

# 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

- 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

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

- 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 material

### 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}
- WARNING**
- Group [C30B 7/005](#) is not complete, see also [C30B 7/00](#)
- 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 . the crystallising material being formed by chemical reactions in the solution
- 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)**
- 9/02 . by evaporation of the molten solvent
- 9/04 . by cooling of the solution
- 9/06 . . using as solvent a component of the crystal composition
- 9/08 . . using other solvents
- 9/10 . . . Metal solvents
- 9/12 . . . Salt solvents, e.g. flux growth
- 9/14 . by electrolysis
- 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)**
- 11/001 . {Continuous growth}
- 11/002 . {Crucibles or containers for supporting the melt}
- 11/003 . {Heating or cooling of the melt or the crystallised material}
- 11/005 . {by irradiation or electric discharge}
- 11/006 . {Controlling or regulating}
- 11/007 . {Mechanisms for moving either the charge or the heater}
- 11/008 . {using centrifugal force to the charge}
- 11/02 . without using solvents (C30B 11/06 takes precedence)
- 11/04 . adding crystallising material or reactants forming it in situ to the melt
- 11/06 . . at least one but not all components of the crystal composition being added
- 11/065 . . . {before crystallising, e.g. synthesis}
- 11/08 . . every component of the crystal composition being added during the crystallisation
- 11/10 . . . Solid or liquid components, e.g. Verneuil method
- 11/12 . . . Vaporous components, e.g. vapour-liquid-solid-growth
- 11/14 . characterised by the seed, e.g. its crystallographic orientation
- 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)**
- 13/005 . {Continuous growth}
- 13/02 . Zone-melting with a solvent, e.g. travelling solvent process
- 13/04 . Homogenisation by zone-levelling
- 13/06 . the molten zone not extending over the whole cross-section
- 13/08 . adding crystallising material or reactants forming it in situ to the molten zone
- 13/10 . . with addition of doping material
- 13/12 . . . in the gaseous or vapour state
- 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
- 13/20 . . by induction, e.g. hot wire technique (C30B 13/18 takes precedence; induction coils H05B 6/36)
- 13/22 . . by irradiation or electric discharge
- 13/24 . . . using electromagnetic waves
- 13/26 . Stirring of the molten zone
- 13/28 . Controlling or regulating (controlling or regulating in general G05)
- 13/285 . . {Crystal holders, e.g. chucks}
- 13/30 . . Stabilisation or shape controlling of the molten zone, e.g. by concentrators, by electromagnetic fields; Controlling the section of the crystal
- 13/32 . Mechanisms for moving either the charge or the heater
- 13/34 . characterised by the seed, e.g. by its crystallographic orientation
- 15/00 Single-crystal growth by pulling from a melt, e.g. Czochralski method (under a protective fluid C30B 27/00)**
- 15/002 . {Continuous growth}
- 15/005 . {Simultaneous pulling of more than one crystal}
- 15/007 . {Pulling on a substrate}
- 15/02 . adding crystallising material or reactants forming it in situ to the melt
- 15/04 . . adding doping material, e.g. for n-p-junction
- 15/06 . Non-vertical pulling
- 15/08 . Downward pulling
- 15/10 . Crucibles or containers for supporting the melt
- 15/12 . . Double crucible methods
- 15/14 . Heating of the melt or the crystallised material
- 15/16 . . by irradiation or electric discharge
- 15/18 . . using direct resistance heating in addition to other methods of heating, e.g. using Peltier heat
- 15/20 . Controlling or regulating (controlling or regulating in general G05)
- 15/203 . . {the relationship of pull rate (v) to axial thermal gradient (G)}
- 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
- 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	<b>Single-crystal growth onto a seed which remains in the melt during growth, e.g. Nacken-Kyropoulos method (C30B 15/00 takes precedence)</b>	23/08	. . by condensing ionised vapours (by reactive sputtering C30B 25/06)
