

# 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**

## NOTES

1. 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.
2. 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](#).
3. 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  $\text{Al}_2\text{O}_3$  crystal material is classified in [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

- |             |  |
|-------------|--|
| <b>1/00</b> | <b>Single-crystal growth directly from the solid state</b> (unidirectional demixing of eutectoid materials <a href="#">C30B 3/00</a> ; under a protective fluid <a href="#">C30B 27/00</a> ) |
| 1/02        | • by thermal treatment, e.g. strain annealing ( <a href="#">C30B 1/12</a> takes precedence)  |
| 1/023       | • . {from solids with amorphous structure}   |
| 1/026       | • . {Solid phase epitaxial growth through a disordered intermediate layer}   |
| 1/04        | • . Isothermal recrystallisation   |
| 1/06        | • . Recrystallisation under a temperature gradient   |
| 1/08        | • . . Zone recrystallisation   |
| 1/10        | • by solid state reactions or multi-phase diffusion  |
| 1/12        | • by pressure treatment during the growth  |
| <b>3/00</b> | <b>Unidirectional demixing of eutectoid materials</b>  |
| <b>5/00</b> | <b>Single-crystal growth from gels</b> (under a protective fluid <a href="#">C30B 27/00</a> )  |
| 5/02        | • with addition of doping material   |

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

- |             |   |
|-------------|---|
| <b>7/00</b> | <b>Single-crystal growth from solutions using solvents which are liquid at normal temperature, e.g. aqueous solutions</b> (from molten solvents <a href="#">C30B 9/00</a> ; by normal or gradient freezing <a href="#">C30B 11/00</a> ; under a protective fluid <a href="#">C30B 27/00</a> ) |
| 7/005       | • {Epitaxial layer growth}  |
|             | <b>WARNING</b>  |
|             | Group <a href="#">C30B 7/005</a> is not complete, see also <a href="#">C30B 7/00</a>  |
| 7/02        | • by evaporation of the solvent   |
| 7/04        | • . using aqueous solvents  |
| 7/06        | • . using non-aqueous solvents  |
| 7/08        | • by cooling of the solution  |
| 7/10        | • by application of pressure, e.g. hydrothermal processes   |
| 7/105       | • . {using ammonia as solvent, i.e. ammonothermal processes}  |
| 7/12        | • by electrolysis   |

