

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 Al_2O_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	• {Epitaxial layer growth}	13/02	• Zone-melting with a solvent, e.g. travelling solvent process
7/02	• by evaporation of the solvent	13/04	• Homogenisation by zone-levelling
7/04	• . using aqueous solvents	13/06	• the molten zone not extending over the whole cross-section
7/06	• . using non-aqueous solvents	13/08	• adding crystallising materials or reactants forming it <u>in situ</u> to the molten zone
7/08	• by cooling of the solution	13/10	• . with addition of doping materials
7/10	• by application of pressure, e.g. hydrothermal processes	13/12	• . . in the gaseous or vapour state
7/105	• . {using ammonia as solvent, i.e. ammonothermal processes}	13/14	• Crucibles or vessels
7/12	• by electrolysis	13/16	• Heating of the molten zone
7/14	• the crystallising materials being formed by chemical reactions in the solution	13/18	• . the heating element being in contact with, or immersed in, the molten zone
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)	13/20	• . by induction, e.g. hot wire technique (C30B 13/18 takes precedence; induction coils H05B 6/36)
9/02	• by evaporation of the molten solvent	13/22	• . by irradiation or electric discharge
9/04	• by cooling of the solution	13/24	• . . using electromagnetic waves
9/06	• . using as solvent a component of the crystal composition	13/26	• Stirring of the molten zone
9/08	• . using other solvents	13/28	• Controlling or regulating (controlling or regulating in general G05)
9/10	• . . Metal solvents	13/285	• . {Crystal holders, e.g. chucks}
9/12	• . . Salt solvents, e.g. flux growth	13/30	• . Stabilisation or shape controlling of the molten zone, e.g. by concentrators, by electromagnetic fields; Controlling the section of the crystal
9/14	• by electrolysis	13/32	• Mechanisms for moving either the charge or the heater
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)	13/34	• characterised by the seed, e.g. by its crystallographic orientation
11/001	• {Continuous growth}	15/00	Single-crystal growth by pulling from a melt, e.g. Czochralski method (under a protective fluid C30B 27/00)
11/002	• {Crucibles or containers for supporting the melt}	15/002	• {Continuous growth}
11/003	• {Heating or cooling of the melt or the crystallised material}	15/005	• {Simultaneous pulling of more than one crystal}
11/005	• {by irradiation or electric discharge}	15/007	• {Pulling on a substrate}
11/006	• {Controlling or regulating}	15/02	• adding crystallising materials or reactants forming it <u>in situ</u> to the melt
11/007	• {Mechanisms for moving either the charge or the heater}	15/04	• . adding doping materials, e.g. for n-p-junction
11/008	• {using centrifugal force to the charge}	15/06	• Non-vertical pulling
11/02	• without using solvents (C30B 11/06 takes precedence)	15/08	• Downward pulling
11/04	• adding crystallising materials or reactants forming it <u>in situ</u> to the melt	15/10	• Crucibles or containers for supporting the melt
11/06	• . at least one but not all components of the crystal composition being added	15/12	• . Double crucible methods
11/065	• . . {before crystallising, e.g. synthesis}	15/14	• Heating of the melt or the crystallised materials
11/08	• . every component of the crystal composition being added during the crystallisation	15/16	• . by irradiation or electric discharge
11/10	• . . Solid or liquid components, e.g. Verneuil method	15/18	• . using direct resistance heating in addition to other methods of heating, e.g. using Peltier heat
11/12	• . . Vaporous components, e.g. vapour-liquid-solid-growth	15/20	• Controlling or regulating (controlling or regulating in general G05)
11/14	• characterised by the seed, e.g. its crystallographic orientation	15/203	• . {the relationship of pull rate (v) to axial thermal gradient (G)}
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)	15/206	• . {the thermal history of growing the ingot}
13/005	• {Continuous growth}	15/22	• . Stabilisation or shape controlling of the molten zone near the pulled crystal; Controlling the section of the crystal
		15/24	• . . using mechanical means, e.g. shaping guides (shaping dies for edge-defined film-fed crystal growth C30B 15/34)
		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

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 (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 AMeO₃, 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 BMe₂O₄, 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
- 29/66 . . Crystals of complex geometrical shape, e.g. tubes, cylinders
- 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}