19/00	<b>Liquid-phase epitaxial-layer growth</b>	25/00	<b>Single-crystal growth by chemical reaction of reactive gases, e.g. chemical vapour-deposition growth</b>
19/02	. using molten solvents, e.g. flux	25/005	. {Growth of whiskers or needles}
19/04	. . the solvent being a component of the crystal composition	25/02	. Epitaxial-layer growth
19/06	. Reaction chambers; Boats for supporting the melt; Substrate holders	25/025	. . {Continuous growth}
19/061	. . {Tipping system, e.g. by rotation}	25/04	. . Pattern deposit, e.g. by using masks
19/062	. . {Vertical dipping system}	25/06	. . by reactive sputtering
19/063	. . {Sliding boat system}	25/08	. . Reaction chambers; Selection of material therefor
19/064	. . {Rotating sliding boat system}	25/10	. . Heating of the reaction chamber or the substrate
19/065	. . {Multiple stacked slider system}	25/105	. . . {by irradiation or electric discharge}
19/066	. . {Injection or centrifugal force system}	25/12	. . Substrate holders or susceptors
19/067	. . {Boots or containers}	25/14	. . Feed and outlet means for the gases; Modifying the flow of the reactive gases
19/068	. . {Substrate holders}	25/16	. . Controlling or regulating (controlling or regulating in general G05)
19/08	. Heating of the reaction chamber or the substrate	25/165	. . . {the flow of the reactive gases}
19/10	. Controlling or regulating (controlling or regulating in general G05)		<b>WARNING</b>
19/103	. . {Current controlled or induced growth}		Not complete pending reclassification, see also group C30B 25/14
19/106	. . {adding crystallising material or reactants forming it <i>in situ</i> to the liquid}		
19/12	. characterised by the substrate	25/18	. . characterised by the substrate
21/00	<b>Unidirectional solidification of eutectic materials</b>	25/183	. . . {being provided with a buffer layer, e.g. a lattice matching layer}
21/02	. by normal casting or gradient freezing		<b>WARNING</b>
21/04	. by zone-melting		This group is not complete pending reclassification; see also C30B 25/18 and subgroups
21/06	. by pulling from a melt		
<b>Single-crystal growth from vapours</b>			
23/00	<b>Single-crystal growth by condensing evaporated or sublimed material</b>	25/186	. . . {being specially pre-treated by, e.g. chemical or physical means}
	<b>NOTE</b>	25/20	. . . the substrate being of the same material as the epitaxial layer
	Groups C30B 23/002 - C30B 23/005 take precedence over groups C30B 23/007 - C30B 23/08	25/205	. . . . {the substrate being of insulating material}
	<b>WARNING</b>	25/22	. . Sandwich processes
	Group C30B 23/002 - C30B 23/005 are not complete, see also C30B 23/02	27/00	<b>Single-crystal growth under a protective fluid</b>
23/002	. {Controlling or regulating}	27/02	. by pulling from a melt
23/005	. . {Controlling or regulating flux or flow of depositing species or vapour}	28/00	<b>Production of homogeneous polycrystalline material with defined structure</b>
23/007	. {Growth of whiskers or needles}	28/02	. directly from the solid state
23/02	. Epitaxial-layer growth	28/04	. from liquids
23/025	. . {characterised by the substrate}	28/06	. . by normal freezing or freezing under temperature gradient
23/04	. . Pattern deposit, e.g. by using masks	28/08	. . by zone-melting
23/06	. . Heating of the deposition chamber, the substrate or the material to be evaporated	28/10	. . by pulling from a melt
23/063	. . . {Heating of the substrate}	28/12	. directly from the gas state
	<b>WARNING</b>	28/14	. . by chemical reaction of reactive gases
	Group C30B 23/063 is not complete, see also C30B 23/06	29/00	<b>Single crystals or homogeneous polycrystalline material with defined structure characterised by the material or by their shape (alloys C22C)</b>
23/066	. . . {Heating of the material to be evaporated}		<b>NOTE</b>
	<b>WARNING</b>		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.
	Group C30B 23/066 is not complete, see also C30B 23/06	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  $AME_3O_3$ , 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, disks
- 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](#)