

**C30 CRYSTAL GROWTH** (separation by crystallisation in general B01D 9/00) [3]

**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** [3]

**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; [3]
  - “homogeneous polycrystalline material” means a material with crystal particles, all of which have the same chemical composition; [5]
  - “defined structure” means the structure of a material with grains which are oriented in a preferential way or have larger dimensions than normally obtained. [5]
- (2) 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; [3]
  - 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. [3]

**Subclass Index****SINGLE-CRYSTAL GROWTH**

from solids or gels ..... 1/00, 3/00, 5/00

from liquids ..... 7/00 to 21/00, 27/00

from vapours ..... 23/00, 25/00

**PRODUCTION OF SINGLE CRYSTALS OR HOMOGENEOUS POLYCRYSTALLINE**

**MATERIAL WITH DEFINED STRUCTURE** ..... 28/00, 30/00

**SINGLE CRYSTALS OR HOMOGENEOUS POLYCRYSTALLINE MATERIAL WITH DEFINED STRUCTURE**

..... 29/00

**AFTER-TREATMENT** ..... 31/00, 33/00

**APPARATUS** ..... 35/00

**Single-crystal growth from solids or gels [3]**

**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) [3]

- 1/02 . by thermal treatment, e.g. strain annealing (C30B 1/12 takes precedence) [3]
- 1/04 . . Isothermal recrystallisation [3]
- 1/06 . . Recrystallisation under a temperature gradient [3]
- 1/08 . . . Zone recrystallisation [3]
- 1/10 . by solid state reactions or multi-phase diffusion [3]
- 1/12 . by pressure treatment during the growth [3]

**3/00 Unidirectional demixing of eutectoid materials [3]**

**5/00 Single-crystal growth from gels** (under a protective fluid C30B 27/00) [3]

- 5/02 . with addition of doping materials [3]

**Single-crystal growth from liquids; Unidirectional solidification of eutectic materials [3]**

**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) [3]

- 7/02 . by evaporation of the solvent [3]
- 7/04 . . using aqueous solvents [3]

- 7/06 . . using non-aqueous solvents [3]
- 7/08 . by cooling of the solution [3]
- 7/10 . by application of pressure, e.g. hydrothermal processes [3]
- 7/12 . by electrolysis [3]
- 7/14 . the crystallising materials being formed by chemical reactions in the solution [3]

**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) [3]

- 9/02 . by evaporation of the molten solvent [3]
- 9/04 . by cooling of the solution [3]
- 9/06 . . using as solvent a component of the crystal composition [3]
- 9/08 . . using other solvents [3]
- 9/10 . . . Metal solvents [3]
- 9/12 . . . Salt solvents, e.g. flux growth [3]
- 9/14 . by electrolysis [3]

