="#">B24</a>
Mechanical fine working of gems, jewels, crystals	<a href="#">B28D 5/00</a>

**C30B 35/007**

**{Apparatus for preparing, pre-treating the source material to be used for crystal growth}**

**Definition statement**

This place covers:

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