

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

5/02 . with addition of doping materials

- 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](#))

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
- 7/14 . the crystallising materials 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 materials 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](#); for the growth of homogeneous polycrystalline material with defined structure [C30B 28/00](#))
- 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 materials or reactants forming it in situ to the molten zone
- 13/10 . . with addition of doping materials
- 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)
- 13/22 . . by irradiation or electric discharge
- 13/24 . . . using electromagnetic waves
- 13/26 . Stirring of the molten zone
- 13/28 . Controlling or regulating
- 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 materials or reactants forming it in situ to the melt
- 15/04 . . adding doping materials, 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 materials
- 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 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 . . {Boats 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
- 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

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
- 29/00 **Single crystals or homogeneous polycrystalline material with defined structure characterised by the material or by their shape**
- NOTES**
- 1. 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.
- 2. 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 $A\text{MeO}_3$, 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 $B\text{Me}_2\text{O}_4$, 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}
- 29/62 . . 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
- 31/08 . . 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
- 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)**
- 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 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**
- 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**
- 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