7/14	<ul style="list-style-type: none"> <li>the crystallising material being formed by chemical reactions in the solution</li> </ul>	13/16	<ul style="list-style-type: none"> <li>Heating of the molten zone</li> </ul>
9/00	<b>Single-crystal growth from melt solutions using molten solvents</b> (by normal or gradient freezing <a href="#">C30B 11/00</a> ; by zone-melting <a href="#">C30B 13/00</a> ; by crystal pulling <a href="#">C30B 15/00</a> ; on immersed seed crystal <a href="#">C30B 17/00</a> ; by liquid phase epitaxial growth <a href="#">C30B 19/00</a> ; under a protective fluid <a href="#">C30B 27/00</a> )	13/18	<ul style="list-style-type: none"> <li>the heating element being in contact with, or immersed in, the molten zone</li> </ul>
9/02	<ul style="list-style-type: none"> <li>by evaporation of the molten solvent</li> </ul>	13/20	<ul style="list-style-type: none"> <li>by induction, e.g. hot wire technique (<a href="#">C30B 13/18</a> takes precedence; induction coils <a href="#">H05B 6/36</a>)</li> </ul>
9/04	<ul style="list-style-type: none"> <li>by cooling of the solution</li> </ul>	13/22	<ul style="list-style-type: none"> <li>by irradiation or electric discharge</li> </ul>
9/06	<ul style="list-style-type: none"> <li>using as solvent a component of the crystal composition</li> </ul>	13/24	<ul style="list-style-type: none"> <li>using electromagnetic waves</li> </ul>
9/08	<ul style="list-style-type: none"> <li>using other solvents</li> </ul>	13/26	<ul style="list-style-type: none"> <li>Stirring of the molten zone</li> </ul>
9/10	<ul style="list-style-type: none"> <li>Metal solvents</li> </ul>	13/28	<ul style="list-style-type: none"> <li>Controlling or regulating (<a href="#">controlling or regulating in general G05</a>)</li> </ul>
9/12	<ul style="list-style-type: none"> <li>Salt solvents, e.g. flux growth</li> </ul>	13/285	<ul style="list-style-type: none"> <li>{Crystal holders, e.g. chucks}</li> </ul>
9/14	<ul style="list-style-type: none"> <li>by electrolysis</li> </ul>	13/30	<ul style="list-style-type: none"> <li>Stabilisation or shape controlling of the molten zone, e.g. by concentrators, by electromagnetic fields; Controlling the section of the crystal</li> </ul>
11/00	<b>Single-crystal growth by normal freezing or freezing under temperature gradient, e.g. Bridgman-Stockbarger method</b> ( <a href="#">C30B 13/00</a> , <a href="#">C30B 15/00</a> , <a href="#">C30B 17/00</a> , <a href="#">C30B 19/00</a> take precedence; under a protective fluid <a href="#">C30B 27/00</a> )	13/32	<ul style="list-style-type: none"> <li>Mechanisms for moving either the charge or the heater</li> </ul>
11/001	<ul style="list-style-type: none"> <li>{Continuous growth}</li> </ul>	13/34	<ul style="list-style-type: none"> <li>characterised by the seed, e.g. by its crystallographic orientation</li> </ul>
11/002	<ul style="list-style-type: none"> <li>{Crucibles or containers for supporting the melt}</li> </ul>	15/00	<b>Single-crystal growth by pulling from a melt, e.g. Czochralski method</b> (under a protective fluid <a href="#">C30B 27/00</a> )
11/003	<ul style="list-style-type: none"> <li>{Heating or cooling of the melt or the crystallised material}</li> </ul>	15/002	<ul style="list-style-type: none"> <li>{Continuous growth}</li> </ul>
11/005	<ul style="list-style-type: none"> <li>{by irradiation or electric discharge}</li> </ul>	15/005	<ul style="list-style-type: none"> <li>{Simultaneous pulling of more than one crystal}</li> </ul>
11/006	<ul style="list-style-type: none"> <li>{Controlling or regulating}</li> </ul>	15/007	<ul style="list-style-type: none"> <li>{Pulling on a substrate}</li> </ul>
11/007	<ul style="list-style-type: none"> <li>{Mechanisms for moving either the charge or the heater}</li> </ul>	15/02	<ul style="list-style-type: none"> <li>adding crystallising material or reactants forming it <u>in situ</u> to the melt</li> </ul>
11/008	<ul style="list-style-type: none"> <li>{using centrifugal force to the charge}</li> </ul>	15/04	<ul style="list-style-type: none"> <li>adding doping material, e.g. for n-p-junction</li> </ul>
11/02	<ul style="list-style-type: none"> <li>without using solvents (<a href="#">C30B 11/06</a> takes precedence)</li> </ul>	15/06	<ul style="list-style-type: none"> <li>Non-vertical pulling</li> </ul>
