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) [3, 5, 2012.01]

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, multi-aspect classification is applied, so that if subject matter is characterised by aspects covered by more than one of its groups, the subject matter should be classified in each of those groups.
3. 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.

Subclass index

SINGLE-CRYSTAL GROWTH
from solids or gels.....1/00, 3/00, 5/00
from liquids.....7/00-21/00, 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, 2006.01]**

1/02 • by thermal treatment, e.g. strain annealing (C30B 1/12 takes precedence) **[3, 2006.01]**

1/04 • • Isothermal recrystallisation **[3, 2006.01]**

1/06 • • Recrystallisation under a temperature gradient **[3, 2006.01]**

1/08 • • • Zone recrystallisation **[3, 2006.01]**

1/10 • by solid state reactions or multi-phase diffusion **[3, 2006.01]**

1/12 • by pressure treatment during the growth **[3, 2006.01]**

3/00 **Unidirectional demixing of eutectoid materials [3, 2006.01]**

5/00 **Single-crystal growth from gels** (under a protective fluid C30B 27/00) **[3, 2006.01]**

5/02 • with addition of doping materials **[3, 2006.01]**

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, 2006.01]**

7/02 • by evaporation of the solvent **[3, 2006.01]**

7/04 • • using aqueous solvents **[3, 2006.01]**
7/06 • • using non-aqueous solvents **[3, 2006.01]**
7/08 • by cooling of the solution **[3, 2006.01]**
7/10 • by application of pressure, e.g. hydrothermal processes **[3, 2006.01]**
7/12 • by electrolysis **[3, 2006.01]**
7/14 • the crystallising materials being formed by chemical reactions in the solution **[3, 2006.01]**

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, 2006.01]**
9/02 • by evaporation of the molten solvent **[3, 2006.01]**
9/04 • by cooling of the solution **[3, 2006.01]**
9/06 • • using as solvent a component of the crystal composition **[3, 2006.01]**
9/08 • • using other solvents **[3, 2006.01]**
9/10 • • • Metal solvents **[3, 2006.01]**
9/12 • • • Salt solvents, e.g. flux growth **[3, 2006.01]**
9/14 • by electrolysis **[3, 2006.01]**

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, 2006.01]**
11/02 • without using solvents (C30B 11/06 takes precedence) **[3, 2006.01]**
11/04 • adding crystallising materials or reactants forming it in situ to the melt **[3, 2006.01]**
11/06 • • at least one but not all components of the crystal composition being added **[3, 2006.01]**
11/08 • • every component of the crystal composition being added during the crystallisation **[3, 2006.01]**
11/10 • • • Solid or liquid components, e.g. Verneuil method **[3, 2006.01]**
11/12 • • • Vaporous components, e.g. vapour-liquid-solid-growth **[3, 2006.01]**
11/14 • characterised by the seed, e.g. its crystallographic orientation **[3, 2006.01]**

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, 2006.01]**
13/02 • Zone-melting with a solvent, e.g. travelling solvent process **[3, 2006.01]**
13/04 • Homogenisation by zone-levelling **[3, 2006.01]**
13/06 • the molten zone not extending over the whole cross-section **[3, 2006.01]**
13/08 • adding crystallising materials or reactants forming it in situ to the molten zone **[3, 2006.01]**
13/10 • • with addition of doping materials **[3, 2006.01]**
13/12 • • • in the gaseous or vapour state **[3, 2006.01]**
13/14 • Crucibles or vessels **[3, 2006.01]**
13/16 • Heating of the molten zone **[3, 2006.01]**
13/18 • • the heating element being in contact with, or immersed in, the molten zone **[3, 2006.01]**
13/20 • • by induction, e.g. hot wire technique (C30B 13/18 takes precedence) **[3, 2006.01]**
13/22 • • by irradiation or electric discharge **[3, 2006.01]**
13/24 • • • using electromagnetic waves **[3, 2006.01]**
13/26 • Stirring of the molten zone **[3, 2006.01]**
13/28 • Controlling or regulating **[3, 2006.01]**
13/30 • • Stabilisation or shape controlling of the molten zone, e.g. by concentrators, by electromagnetic fields; Controlling the section of the crystal **[3, 2006.01]**
13/32 • Mechanisms for moving either the charge or the heater **[3, 2006.01]**
13/34 • characterised by the seed, e.g. by its crystallographic orientation **[3, 2006.01]**

