

SECTION C — CHEMISTRY; 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** [3]

Note(s)

- 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.

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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) [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 [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 [3, 5]**
- Note(s)**
- In groups C30B 29/02-C30B 29/54, in the absence of an indication to the contrary, a material is classified in the last appropriate place.
 - 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 IPC refers.
- 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(s)**
- When classifying in this group, classification is also made in groups C30B 1/00-C30B 28/00 according to the process of crystal growth.
- 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]

C30B

- 31/18 • • Controlling or regulating [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) [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]
 - 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]