

**CPC****COOPERATIVE PATENT CLASSIFICATION****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**

**NOTE**

In this subclass, the following expressions are used with the meaning indicated:

- "single-crystal" includes also twin crystals and a predominantly single crystal product;
- "homogeneous polycrystalline material" means a material with crystal particles, all of which have the same chemical composition;
- "defined structure" means the structure of a material with grains which are oriented in a preferential way or have larger dimensions than normally obtained.

In this subclass:

- 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](#);
- 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](#).

After the notation of [C30B](#) and separated therefrom by a + sign, notations concerning the particular composition or shape of the material may be added. These notations are selected from [C30B 29/00](#).

Example: A crystal-growth process by zone-melting directly related to Al<sub>2</sub>O<sub>3</sub> crystal material is classified in

## C30B

(continued)

[C30B 13/00](#) + [C30B 29/20](#)**WARNING**

The following IPC groups are not used in the CPC system. Subject matter covered by these groups is classified in the following CPC groups:

[C30B 29/64](#), [C30B 29/66](#) covered by [C30B 29/60](#)

**Single-crystal growth from solids or gels**

**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](#))

- C30B 1/02      . by thermal treatment, e.g. strain annealing ([C30B 1/12](#) takes precedence)
- C30B 1/023      . . {from solids with amorphous structure}
- C30B 1/026      . . {Solid phase epitaxial growth through a disordered intermediate layer}
- C30B 1/04      . . Isothermal recrystallisation
- C30B 1/06      . . Recrystallisation under a temperature gradient
- C30B 1/08      . . . Zone recrystallisation
- C30B 1/10      . by solid state reactions or multi-phase diffusion
- C30B 1/12      . by pressure treatment during the growth

**C30B 3/00**      **Unidirectional demixing of eutectoid materials**

**C30B 5/00**      **Single-crystal growth from gels** (under a protective fluid [C30B 27/00](#))

- C30B 5/02      . with addition of doping material

**Single-crystal growth from liquids; Unidirectional solidification of eutectic materials**

**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 7/005      . {Epitaxial layer growth}

**WARNING**

Group [C30B 7/005](#) is not complete, see also [C30B 7/00](#)

- C30B 7/02      . by evaporation of the solvent
- C30B 7/04      . . using aqueous solvents
- C30B 7/06      . . using non-aqueous solvents
- C30B 7/08      . by cooling of the solution
- C30B 7/10      . by application of pressure, e.g. hydrothermal processes

- C30B 7/105 . . {using ammonia as solvent, i.e. ammonothermal processes}
- C30B 7/12 . by electrolysis
- C30B 7/14 . the crystallising material being formed by chemical reactions in the solution

**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](#))

- C30B 9/02 . by evaporation of the molten solvent
- C30B 9/04 . by cooling of the solution
- C30B 9/06 . . using as solvent a component of the crystal composition
- C30B 9/08 . . using other solvents
- C30B 9/10 . . . Metal solvents
- C30B 9/12 . . . Salt solvents, e.g. flux growth
- C30B 9/14 . by electrolysis

**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 11/001 . {Continuous growth}
- C30B 11/002 . {Crucibles or containers for supporting the melt}
- C30B 11/003 . {Heating or cooling of the melt or the crystallised material}
- C30B 11/005 . {by irradiation or electric discharge}
- C30B 11/006 . {Controlling or regulating}
- C30B 11/007 . {Mechanisms for moving either the charge or the heater}
- C30B 11/008 . {using centrifugal force to the charge}
- C30B 11/02 . without using solvents ([C30B 11/06](#) takes precedence)
- C30B 11/04 . adding crystallising material or reactants forming it in situ to the melt
- C30B 11/06 . . at least one but not all components of the crystal composition being added
- C30B 11/065 . . . {before crystallising, e.g. synthesis}
- C30B 11/08 . . every component of the crystal composition being added during the crystallisation
- C30B 11/10 . . . Solid or liquid components, e.g. Verneuil method
- C30B 11/12 . . . Vaporous components, e.g. vapour-liquid-solid-growth
- C30B 11/14 . characterised by the seed, e.g. its crystallographic orientation

**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 13/005 . {Continuous growth}
- C30B 13/02 . Zone-melting with a solvent, e.g. travelling solvent process
- C30B 13/04 . Homogenisation by zone-levelling
- C30B 13/06 . the molten zone not extending over the whole cross-section

