

# 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](#), [H10](#)); **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 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](#).

### 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 . {Epitaxial layer growth}
- 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	13/14	• Crucibles or vessels
7/14	• the crystallising materials being formed by chemical reactions in the solution	13/16	• Heating of the molten zone
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	• • the heating element being in contact with, or immersed in, the molten zone
9/02	• by evaporation of the molten solvent	13/20	• • by induction, e.g. hot wire technique ( <a href="#">C30B 13/18</a> takes precedence)
9/04	• by cooling of the solution	13/22	• • by irradiation or electric discharge
9/06	• • using as solvent a component of the crystal composition	13/24	• • • using electromagnetic waves
9/08	• • using other solvents	13/26	• Stirring of the molten zone
9/10	• • • Metal solvents	13/28	• Controlling or regulating
9/12	• • • Salt solvents, e.g. flux growth	13/285	• • {Crystal holders, e.g. chucks}
9/14	• by electrolysis	13/30	• • Stabilisation or shape controlling of the molten zone, e.g. by concentrators, by electromagnetic fields; Controlling the section of the crystal
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	• Mechanisms for moving either the charge or the heater
11/001	• {Continuous growth}	13/34	• characterised by the seed, e.g. by its crystallographic orientation
11/002	• {Crucibles or containers for supporting the melt}	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	• {Heating or cooling of the melt or the crystallised material}	15/002	• {Continuous growth}
11/005	• {by irradiation or electric discharge}	15/005	• {Simultaneous pulling of more than one crystal}
11/006	• {Controlling or regulating}	15/007	• {Pulling on a substrate}
11/007	• {Mechanisms for moving either the charge or the heater}	15/02	• adding crystallising materials or reactants forming it <u>in situ</u> to the melt
11/008	• {using centrifugal force to the charge}	15/04	• • adding doping materials, e.g. for n-p-junction
11/02	• without using solvents ( <a href="#">C30B 11/06</a> takes precedence)	15/06	• Non-vertical pulling
11/04	• adding crystallising materials or reactants forming it <u>in situ</u> to the melt	15/08	• Downward pulling
11/06	• • at least one but not all components of the crystal composition being added	15/10	• Crucibles or containers for supporting the melt
11/065	• • • {before crystallising, e.g. synthesis}	15/12	• • Double crucible methods
11/08	• • every component of the crystal composition being added during the crystallisation	15/14	• Heating of the melt or the crystallised materials
11/10	• • • Solid or liquid components, e.g. Verneuil method	15/16	• • by irradiation or electric discharge
11/12	• • • Vaporous components, e.g. vapour-liquid-solid-growth	15/18	• • using direct resistance heating in addition to other methods of heating, e.g. using Peltier heat
11/14	• characterised by the seed, e.g. its crystallographic orientation	15/20	• Controlling or regulating ( <a href="#">controlling or regulating in general G05</a> )
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> ; for the growth of homogeneous polycrystalline material with defined structure <a href="#">C30B 28/00</a> )	15/203	• • {the relationship of pull rate (v) to axial thermal gradient (G)}
13/005	• {Continuous growth}	15/206	• • {the thermal history of growing the ingot}
13/02	• Zone-melting with a solvent, e.g. travelling solvent process	15/22	• • Stabilisation or shape controlling of the molten zone near the pulled crystal; Controlling the section of the crystal
13/04	• Homogenisation by zone-levelling	15/24	• • • using mechanical means, e.g. shaping guides ( <a href="#">shaping dies for edge-defined film-fed crystal growth C30B 15/34</a> )
13/06	• the molten zone not extending over the whole cross-section	15/26	• • • using television detectors; using photo or X-ray detectors
13/08	• adding crystallising materials or reactants forming it <u>in situ</u> to the molten zone	15/28	• • • using weight changes of the crystal or the melt, e.g. flotation methods
13/10	• • with addition of doping materials	15/30	• Mechanisms for rotating or moving either the melt or the crystal ( <a href="#">flotation methods C30B 15/28</a> )
13/12	• • • in the gaseous or vapour state	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	<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 materials****NOTE**

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

- 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 materials to be evaporated
- 23/063 . . . {Heating of the substrate}
- 23/066 . . . {Heating of the material to be evaporated}
- 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}
- 25/18 . . characterised by the substrate
- 25/183 . . . {being provided with a buffer layer, e.g. a lattice matching layer}
- 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
- 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****NOTES**

- In groups [C30B 29/02](#) - [C30B 29/54](#), the last place priority rule is applied, i.e. at each hierarchical level, in the absence of an indication to the contrary, a material is classified in the last appropriate place.
- Attention is drawn to Note (3) after the title of section [C](#), which Note indicates to which version of the Periodic Table of chemical elements the CPC refers. In this group, the system used is the 8 group system indicated by Roman numerals in the Periodic Table thereunder.

- 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	31/08	. . the diffusion materials being a compound of the elements to be diffused
29/30	. . . . Niobates; Vanadates; Tantalates	31/10	. . Reaction chambers; Selection of materials therefor
29/32	. . . . Titanates; Germanates; Molybdates; Tungstates	31/103	. . . {Mechanisms for moving either the charge or heater}
29/34	. . Silicates	31/106	. . . {Continuous processes}
29/36	. . Carbides	31/12	. . Heating of the reaction chamber
29/38	. . Nitrides	31/14	. . Substrate holders or susceptors
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}	31/16	. . Feed and outlet means for the gases; Modifying the flow of the gases
29/403	. . . { $A_{III}$ -nitrides}	31/165	. . . {Diffusion sources}
29/406	. . . . {Gallium nitride}	31/18	. . Controlling or regulating
29/42	. . . Gallium arsenide	31/185	. . . {Pattern diffusion, e.g. by using masks}
29/44	. . . Gallium phosphide	31/20	. Doping by irradiation with electromagnetic waves or by particle radiation
29/46	. . Sulfur-, selenium- or tellurium-containing compounds	31/22	. . by ion-implantation
29/48	. . . $A_{II}B_{VI}$ compounds {wherein A is Zn, Cd or Hg, and B is S, Se or Te}	<b>33/00</b>	<b>After-treatment of single crystals or homogeneous polycrystalline material with defined structure</b> (C30B 31/00 takes precedence)
29/50	. . . . Cadmium sulfide	33/005	. {Oxydation}
29/52	. . Alloys	33/02	. Heat treatment (C30B 33/04, C30B 33/06 take precedence)
29/54	. Organic compounds	33/04	. using electric or magnetic fields or particle radiation
29/56	. . Tartrates	33/06	. Joining of crystals
29/58	. . Macromolecular compounds	33/08	. Etching
29/60	. characterised by shape	33/10	. . in solutions or melts
29/602	. . {Nanotubes}	33/12	. . in gas atmosphere or plasma
29/605	. . {Products containing multiple oriented crystallites, e.g. columnar crystallites}	<b>35/00</b>	<b>Apparatus not otherwise provided for, specially adapted for the growth, production or after-treatment of single crystals or of a homogeneous polycrystalline material with defined structure</b>
29/62	. . Whiskers or needles	35/002	. {Crucibles or containers}
29/64	. . Flat crystals, e.g. plates, strips or discs	35/005	. {Transport systems}
29/66	. . Crystals of complex geometrical shape, e.g. tubes, cylinders	35/007	. {Apparatus for preparing, pre-treating the source material to be used for crystal growth}
29/68	. . Crystals with laminate structure, e.g. "superlattices"		
<b>30/00</b>	<b>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</b>		

**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**

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