15/00 Single-crystal growth by pulling from a melt, e.g. Czochralski method (under a protective fluid C30B 27/00) **[3, 2006.01]**
15/02 • adding crystallising materials or reactants forming it in situ to the melt **[3, 2006.01]**
15/04 • • adding doping materials, e.g. for n–p-junction **[3, 2006.01]**
15/06 • Non-vertical pulling **[3, 2006.01]**
15/08 • Downward pulling **[3, 2006.01]**
15/10 • Crucibles or containers for supporting the melt **[3, 2006.01]**
15/12 • • Double crucible methods **[3, 2006.01]**
15/14 • Heating of the melt or the crystallised materials **[3, 2006.01]**
15/16 • • by irradiation or electric discharge **[3, 2006.01]**
15/18 • • using direct resistance heating in addition to other methods of heating, e.g. using Peltier heat **[3, 2006.01]**
15/20 • Controlling or regulating (controlling or regulating in general G05) **[3, 2006.01]**
15/22 • • Stabilisation or shape controlling of the molten zone near the pulled crystal; Controlling the section of the crystal **[3, 2006.01]**
15/24 • • • using mechanical means, e.g. shaping guides (shaping dies for edge-defined film-fed crystal growth C30B 15/34) **[3, 2006.01]**
15/26 • • • using television detectors; using photo or X-ray detectors **[3, 2006.01]**
15/28 • • • using weight changes of the crystal or the melt, e.g. flotation methods **[3, 2006.01]**
15/30 • Mechanisms for rotating or moving either the melt or the crystal (flotation methods C30B 15/28) **[3, 2006.01]**
15/32 • Seed holders, e.g. chucks **[3, 2006.01]**
15/34 • Edge-defined film-fed crystal growth using dies or slits **[3, 2006.01]**
15/36 • characterised by the seed, e.g. its crystallographic orientation **[3, 2006.01]**

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, 2006.01]**

19/00 Liquid-phase epitaxial-layer growth [3, 2006.01]
19/02 • using molten solvents, e.g. flux **[3, 2006.01]**
19/04 • • the solvent being a component of the crystal composition **[3, 2006.01]**
19/06 • Reaction chambers; Boats for supporting the melt; Substrate holders **[3, 2006.01]**
19/08 • Heating of the reaction chamber or the substrate **[3, 2006.01]**

19/10 • Controlling or regulating (controlling or regulating in general G05) **[3, 2006.01]**
19/12 • characterised by the substrate **[3, 2006.01]**

21/00 Unidirectional solidification of eutectic materials [3, 2006.01]
21/02 • by normal casting or gradient freezing **[3, 2006.01]**
21/04 • by zone-melting **[3, 2006.01]**
21/06 • by pulling from a melt **[3, 2006.01]**

Single-crystal growth from vapours [3]

23/00 Single-crystal growth by condensing evaporated or sublimed materials [3, 2006.01]
23/02 • Epitaxial-layer growth **[3, 2006.01]**
23/04 • • Pattern deposit, e.g. by using masks **[3, 2006.01]**
23/06 • • Heating of the deposition chamber, the substrate, or the materials to be evaporated **[3, 2006.01]**
23/08 • • by condensing ionised vapours (by reactive sputtering C30B 25/06) **[3, 2006.01]**

25/00 Single-crystal growth by chemical reaction of reactive gases, e.g. chemical vapour deposition growth [3, 2006.01]
25/02 • Epitaxial-layer growth **[3, 2006.01]**
25/04 • • Pattern deposit, e.g. by using masks **[3, 2006.01]**
25/06 • • by reactive sputtering **[3, 2006.01]**
25/08 • • Reaction chambers; Selection of materials therefor **[3, 2006.01]**
25/10 • • Heating of the reaction chamber or the substrate **[3, 2006.01]**
25/12 • • Substrate holders or susceptors **[3, 2006.01]**
25/14 • • Feed and outlet means for the gases; Modifying the flow of the reactive gases **[3, 2006.01]**
25/16 • • Controlling or regulating (controlling or regulating in general G05) **[3, 2006.01]**
25/18 • • characterised by the substrate **[3, 2006.01]**
25/20 • • • the substrate being of the same materials as the epitaxial layer **[3, 2006.01]**
25/22 • • Sandwich processes **[3, 2006.01]**

27/00 Single-crystal growth under a protective fluid [3, 2006.01]
27/02 • by pulling from a melt **[3, 2006.01]**

28/00 Production of homogeneous polycrystalline material with defined structure [5, 2006.01]
28/02 • directly from the solid state **[5, 2006.01]**
28/04 • from liquids **[5, 2006.01]**
28/06 • • by normal freezing or freezing under temperature gradient **[5, 2006.01]**
28/08 • • by zone-melting **[5, 2006.01]**
28/10 • • by pulling from a melt **[5, 2006.01]**
28/12 • directly from the gas state **[5, 2006.01]**
28/14 • • by chemical reaction of reactive gases **[5, 2006.01]**

29/00 Single crystals or homogeneous polycrystalline material with defined structure characterised by the material or by their shape [3, 5, 2006.01]

Note(s) [3, 2010.01]

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 IPC refers. In this group, the Periodic System used is the 8 group system indicated by Roman numerals in the Periodic Table thereunder.