- C30B 13/08 . adding crystallising material or reactants forming it in situ to the molten zone
- C30B 13/10 . . with addition of doping material
- C30B 13/12 . . . in the gaseous or vapour state
- C30B 13/14 . Crucibles or vessels
- C30B 13/16 . Heating of the molten zone
- C30B 13/18 . . the heating element being in contact with, or immersed in, the molten zone
- C30B 13/20 . . by induction, e.g. hot wire technique ([C30B 13/18](#) takes precedence; induction coils [H05B 6/36](#))
- C30B 13/22 . . by irradiation or electric discharge
- C30B 13/24 . . . using electromagnetic waves
- C30B 13/26 . Stirring of the molten zone
- C30B 13/28 . Controlling or regulating ([controlling or regulating in general G05](#))
- C30B 13/285 . . {Crystal holders, e.g. chucks}
- C30B 13/30 . . Stabilisation or shape controlling of the molten zone, e.g. by concentrators, by electromagnetic fields; Controlling the section of the crystal
- C30B 13/32 . Mechanisms for moving either the charge or the heater
- C30B 13/34 . characterised by the seed, e.g. by its crystallographic orientation
  
- C30B 15/00** **Single-crystal growth by pulling from a melt, e.g. Czochralski method** ([under a protective fluid C30B 27/00](#))
- C30B 15/002 . {Continuous growth}
- C30B 15/005 . {Simultaneous pulling of more than one crystal}
- C30B 15/007 . {Pulling on a substrate}
- C30B 15/02 . adding crystallising material or reactants forming it in situ to the melt
- C30B 15/04 . . adding doping material, e.g. for n-p-junction
- C30B 15/06 . Non-vertical pulling
- C30B 15/08 . Downward pulling
- C30B 15/10 . Crucibles or containers for supporting the melt
- C30B 15/12 . . Double crucible methods
- C30B 15/14 . Heating of the melt or the crystallised material
- C30B 15/16 . . by irradiation or electric discharge
- C30B 15/18 . . using direct resistance heating in addition to other methods of heating, e.g. using Peltier heat
- C30B 15/20 . Controlling or regulating ([controlling or regulating in general G05](#))
- C30B 15/203 . . {the relationship of pull rate (v) to axial thermal gradient (G)}
- C30B 15/206 . . {the thermal history of growing the ingot}
- C30B 15/22 . . Stabilisation or shape controlling of the molten zone near the pulled crystal; Controlling the section of the crystal
- C30B 15/24 . . . using mechanical means, e.g. shaping guides ([shaping dies for edge-defined film-fed crystal growth C30B 15/34](#))
- C30B 15/26 . . . using television detectors; using photo or X-ray detectors
- C30B 15/28 . . . using weight changes of the crystal or the melt, e.g. flotation methods

- C30B 15/30 . Mechanisms for rotating or moving either the melt or the crystal ([flotation methods C30B 15/28](#))
- C30B 15/305 . . {Stirring of the melt}
- C30B 15/32 . Seed holders, e.g. chucks
- C30B 15/34 . Edge-defined film-fed crystal-growth using dies or slits
- C30B 15/36 . characterised by the seed, e.g. its crystallographic orientation
  
- 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 19/02 . using molten solvents, e.g. flux
- C30B 19/04 . . the solvent being a component of the crystal composition
- C30B 19/06 . Reaction chambers; Boats for supporting the melt; Substrate holders
- C30B 19/061 . . {Tipping system, e.g. by rotation}
- C30B 19/062 . . {Vertical dipping system}
- C30B 19/063 . . {Sliding boat system}
- C30B 19/064 . . {Rotating sliding boat system}
- C30B 19/065 . . {Multiple stacked slider system}
- C30B 19/066 . . {Injection or centrifugal force system}
- C30B 19/067 . . {Boots or containers}
- C30B 19/068 . . {Substrate holders}
- C30B 19/08 . Heating of the reaction chamber or the substrate
- C30B 19/10 . Controlling or regulating ([controlling or regulating in general G05](#))
- C30B 19/103 . . {Current controlled or induced growth}
- C30B 19/106 . . {adding crystallising material or reactants forming it in situ to the liquid}
- C30B 19/12 . characterised by the substrate
  
- C30B 21/00** **Unidirectional solidification of eutectic materials**
- C30B 21/02 . by normal casting or gradient freezing
- C30B 21/04 . by zone-melting
- C30B 21/06 . by pulling from a melt

### Single-crystal growth from vapours

#### **C30B 23/00** **Single-crystal growth by condensing evaporated or sublimed material**

##### **NOTE**

Groups [C30B 23/002](#) to [C30B 23/005](#) take precedence over groups [C30B 23/007](#) to [C30B 23/08](#)

##### **WARNING**

C30B 23/00  
(continued)

Group [C30B 23/002](#) to [C30B 23/005](#) are not complete, see also [C30B 23/02](#)

