

# CPC COOPERATIVE PATENT CLASSIFICATION

## C CHEMISTRY; METALLURGY

(NOTES omitted)

### METALLURGY

#### C30 CRYSTAL GROWTH

**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

- 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  $\text{Al}_2\text{O}_3$  crystal material is classified in [C30B 13/00](#) + [C30B 29/20](#)

#### WARNING

In this subclass non-limiting references (in the sense of paragraph 39 of the Guide to the IPC) may still be displayed in the scheme.

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

- 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](#))
- 1/02 . by thermal treatment, e.g. strain annealing ([C30B 1/12](#) 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

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

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

5/02 . with addition of doping materials

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

**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](#))

7/005	<ul style="list-style-type: none"> <li>• {Epitaxial layer growth}</li> </ul> <p><b>WARNING</b></p> <p>Group <a href="#">C30B 7/005</a> is not complete, see also <a href="#">C30B 7/00</a></p>	13/00	<p><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, see the relevant subclasses for the materials)</p> <ul style="list-style-type: none"> <li>• {Continuous growth}</li> <li>• Zone-melting with a solvent, e.g. travelling solvent process</li> <li>• Homogenisation by zone-levelling</li> <li>• the molten zone not extending over the whole cross-section</li> <li>• adding crystallising materials or reactants forming it <u>in situ</u> to the molten zone <ul style="list-style-type: none"> <li>• . . with addition of doping materials</li> <li>• . . . in the gaseous or vapour state</li> </ul> </li> <li>• Crucibles or vessels</li> <li>• Heating of the molten zone <ul style="list-style-type: none"> <li>• . the heating element being in contact with, or immersed in, the molten zone</li> </ul> </li> <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> <li>• . by irradiation or electric discharge <ul style="list-style-type: none"> <li>• . . . using electromagnetic waves</li> </ul> </li> <li>• Stirring of the molten zone</li> <li>• Controlling or regulating (<a href="#">controlling or regulating in general G05</a>) <ul style="list-style-type: none"> <li>• . {Crystal holders, e.g. chucks}</li> </ul> </li> <li>• . Stabilisation or shape controlling of the molten zone, e.g. by concentrators, by electromagnetic fields; Controlling the section of the crystal</li> <li>• Mechanisms for moving either the charge or the heater</li> <li>• characterised by the seed, e.g. by its crystallographic orientation</li> </ul>
7/02	<ul style="list-style-type: none"> <li>• by evaporation of the solvent</li> </ul>	13/005	
7/04	<ul style="list-style-type: none"> <li>• . using aqueous solvents</li> </ul>	13/02	
7/06	<ul style="list-style-type: none"> <li>• . using non-aqueous solvents</li> </ul>	13/04	
7/08	<ul style="list-style-type: none"> <li>• by cooling of the solution</li> </ul>	13/06	
7/10	<ul style="list-style-type: none"> <li>• by application of pressure, e.g. hydrothermal processes</li> </ul>	13/08	
7/105	<ul style="list-style-type: none"> <li>• . {using ammonia as solvent, i.e. ammonothermal processes}</li> </ul>	13/10	
7/12	<ul style="list-style-type: none"> <li>• by electrolysis</li> </ul>	13/12	
7/14	<ul style="list-style-type: none"> <li>• the crystallising materials being formed by chemical reactions in the solution</li> </ul>	13/14	
9/00	<p><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>)</p>	13/16	
9/02	<ul style="list-style-type: none"> <li>• by evaporation of the molten solvent</li> </ul>	13/18	
9/04	<ul style="list-style-type: none"> <li>• by cooling of the solution</li> </ul>	13/20	
9/06	<ul style="list-style-type: none"> <li>• . using as solvent a component of the crystal composition</li> </ul>	13/22	
9/08	<ul style="list-style-type: none"> <li>• . using other solvents</li> </ul>	13/24	
9/10	<ul style="list-style-type: none"> <li>• . . Metal solvents</li> </ul>	13/26	
9/12	<ul style="list-style-type: none"> <li>• . . Salt solvents, e.g. flux growth</li> </ul>	13/28	
9/14	<ul style="list-style-type: none"> <li>• by electrolysis</li> </ul>	13/285	
11/00	<p><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>)</p>	13/30	
11/001	<ul style="list-style-type: none"> <li>• {Continuous growth}</li> </ul>	13/32	
11/002	<ul style="list-style-type: none"> <li>• {Crucibles or containers for supporting the melt}</li> </ul>	13/34	
11/003	<ul style="list-style-type: none"> <li>• {Heating or cooling of the melt or the crystallised material}</li> </ul>	15/00	<p><b>Single-crystal growth by pulling from a melt, e.g. Czochralski method</b> (under a protective fluid <a href="#">C30B 27/00</a>)</p> <ul style="list-style-type: none"> <li>• {Continuous growth}</li> <li>• {Simultaneous pulling of more than one crystal}</li> <li>• {Pulling on a substrate}</li> <li>• adding crystallising materials or reactants forming it <u>in situ</u> to the melt <ul style="list-style-type: none"> <li>• . adding doping materials, e.g. for n-p-junction</li> </ul> </li> <li>• Non-vertical pulling</li> <li>• Downward pulling</li> <li>• Crucibles or containers for supporting the melt <ul style="list-style-type: none"> <li>• . Double crucible methods</li> </ul> </li> <li>• Heating of the melt or the crystallised materials <ul style="list-style-type: none"> <li>• . by irradiation or electric discharge</li> <li>• . using direct resistance heating in addition to other methods of heating, e.g. using Peltier heat</li> </ul> </li> <li>• Controlling or regulating (<a href="#">controlling or regulating in general G05</a>) <ul style="list-style-type: none"> <li>• . {the relationship of pull rate (v) to axial thermal gradient (G)}</li> <li>• . {the thermal history of growing the ingot}</li> </ul> </li> <li>• . Stabilisation or shape controlling of the molten zone near the pulled crystal; Controlling the section of the crystal <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> </li> </ul>
11/005	<ul style="list-style-type: none"> <li>• {by irradiation or electric discharge}</li> </ul>	15/002	
11/006	<ul style="list-style-type: none"> <li>• {Controlling or regulating}</li> </ul>	15/005	
11/007	<ul style="list-style-type: none"> <li>• {Mechanisms for moving either the charge or the heater}</li> </ul>	15/007	
11/008	<ul style="list-style-type: none"> <li>• {using centrifugal force to the charge}</li> </ul>	15/02	
11/02	<ul style="list-style-type: none"> <li>• without using solvents (<a href="#">C30B 11/06</a> takes precedence)</li> </ul>	15/04	
11/04	<ul style="list-style-type: none"> <li>• adding crystallising materials or reactants forming it <u>in situ</u> to the melt</li> </ul>	15/06	
11/06	<ul style="list-style-type: none"> <li>• . at least one but not all components of the crystal composition being added</li> </ul>	15/08	
11/065	<ul style="list-style-type: none"> <li>• . . {before crystallising, e.g. synthesis}</li> </ul>	15/10	
11/08	<ul style="list-style-type: none"> <li>• . every component of the crystal composition being added during the crystallisation</li> </ul>	15/12	
11/10	<ul style="list-style-type: none"> <li>• . . Solid or liquid components, e.g. Verneuil method</li> </ul>	15/14	
11/12	<ul style="list-style-type: none"> <li>• . . Vaporous components, e.g. vapour-liquid-solid-growth</li> </ul>	15/16	
11/14	<ul style="list-style-type: none"> <li>• characterised by the seed, e.g. its crystallographic orientation</li> </ul>	15/18	
		15/20	
		15/203	
		15/206	
		15/22	
		15/24	