29/02 • Elements **[3, 2006.01]**
29/04 • • Diamond **[3, 2006.01]**
29/06 • • Silicon **[3, 2006.01]**
29/08 • • Germanium **[3, 2006.01]**
29/10 • Inorganic compounds or compositions **[3, 2006.01]**
29/12 • • Halides **[3, 2006.01]**
29/14 • • Phosphates **[3, 2006.01]**
29/16 • • Oxides **[3, 2006.01]**
29/18 • • • Quartz **[3, 2006.01]**
29/20 • • • Aluminium oxides **[3, 2006.01]**
29/22 • • • Complex oxides **[3, 2006.01]**
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 **[3, 2006.01]**
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 **[3, 2006.01]**
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 **[3, 2006.01]**
29/30 • • • • Niobates; Vanadates; Tantalates **[3, 2006.01]**
29/32 • • • • Titanates; Germanates; Molybdates; Tungstates **[3, 2006.01]**
29/34 • • Silicates **[3, 2006.01]**
29/36 • • Carbides **[3, 2006.01]**
29/38 • • Nitrides **[3, 2006.01]**
29/40 • • $A_{III}B_V$ compounds **[3, 2006.01]**
29/42 • • • Gallium arsenide **[3, 2006.01]**
29/44 • • • Gallium phosphide **[3, 2006.01]**
29/46 • • Sulfur-, selenium- or tellurium-containing compounds **[3, 2006.01]**
29/48 • • • $A_{II}B_{VI}$ compounds **[3, 2006.01]**
29/50 • • • • Cadmium sulfide **[3, 2006.01]**
29/52 • • Alloys **[3, 2006.01]**
29/54 • Organic compounds **[3, 2006.01]**
29/56 • • Tartrates **[3, 2006.01]**
29/58 • • Macromolecular compounds **[3, 2006.01]**
29/60 • characterised by shape **[3, 2006.01]**
29/62 • • Whiskers or needles **[3, 2006.01]**
29/64 • • Flat crystals, e.g. plates, strips, disks **[5, 2006.01]**
29/66 • • Crystals of complex geometrical shape, e.g. tubes, cylinders **[5, 2006.01]**
29/68 • • Crystals with laminate structure, e.g. "superlattices" **[5, 2006.01]**

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, 2006.01]

Note(s) [5]

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, 2006.01]**
30/04 • using magnetic fields **[5, 2006.01]**
30/06 • using mechanical vibrations **[5, 2006.01]**
30/08 • in conditions of zero-gravity or low gravity **[5, 2006.01]**

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, 2006.01]
31/02 • by contacting with diffusion materials in the solid state **[3, 2006.01]**
31/04 • by contacting with diffusion materials in the liquid state **[3, 2006.01]**
31/06 • by contacting with diffusion material in the gaseous state (C30B 31/18 takes precedence) **[3, 2006.01]**
31/08 • • the diffusion materials being a compound of the elements to be diffused **[3, 2006.01]**
31/10 • • Reaction chambers; Selection of materials therefor **[3, 2006.01]**
31/12 • • Heating of the reaction chamber **[3, 2006.01]**
31/14 • • Substrate holders or susceptors **[3, 2006.01]**
31/16 • • Feed and outlet means for the gases; Modifying the flow of the gases **[3, 2006.01]**
31/18 • • Controlling or regulating **[3, 2006.01]**
31/20 • Doping by irradiation with electromagnetic waves or by particle radiation **[3, 2006.01]**
31/22 • • by ion-implantation **[3, 2006.01]**

33/00 After-treatment of single crystals or homogeneous polycrystalline material with defined structure (C30B 31/00 takes precedence) **[3, 5, 2006.01]**
33/02 • Heat treatment (C30B 33/04, C30B 33/06 take precedence) **[5, 2006.01]**
33/04 • using electric or magnetic fields or particle radiation **[5, 2006.01]**
33/06 • Joining of crystals **[5, 2006.01]**
33/08 • Etching **[5, 2006.01]**
33/10 • • in solutions or melts **[5, 2006.01]**
33/12 • • in gas atmosphere or plasma **[5, 2006.01]**

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 [3, 5, 2006.01]