- C30B 23/002 . {Controlling or regulating}
- C30B 23/005 . . {Controlling or regulating flux or flow of depositing species or vapour}
- C30B 23/007 . {Growth of whiskers or needles}
- C30B 23/02 . Epitaxial-layer growth
- C30B 23/025 . . {characterised by the substrate}
- C30B 23/04 . . Pattern deposit, e.g. by using masks
- C30B 23/06 . . Heating of the deposition chamber, the substrate or the material to be evaporated
- C30B 23/063 . . . {Heating of the substrate}

#### **WARNING**

Group [C30B 23/063](#) is not complete, see also [C30B 23/06](#)

- C30B 23/066 . . . {Heating of the material to be evaporated}

#### **WARNING**

Group [C30B 23/066](#) is not complete, see also [C30B 23/06](#)

- C30B 23/08 . . by condensing ionised vapours (by reactive sputtering [C30B 25/06](#))

### **C30B 25/00      Single-crystal growth by chemical reaction of reactive gases, e.g. chemical vapour-deposition growth**

- C30B 25/005 . {Growth of whiskers or needles}
- C30B 25/02 . Epitaxial-layer growth
- C30B 25/025 . . {Continuous growth}
- C30B 25/04 . . Pattern deposit, e.g. by using masks
- C30B 25/06 . . by reactive sputtering
- C30B 25/08 . . Reaction chambers; Selection of material therefor
- C30B 25/10 . . Heating of the reaction chamber or the substrate
- C30B 25/105 . . . {by irradiation or electric discharge}
- C30B 25/12 . . Substrate holders or susceptors
- C30B 25/14 . . Feed and outlet means for the gases; Modifying the flow of the reactive gases
- C30B 25/16 . . Controlling or regulating ([controlling or regulating in general G05](#))
- C30B 25/165 . . . {the flow of the reactive gases}

#### **WARNING**

Not complete pending reclassification, see also group [C30B 25/14](#)

- C30B 25/18 . . characterised by the substrate
- C30B 25/183 . . . {being provided with a buffer layer, e.g. a lattice matching layer}

#### **WARNING**

**C30B 25/183**

(continued)

This group is not complete pending reclassification; see also [C30B 25/18](#) and subgroups

**C30B 25/186**

... {being specially pre-treated by e.g. chemical or physical means}

**C30B 25/20**

... the substrate being of the same material as the epitaxial layer

**C30B 25/205**

.... {the substrate being of insulating material}

**C30B 25/22**

.. Sandwich processes

**C30B 27/00****Single-crystal growth under a protective fluid****C30B 27/02**

. by pulling from a melt

**C30B 28/00****Production of homogeneous polycrystalline material with defined structure****C30B 28/02**

. directly from the solid state

**C30B 28/04**

. from liquids

**C30B 28/06**

.. by normal freezing or freezing under temperature gradient

**C30B 28/08**

.. by zone-melting

**C30B 28/10**

.. by pulling from a melt

**C30B 28/12**

. directly from the gas state

**C30B 28/14**

.. by chemical reaction of reactive gases

**C30B 29/00****Single crystals or homogeneous polycrystalline material with defined structure characterised by the material or by their shape ([alloys C22C](#))****NOTE**

In groups [C30B 29/02](#) to [C30B 29/58](#), in the absence of an indication to the contrary, a material is classified in the last appropriate place.

**C30B 29/02**

. Elements

**C30B 29/04**

.. Diamond

**C30B 29/06**

.. Silicon

**C30B 29/08**

.. Germanium

**C30B 29/10**

. Inorganic compounds or compositions

**C30B 29/12**

.. Halides

**C30B 29/14**

.. Phosphates

**C30B 29/16**

.. Oxides

**C30B 29/18**

... Quartz

**C30B 29/20**

... Aluminium oxides

**C30B 29/22**

... Complex oxides

**C30B 29/225**

.... {based on rare earth copper oxides, e.g. high T-superconductors}

**C30B 29/24**

.... with formula  $AMeO_3$ , wherein A is a rare earth metal and Me is Fe, Ga, Sc, Cr, Co or Al, e.g. ortho ferrites

**C30B 29/26**

.... with formula  $BMe_2O_4$ , wherein B is Mg, Ni, Co, Al, Zn, or Cd and Me is Fe, Ga, Sc, Cr, Co, or Al