- 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) [3]
- 11/02 . without using solvents (C30B 11/06 takes precedence) [3]
  - 11/04 . adding crystallising materials or reactants forming it in situ to the melt [3]
  - 11/06 . . at least one but not all components of the crystal composition being added [3]
  - 11/08 . . every component of the crystal composition being added during the crystallisation [3]
  - 11/10 . . . Solid or liquid components, e.g. Verneuil method [3]
  - 11/12 . . . Vaporous components, e.g. vapour-liquid-solid-growth [3]
  - 11/14 . characterised by the seed, e.g. its crystallographic orientation [3]
- 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; zone-refining of specific materials, see the relevant subclasses for the materials) [3,5]
- 13/02 . Zone-melting with a solvent, e.g. travelling solvent process [3]
  - 13/04 . Homogenisation by zone-levelling [3]
  - 13/06 . the molten zone not extending over the whole cross-section [3]
  - 13/08 . adding crystallising materials or reactants forming it in situ to the molten zone [3]
  - 13/10 . . with addition of doping materials [3]
  - 13/12 . . . in the gaseous or vapour state [3]
  - 13/14 . Crucibles or vessels [3]
  - 13/16 . Heating of the molten zone [3]
  - 13/18 . . the heating element being in contact with, or immersed in, the molten zone [3]
  - 13/20 . . by induction, e.g. hot wire technique (C30B 13/18 takes precedence; induction coils H05B 6/36) [3]
  - 13/22 . . by irradiation or electric discharge [3]
  - 13/24 . . . using electromagnetic waves [3]
  - 13/26 . Stirring of the molten zone [3]
  - 13/28 . Controlling or regulating (controlling or regulating in general G05) [3]
  - 13/30 . . Stabilisation or shape controlling of the molten zone, e.g. by concentrators, by electromagnetic fields; Controlling the section of the crystal [3]
  - 13/32 . Mechanisms for moving either the charge or the heater [3]
  - 13/34 . characterised by the seed, e.g. by its crystallographic orientation [3]
- 15/00 Single-crystal growth by pulling from a melt, e.g. Czochralski method** (under a protective fluid C30B 27/00) [3]
- 15/02 . adding crystallising materials or reactants forming it in situ to the melt [3]
  - 15/04 . . adding doping materials, e.g. for n-p-junction [3]
  - 15/06 . Non-vertical pulling [3]
  - 15/08 . Downward pulling [3]
  - 15/10 . Crucibles or containers for supporting the melt [3]
  - 15/12 . . Double crucible methods [3]
  - 15/14 . . Heating of the melt or the crystallised materials [3]
  - 15/16 . . . by irradiation or electric discharge [3]
  - 15/18 . . . using direct resistance heating in addition to other methods of heating, e.g. using Peltier heat [3]
  - 15/20 . Controlling or regulating (controlling or regulating in general G05) [3]
  - 15/22 . . Stabilisation or shape controlling of the molten zone near the pulled crystal; Controlling the section of the crystal [3]
  - 15/24 . . . using mechanical means, e.g. shaping guides (shaping dies for edge-defined film-fed crystal growth C30B 15/34) [3]
  - 15/26 . . . using television detectors; using photo or X-ray detectors [3]
  - 15/28 . . . using weight changes of the crystal or the melt, e.g. flotation methods [3]
  - 15/30 . Mechanisms for rotating or moving either the melt or the crystal (flotation methods C30B 15/28) [3]
  - 15/32 . Seed holders, e.g. chucks [3]
  - 15/34 . Edge-defined film-fed crystal growth using dies or slits [3]
  - 15/36 . characterised by the seed, e.g. its crystallographic orientation [3]
- 17/00 Single-crystal growth on to a seed which remains in the melt during growth, e.g. Nacken-Kyropoulos method** (C30B 15/00 takes precedence) [3]
- 19/00 Liquid-phase epitaxial-layer growth** [3]
- 19/02 . using molten solvents, e.g. flux [3]
  - 19/04 . . the solvent being a component of the crystal composition [3]
  - 19/06 . Reaction chambers; Boats for supporting the melt; Substrate holders [3]
  - 19/08 . Heating of the reaction chamber or the substrate [3]
  - 19/10 . Controlling or regulating (controlling or regulating in general G05) [3]
  - 19/12 . characterised by the substrate [3]
- 21/00 Unidirectional solidification of eutectic materials** [3]
- 21/02 . by normal casting or gradient freezing [3]
  - 21/04 . by zone-melting [3]
  - 21/06 . by pulling from a melt [3]
- Single-crystal growth from vapours** [3]
- 23/00 Single-crystal growth by condensing evaporated or sublimed materials** [3]
- 23/02 . Epitaxial-layer growth [3]
  - 23/04 . . Pattern deposit, e.g. by using masks [3]
  - 23/06 . . Heating of the deposition chamber, the substrate, or the materials to be evaporated [3]
  - 23/08 . . by condensing ionised vapours (by reactive sputtering C30B 25/06) [3]
- 25/00 Single-crystal growth by chemical reaction of reactive gases, e.g. chemical vapour deposition growth** [3]
- 25/02 . Epitaxial-layer growth [3]
  - 25/04 . . Pattern deposit, e.g. by using masks [3]
  - 25/06 . . by reactive sputtering [3]
  - 25/08 . . Reaction chambers; Selection of materials therefor [3]
  - 25/10 . . Heating of the reaction chamber or the substrate [3]
  - 25/12 . . Substrate holders or susceptors [3]
  - 25/14 . . Feed and outlet means for the gases; Modifying the flow of the reactive gases [3]

- 25/16 . . Controlling or regulating (controlling or regulating in general G05) [3]
- 25/18 . . characterised by the substrate [3]
- 25/20 . . . the substrate being of the same materials as the epitaxial layer [3]
- 25/22 . . Sandwich processes [3]

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**27/00 Single-crystal growth under a protective fluid [3]**

- 27/02 . by pulling from a melt [3]