11/04	<ul style="list-style-type: none"> <li>adding crystallising material or reactants forming it <u>in situ</u> to the melt</li> </ul>	15/08	<ul style="list-style-type: none"> <li>Downward pulling</li> </ul>
11/06	<ul style="list-style-type: none"> <li>at least one but not all components of the crystal composition being added</li> </ul>	15/10	<ul style="list-style-type: none"> <li>Crucibles or containers for supporting the melt</li> </ul>
11/065	<ul style="list-style-type: none"> <li>{before crystallising, e.g. synthesis}</li> </ul>	15/12	<ul style="list-style-type: none"> <li>Double crucible methods</li> </ul>
11/08	<ul style="list-style-type: none"> <li>every component of the crystal composition being added during the crystallisation</li> </ul>	15/14	<ul style="list-style-type: none"> <li>Heating of the melt or the crystallised material</li> </ul>
11/10	<ul style="list-style-type: none"> <li>Solid or liquid components, e.g. Verneuil method</li> </ul>	15/16	<ul style="list-style-type: none"> <li>by irradiation or electric discharge</li> </ul>
11/12	<ul style="list-style-type: none"> <li>Vaporous components, e.g. vapour-liquid-solid-growth</li> </ul>	15/18	<ul style="list-style-type: none"> <li>using direct resistance heating in addition to other methods of heating, e.g. using Peltier heat</li> </ul>
11/14	<ul style="list-style-type: none"> <li>characterised by the seed, e.g. its crystallographic orientation</li> </ul>	15/20	<ul style="list-style-type: none"> <li>Controlling or regulating (<a href="#">controlling or regulating in general G05</a>)</li> </ul>
13/00	<b>Single-crystal growth by zone-melting; Refining by zone-melting</b> ( <a href="#">C30B 17/00</a> takes precedence; by changing the cross-section of the treated solid <a href="#">C30B 15/00</a> ; under a protective fluid <a href="#">C30B 27/00</a> ; zone-refining of specific materials, <u>see</u> the relevant subclasses for the materials)	15/203	<ul style="list-style-type: none"> <li>{the relationship of pull rate (v) to axial thermal gradient (G)}</li> </ul>
13/005	<ul style="list-style-type: none"> <li>{Continuous growth}</li> </ul>	15/206	<ul style="list-style-type: none"> <li>{the thermal history of growing the ingot}</li> </ul>
13/02	<ul style="list-style-type: none"> <li>Zone-melting with a solvent, e.g. travelling solvent process</li> </ul>	15/22	<ul style="list-style-type: none"> <li>Stabilisation or shape controlling of the molten zone near the pulled crystal; Controlling the section of the crystal</li> </ul>
13/04	<ul style="list-style-type: none"> <li>Homogenisation by zone-levelling</li> </ul>	15/24	<ul style="list-style-type: none"> <li>using mechanical means, e.g. shaping guides (<a href="#">shaping dies for edge-defined film-fed crystal growth C30B 15/34</a>)</li> </ul>
13/06	<ul style="list-style-type: none"> <li>the molten zone not extending over the whole cross-section</li> </ul>	15/26	<ul style="list-style-type: none"> <li>using television detectors; using photo or X-ray detectors</li> </ul>
13/08	<ul style="list-style-type: none"> <li>adding crystallising material or reactants forming it <u>in situ</u> to the molten zone</li> </ul>	15/28	<ul style="list-style-type: none"> <li>using weight changes of the crystal or the melt, e.g. flotation methods</li> </ul>
13/10	<ul style="list-style-type: none"> <li>with addition of doping material</li> </ul>	15/30	<ul style="list-style-type: none"> <li>Mechanisms for rotating or moving either the melt or the crystal (<a href="#">flotation methods C30B 15/28</a>)</li> </ul>
13/12	<ul style="list-style-type: none"> <li>in the gaseous or vapour state</li> </ul>	15/305	<ul style="list-style-type: none"> <li>{Stirring of the melt}</li> </ul>
13/14	<ul style="list-style-type: none"> <li>Crucibles or vessels</li> </ul>	15/32	<ul style="list-style-type: none"> <li>Seed holders, e.g. chucks</li> </ul>
		15/34	<ul style="list-style-type: none"> <li>Edge-defined film-fed crystal-growth using dies or slits</li> </ul>
		15/36	<ul style="list-style-type: none"> <li>characterised by the seed, e.g. its crystallographic orientation</li> </ul>
		17/00	<b>Single-crystal growth onto a seed which remains in the melt during growth, e.g. Nacken-Kyropoulos method</b> ( <a href="#">C30B 15/00</a> takes precedence)
		19/00	<b>Liquid-phase epitaxial-layer growth</b>

