# 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**

1. 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.
2. 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
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 . . {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**

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 $AMeO_3$, 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
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

**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
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}