**28/00 Production of homogeneous polycrystalline material with defined structure [5]**

- 28/02 . directly from the solid state [5]
- 28/04 . from liquids [5]
- 28/06 . . by normal freezing or freezing under temperature gradient [5]
- 28/08 . . by zone-melting [5]
- 28/10 . . by pulling from a melt [5]
- 28/12 . directly from the gas state [5]
- 28/14 . . by chemical reaction of reactive gases [5]

**29/00 Single crystals or homogeneous polycrystalline material with defined structure characterised by the material or by their shape (alloys C22C) [3,5]**

**Note**

In groups C30B 29/02 to C30B 29/54, in the absence of an indication to the contrary, a material is classified in the last appropriate place. [3]

- 29/02 . Elements [3]
- 29/04 . . Diamond [3]
- 29/06 . . Silicon [3]
- 29/08 . . Germanium [3]
- 29/10 . Inorganic compounds or compositions [3]
- 29/12 . . Halides [3]
- 29/14 . . Phosphates [3]
- 29/16 . . Oxides [3]
- 29/18 . . . Quartz [3]
- 29/20 . . . Aluminium oxides [3]
- 29/22 . . . Complex oxides [3]
- 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 [3]
- 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 [3]
- 29/28 . . . with formula  $A_3\text{Me}_5\text{O}_{12}$ , wherein A is a rare earth metal and Me is Fe, Ga, Sc, Cr, Co or Al, e.g. garnets [3]
- 29/30 . . . . Niobates; Vanadates; Tantalates [3]
- 29/32 . . . . Titanates; Germanates; Molybdates; Tungstates [3]
- 29/34 . . Silicates [3]
- 29/36 . . Carbides [3]
- 29/38 . . Nitrides [3]
- 29/40 . .  $A_{III}B_V$  compounds [3]
- 29/42 . . . Gallium arsenide [3]
- 29/44 . . . Gallium phosphide [3]
- 29/46 . . Sulfur-, selenium- or tellurium-containing compounds [3]
- 29/48 . . .  $A_{II}B_{VI}$  compounds [3]
- 29/50 . . . . Cadmium sulfide [3]

- 29/52 . . Alloys [3]
- 29/54 . Organic compounds [3]
- 29/56 . . Tartrates [3]
- 29/58 . . Macromolecular compounds [3]
- 29/60 . characterised by shape [3]
- 29/62 . . Whiskers or needles [3]
- 29/64 . . Flat crystals, e.g. plates, strips, disks [5]
- 29/66 . . Crystals of complex geometrical shape, e.g. tubes, cylinders [5]
- 29/68 . . Crystals with laminate structure, e.g. "superlattices" [5]

**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 [5]**

**Note**

When classifying in this group, classification is also made in groups C30B 1/00 to C30B 28/00 according to the process of crystal growth. [5]

- 30/02 . using electric fields, e.g. electrolysis [5]
- 30/04 . using magnetic fields [5]
- 30/06 . using mechanical vibrations [5]
- 30/08 . in conditions of zero-gravity or low gravity [5]

**After-treatment of single crystals or homogeneous polycrystalline material with defined structure [3,5]**

**31/00 Diffusion or doping processes for single crystals or homogeneous polycrystalline material with defined structure; Apparatus therefor [3,5]**

- 31/02 . by contacting with diffusion materials in the solid state [3]
- 31/04 . by contacting with diffusion materials in the liquid state [3]
- 31/06 . by contacting with diffusion material in the gaseous state (C30B 31/18 takes precedence) [3]
- 31/08 . . the diffusion materials being a compound of the elements to be diffused [3]
- 31/10 . . Reaction chambers; Selection of materials therefor [3]
- 31/12 . . Heating of the reaction chamber [3]
- 31/14 . . Substrate holders or susceptors [3]
- 31/16 . . Feed and outlet means for the gases; Modifying the flow of the gases [3]
- 31/18 . . Controlling or regulating (controlling or regulating in general G05) [3]
- 31/20 . Doping by irradiation with electromagnetic waves or by particle radiation [3]
- 31/22 . . by ion-implantation [3]

**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) [3,5]**

- 33/02 . Heat treatment (C30B 33/04, C30B 33/06 take precedence) [5]
- 33/04 . using electric or magnetic fields or particle radiation [5]
- 33/06 . Joining of crystals [5]
- 33/08 . Etching [5]

**C30B**

- 33/10 . . in solutions or melts [5]
  - 33/12 . . in gas atmosphere or plasma [5]
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**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 [3,5]**