- 19/02 . using molten solvents, e.g. flux
- 19/04 . . the solvent being a component of the crystal composition
- 19/06 . Reaction chambers; Boats for supporting the melt; Substrate holders
- 19/061 . . {Tipping system, e.g. by rotation}
- 19/062 . . {Vertical dipping system}
- 19/063 . . {Sliding boat system}
- 19/064 . . {Rotating sliding boat system}
- 19/065 . . {Multiple stacked slider system}
- 19/066 . . {Injection or centrifugal force system}
- 19/067 . . {Boots or containers}
- 19/068 . . {Substrate holders}
- 19/08 . Heating of the reaction chamber or the substrate
- 19/10 . Controlling or regulating (controlling or regulating in general G05)
- 19/103 . . {Current controlled or induced growth}
- 19/106 . . {adding crystallising material or reactants forming it *in situ* to the liquid}
- 19/12 . characterised by the substrate
- 21/00 Unidirectional solidification of eutectic materials**
- 21/02 . by normal casting or gradient freezing
- 21/04 . by zone-melting
- 21/06 . by pulling from a melt

**Single-crystal growth from vapours****23/00 Single-crystal growth by condensing evaporated or sublimed material****NOTE**

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

**WARNING**

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

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

**WARNING**

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

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

**WARNING**

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

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

**25/00****25/005****25/02****25/025****25/04****25/06****25/08****25/10****25/105****25/12****25/14****25/16****25/165****25/18****25/183****25/186****25/20****25/205****25/22****27/00****27/02****28/00****28/02****28/04****28/06****28/08****28/10****28/12****28/14****29/00****29/02****29/04****29/06****29/08****29/10****Single-crystal growth by chemical reaction of reactive gases, e.g. chemical vapour-deposition growth**

- . {Growth of whiskers or needles}
- . Epitaxial-layer growth
- . . {Continuous growth}
- . . Pattern deposit, e.g. by using masks
- . . by reactive sputtering
- . . Reaction chambers; Selection of material therefor
- . . Heating of the reaction chamber or the substrate
- . . . {by irradiation or electric discharge}
- . . Substrate holders or susceptors
- . . Feed and outlet means for the gases; Modifying the flow of the reactive gases
- . . Controlling or regulating (controlling or regulating in general G05)
- . . . {the flow of the reactive gases}

**WARNING**

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

- . . characterised by the substrate
- . . . {being provided with a buffer layer, e.g. a lattice matching layer}

**WARNING**

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

- . . . {being specially pre-treated by, e.g. chemical or physical means}
- . . . the substrate being of the same material as the epitaxial layer
- . . . . {the substrate being of insulating material}
- . . Sandwich processes

**Single-crystal growth under a protective fluid**

- . by pulling from a melt

**Production of homogeneous polycrystalline material with defined structure**

- . directly from the solid state
- . from liquids
- . . by normal freezing or freezing under temperature gradient
- . . by zone-melting
- . . by pulling from a melt
- . directly from the gas state
- . . by chemical reaction of reactive gases

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

- . Elements
- . . Diamond
- . . Silicon
- . . Germanium
- . Inorganic compounds or compositions

- 29/12 . . Halides
- 29/14 . . Phosphates
- 29/16 . . Oxides
- 29/18 . . . Quartz
- 29/20 . . . Aluminium oxides
- 29/22 . . . Complex oxides
- 29/225 . . . . {based on rare earth copper oxides, e.g. high T-superconductors}
- 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
- 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
- 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
- 29/30 . . . . Niobates; Vanadates; Tantalates
- 29/32 . . . . Titanates; Germanates; Molybdates; Tungstates
- 29/34 . . Silicates
- 29/36 . . Carbides
- 29/38 . . Nitrides
- 29/40 . .  $A_{III}B_V$  compounds {wherein A is B, Al, Ga, In or Tl and B is N, P, As, Sb or Bi}
- 29/403 . . . { $A_{III}$ -nitrides}
- 29/406 . . . . {Gallium nitride}
- 29/42 . . . Gallium arsenide
- 29/44 . . . Gallium phosphide
- 29/46 . . Sulfur-, selenium- or tellurium-containing compounds
- 29/48 . . .  $A_{II}B_{VI}$  compounds {wherein A is Zn, Cd or Hg, and B is S, Se or Te}
- 29/50 . . . . Cadmium sulfide
- 29/52 . . Alloys
- 29/54 . Organic compounds
- 29/56 . . Tartrates
- 29/58 . . Macromolecular compounds
- 29/60 . characterised by shape
- 29/602 . . {Nanotubes}
- 29/605 . . {Products containing multiple oriented crystallites, e.g. columnar crystallites}
- 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

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

**WARNING**

This group is not complete pending reclassification; see also C30B 29/60 and subgroups

- 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

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

**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 - C30B 27/00 according to the process of crystal growth.

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

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

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

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

**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)**

- 33/005 . {Oxydation}
- 33/02 . Heat treatment (C30B 33/04, C30B 33/06 take precedence)
- 33/04 . using electric or magnetic fields or particle radiation
- 33/06 . Joining of crystals
- 33/08 . Etching
- 33/10 . . in solutions or melts
- 33/12 . . in gas atmosphere or plasma

**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**

- 35/002 . {Crucibles or containers}
- 35/005 . {Transport systems}
- 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](#)