

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		
7/04	• . . using aqueous solvents	13/04	• Homogenisation by zone-levelling
7/06	• . . using non-aqueous solvents	13/06	• the molten zone not extending over the whole cross-section
7/08	• by cooling of the solution		
7/10	• by application of pressure, e.g. hydrothermal processes	13/08	• adding crystallising materials or reactants forming it <u>in situ</u> to the molten zone
7/105	• . . {using ammonia as solvent, i.e. ammonothermal processes}	13/10	• . . with addition of doping materials
7/12	• by electrolysis	13/12	• . . . in the gaseous or vapour state
7/14	• the crystallising materials being formed by chemical reactions in the solution	13/14	• Crucibles or vessels
		13/16	• Heating of the molten zone
		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
		13/34	• characterised by the seed, e.g. by its crystallographic orientation
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)	15/00	Single-crystal growth by pulling from a melt, e.g. Czochralski method (under a protective fluid C30B 27/00)
11/001	• {Continuous growth}	15/002	• {Continuous growth}
11/002	• {Crucibles or containers for supporting the melt}	15/005	• {Simultaneous pulling of more than one crystal}
11/003	• {Heating or cooling of the melt or the crystallised material}	15/007	• {Pulling on a substrate}
11/005	• {by irradiation or electric discharge}	15/02	• adding crystallising materials or reactants forming it <u>in situ</u> to the melt
11/006	• {Controlling or regulating}	15/04	• . . adding doping materials, e.g. for n-p-junction
11/007	• {Mechanisms for moving either the charge or the heater}	15/06	• Non-vertical pulling
11/008	• {using centrifugal force to the charge}	15/08	• Downward pulling
11/02	• without using solvents (C30B 11/06 takes precedence)	15/10	• Crucibles or containers for supporting the melt
11/04	• adding crystallising materials or reactants forming it <u>in situ</u> to the melt	15/12	• . . Double crucible methods
11/06	• . . at least one but not all components of the crystal composition being added	15/14	• Heating of the melt or the crystallised materials
11/065	• . . . {before crystallising, e.g. synthesis}	15/16	• . . by irradiation or electric discharge
11/08	• . . every component of the crystal composition being added during the crystallisation	15/18	• . . using direct resistance heating in addition to other methods of heating, e.g. using Peltier heat
11/10	• . . . Solid or liquid components, e.g. Verneuil method	15/20	• Controlling or regulating (controlling or regulating in general G05)
11/12	• . . . Vaporous components, e.g. vapour-liquid-solid-growth	15/203	• . . {the relationship of pull rate (v) to axial thermal gradient (G)}
11/14	• characterised by the seed, e.g. its crystallographic orientation	15/206	• . . {the thermal history of growing the ingot}
		15/22	• . . Stabilisation or shape controlling of the molten zone near the pulled crystal; Controlling the section of the crystal
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)	15/24	• . . . using mechanical means, e.g. shaping guides (shaping dies for edge-defined film-fed crystal growth C30B 15/34)
13/005	• {Continuous growth}	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	25/025	. . {Continuous growth}
15/34	. Edge-defined film-fed crystal-growth using dies or slits	25/04	. . Pattern deposit, e.g. by using masks
15/36	. characterised by the seed, e.g. its crystallographic orientation	25/06	. . by reactive sputtering
		25/08	. . Reaction chambers; Selection of materials therefor
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)	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
19/00	Liquid-phase epitaxial-layer growth	25/16	. . Controlling or regulating (controlling or regulating in general G05)
19/02	. using molten solvents, e.g. flux	25/165	. . . {the flow of the reactive gases}
19/04	. . the solvent being a component of the crystal composition	25/18	. . characterised by the substrate
19/06	. Reaction chambers; Boats for supporting the melt; Substrate holders	25/183	. . . {being provided with a buffer layer, e.g. a lattice matching layer}
19/061	. . {Tipping system, e.g. by rotation}	25/186	. . . {being specially pre-treated by, e.g. chemical or physical means}
19/062	. . {Vertical dipping system}	25/20	. . . the substrate being of the same materials as the epitaxial layer
19/063	. . {Sliding boat system}	25/205 {the substrate being of insulating material}
19/064	. . {Rotating sliding boat system}	25/22	. . Sandwich processes
19/065	. . {Multiple stacked slider system}		
19/066	. . {Injection or centrifugal force system}	27/00	Single-crystal growth under a protective fluid
19/067	. . {Boots or containers}	27/02	. by pulling from a melt
19/068	. . {Substrate holders}	28/00	Production of homogeneous polycrystalline material with defined structure
19/08	. Heating of the reaction chamber or the substrate	28/02	. directly from the solid state
19/10	. Controlling or regulating (controlling or regulating in general G05)	28/04	. from liquids
19/103	. . {Current controlled or induced growth}	28/06	. . by normal freezing or freezing under temperature gradient
19/106	. . {adding crystallising material or reactants forming it <i>in situ</i> to the liquid}	28/08	. . by zone-melting
19/12	. characterised by the substrate	28/10	. . by pulling from a melt
21/00	Unidirectional solidification of eutectic materials	28/12	. directly from the gas state
21/02	. by normal casting or gradient freezing	28/14	. . by chemical reaction of reactive gases
21/04	. by zone-melting		
21/06	. by pulling from a melt	29/00	Single crystals or homogeneous polycrystalline material with defined structure characterised by the material or by their shape (alloys C22C)
Single-crystal growth from vapours			NOTE
23/00	Single-crystal growth by condensing evaporated or sublimed materials		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.
	NOTE		
	Groups C30B 23/002 - C30B 23/005 take precedence over groups C30B 23/007 - C30B 23/08		
23/002	. {Controlling or regulating}	29/02	. Elements
23/005	. . {Controlling or regulating flux or flow of depositing species or vapour}	29/04	. . Diamond
23/007	. {Growth of whiskers or needles}	29/06	. . Silicon
23/02	. Epitaxial-layer growth	29/08	. . Germanium
23/025	. . {characterised by the substrate}	29/10	. Inorganic compounds or compositions
23/04	. . Pattern deposit, e.g. by using masks	29/12	. . Halides
23/06	. . Heating of the deposition chamber, the substrate or the materials to be evaporated	29/14	. . Phosphates
23/063	. . . {Heating of the substrate}	29/16	. . Oxides
23/066	. . . {Heating of the material to be evaporated}	29/18	. . . Quartz
23/08	. . by condensing ionised vapours (by reactive sputtering C30B 25/06)	29/20	. . . Aluminium oxides
		29/22	. . . Complex oxides
		29/225 {based on rare earth copper oxides, e.g. high T-superconductors}
25/00	Single-crystal growth by chemical reaction of reactive gases, e.g. chemical vapour-deposition growth	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
25/005	. {Growth of whiskers or needles}	29/26 with formula BMe ₂ O ₄ , wherein B is Mg, Ni, Co, Al, Zn, or Cd and Me is Fe, Ga, Sc, Cr, Co, or Al
25/02	. Epitaxial-layer growth		

- 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
- 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}

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**