- 15/26 . . . using television detectors; using photo or X-ray detectors
- 15/28 . . . using weight changes of the crystal or the melt, e.g. flotation methods
- 15/30 . Mechanisms for rotating or moving either the melt or the crystal ([flotation methods C30B 15/28](#))
- 15/305 . . {Stirring of the melt}
- 15/32 . Seed holders, e.g. chucks
- 15/34 . Edge-defined film-fed crystal-growth using dies or slits
- 15/36 . characterised by the seed, e.g. its crystallographic orientation
- 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)**
- 19/00 Liquid-phase epitaxial-layer growth**
  - 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
- 23/06 . . Heating of the deposition chamber, the substrate or the materials 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 Single-crystal growth by chemical reaction of reactive gases, e.g. chemical vapour-deposition growth**
  - 25/005 . {Growth of whiskers or needles}
  - 25/02 . Epitaxial-layer growth
    - 25/025 . . {Continuous growth}
    - 25/04 . . Pattern deposit, e.g. by using masks
    - 25/06 . . by reactive sputtering
    - 25/08 . . Reaction chambers; Selection of materials therefor
    - 25/10 . . Heating of the reaction chamber or the substrate
      - 25/105 . . . {by irradiation or electric discharge}
    - 25/12 . . Substrate holders or susceptors
    - 25/14 . . Feed and outlet means for the gases; Modifying the flow of the reactive gases
    - 25/16 . . Controlling or regulating ([controlling or regulating in general G05](#))
      - 25/165 . . . {the flow of the reactive gases}

**WARNING**

Not complete pending reclassification, see also group [C30B 25/14](#)
- 25/18 . . characterised by the substrate
- 25/183 . . . {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
- 25/186 . . . {being specially pre-treated by, e.g. chemical or physical means}
- 25/20 . . . the substrate being of the same materials as the epitaxial layer
  - 25/205 . . . . {the substrate being of insulating material}
- 25/22 . . Sandwich processes
- 27/00 Single-crystal growth under a protective fluid**
  - 27/02 . by pulling from a melt
- 28/00 Production of homogeneous polycrystalline material with defined structure**
  - 28/02 . directly from the solid state
  - 28/04 . from liquids
    - 28/06 . . by normal freezing or freezing under temperature gradient
      - 28/08 . . by zone-melting
      - 28/10 . . by pulling from a melt

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

- 28/12 . directly from the gas state
- 28/14 . . by chemical reaction of reactive gases

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

- 29/02 . Elements
- 29/04 . . Diamond
- 29/06 . . Silicon
- 29/08 . . Germanium
- 29/10 . 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 materials in the solid state
- 31/04 . by contacting with diffusion materials in the liquid state
- 31/045 . . {by electrolysis}
- 31/06 . by contacting with diffusion material in the gaseous state
- 31/08 . . the diffusion materials being a compound of the elements to be diffused
- 31/10 . . Reaction chambers; Selection of materials 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](#)