- C30B 29/28 . . . . with formula  $A_3Me_5O_{12}$  wherein A is a rare earth metal and Me is Fe, Ga, Sc, Cr, Co or Al, e.g. garnets
- C30B 29/30 . . . . Niobates; Vanadates; Tantalates
- C30B 29/32 . . . . Titanates; Germanates; Molybdates; Tungstates
- C30B 29/34 . . Silicates
- C30B 29/36 . . Carbides
- C30B 29/38 . . Nitrides
- C30B 29/40 . . AllIBV compounds {wherein A is B, Al, Ga, In or Tl and B is N, P, As, Sb or Bi}
- C30B 29/403 . . . . All-nitrides
- C30B 29/406 . . . . Gallium nitride
- C30B 29/42 . . . . Gallium arsenide
- C30B 29/44 . . . . Gallium phosphide
- C30B 29/46 . . Sulfur-, selenium- or tellurium-containing compounds
- C30B 29/48 . . . . AllBVI compounds {wherein A is Zn, Cd or Hg, and B is S, Se or Te}
- C30B 29/50 . . . . Cadmium sulfide
- C30B 29/52 . . Alloys
- C30B 29/54 . Organic compounds
- C30B 29/56 . . Tartrates
- C30B 29/58 . . Macromolecular compounds
- C30B 29/60 . characterised by shape
- C30B 29/602 . . {Nanotubes}
- C30B 29/605 . . {Products containing multiple oriented crystallites, e.g. columnar crystallites}
- C30B 29/607 . . {Crystals of complex geometrical shape, e.g. tubes, cylinders }(nanotubes [C30B 29/602](#))

**WARNING**

Group [C30B 29/607](#) is not complete, see also [C30B 29/602](#), [C30B 29/605](#)

- C30B 29/62 . . Whiskers or needles
- C30B 29/64 . . Flat crystals, e.g. plates, strips, disks

**WARNING**

This group is not complete pending reclassification; see also [C30B 29/60](#) and subgroups

- C30B 29/66 . . Crystals of complex geometrical shape, e.g. tubes, cylinders

**WARNING**

This group is not complete pending reclassification; see also [C30B 29/60](#) and subgroups

- C30B 29/68 . . Crystals with laminate structure, e.g. "superlattices"



**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**

**NOTE**

When classifying in this group, classification is also made in groups [C30B 1/00](#) to [C30B 27/00](#) according to the process of crystal growth.

- C30B 30/02      . using electric fields, e.g. electrolysis
- C30B 30/04      . using magnetic fields
- C30B 30/06      . using mechanical vibrations
- C30B 30/08      . in conditions of zero-gravity or low gravity

**After-treatment of single crystals or homogeneous polycrystalline material with defined structure**

**C30B 31/00**      **Diffusion or doping processes for single crystals or homogeneous polycrystalline material with defined structure; Apparatus therefor**

- C30B 31/02      . by contacting with diffusion material in the solid state
- C30B 31/04      . by contacting with diffusion material in the liquid state
- C30B 31/045      . . {by electrolysis}
- C30B 31/06      . by contacting with diffusion material in the gaseous state ([C30B 31/18](#) takes precedence)
- C30B 31/08      . . the diffusion material being a compound of the elements to be diffused
- C30B 31/10      . . Reaction chambers; Selection of material therefor
- C30B 31/103      . . . {Mechanisms for moving either the charge or heater}
- C30B 31/106      . . . {Continuous processes}
- C30B 31/12      . . Heating of the reaction chamber
- C30B 31/14      . . Substrate holders or susceptors
- C30B 31/16      . . Feed and outlet means for the gases; Modifying the flow of the gases
- C30B 31/165      . . . {Diffusion sources}
- C30B 31/18      . . Controlling or regulating ([controlling or regulating in general G05](#))
- C30B 31/185      . . . {Pattern diffusion, e.g. by using masks}
- C30B 31/20      . Doping by irradiation with electromagnetic waves or by particle radiation
- C30B 31/22      . . by ion-implantation

**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 33/005      . {Oxydation}
- C30B 33/02      . Heat treatment ([C30B 33/04](#), [C30B 33/06](#) take precedence)
- C30B 33/04      . using electric or magnetic fields or particle radiation
- C30B 33/06      . Joining of crystals

- C30B 33/08 . Etching
- C30B 33/10 . . in solutions or melts
- C30B 33/12 . . in gas atmosphere or plasma

**C30B 35/00** **Apparatus in general, specially adapted for the growth, production or after-treatment of single crystals or a homogeneous polycrystalline material with defined structure**

- C30B 35/002 . {Crucibles or containers}
- C30B 35/005 . {Transport systems}
- C30B 35/007 . {Apparatus for preparing, pre-treating the source material to be used for crystal growth}

**WARNING**

This group is not complete pending reclassification; see also groups pertaining to the different crystal growth methods, particularly the main groups of subclass [C30B](#)