## SECTION C — CHEMISTRY; METALLURGY

## C30 CRYSTAL GROWTH

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)

- 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 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	
from vapours	
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	
APPARATUS	35/00

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

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- 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]**
- the crystallising materials being formed by chemical reactions in the solution [3]

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9/00	Single-crystal growth from melt solutions using molten solvents (by normal or gradient freezing	13/34	<ul> <li>characterised by the seed, e.g. by its crystallographic orientation [3]</li> </ul>
	C30B 11/00; by zone-melting C30B 13/00; by crystal		
	pulling C30B 15/00; on immersed seed crystal	15/00	Single-crystal growth by pulling from a melt, e.g.
	C30B 17/00; by liquid phase epitaxial growth		Czochralski method (under a protective fluid
	C30B 19/00; under a protective fluid C30B 27/00) [3]		C30B 27/00) [3]
9/02	<ul> <li>by evaporation of the molten solvent [3]</li> </ul>	15/02	<ul> <li>adding crystallising materials or reactants forming it</li> </ul>
9/04	<ul> <li>by cooling of the solution [3]</li> </ul>		in situ to the melt [3]
9/06	<ul> <li>using as solvent a component of the crystal</li> </ul>	15/04	• • adding doping materials, e.g. for n-p-junction [3]
5,00	composition [3]	15/06	Non-vertical pulling [3]
9/08	• • using other solvents [3]	15/08	Downward pulling [3]
9/10	Metal solvents [3]	15/10	• Crucibles or containers for supporting the melt [3]
9/12	• • • Salt solvents, e.g. flux growth [3]	15/12	Double crucible methods [3]
		15/14	<ul> <li>Heating of the melt or the crystallised materials [3]</li> </ul>
9/14	• by electrolysis [3]	15/14	<ul> <li>by irradiation or electric discharge [3]</li> </ul>
11/00	Single-crystal-growth by normal freezing or freezing		-
11,00	under temperature gradient, e.g. Bridgman-	15/18	• • using direct resistance heating in addition to other
	Stockbarger method (C30B 13/00, C30B 15/00,	15/20	methods of heating, e.g. using Peltier heat [3]
	C30B 17/00, C30B 19/00 take precedence; under a	15/20	• Controlling or regulating (controlling or regulating in
	protective fluid C30B 27/00) [3]	45 (00	general G05) [3]
11/02	without using solvents (C30B 11/06 takes	15/22	Stabilisation or shape controlling of the molten
	precedence) [3]		zone near the pulled crystal; Controlling the
11/04	adding crystallising materials or reactants forming it	45/04	section of the crystal [3]
, .	in situ to the melt [3]	15/24	• • using mechanical means, e.g. shaping guides
11/06	at least one but not all components of the crystal		(shaping dies for edge-defined film-fed crystal
11,00	composition being added [3]	45 (0.6	growth C30B 15/34) [3]
11/08	every component of the crystal composition being	15/26	• • using television detectors; using photo or X-ray
11700	added during the crystallisation [3]	4 = 400	detectors [3]
11/10	Solid or liquid components, e.g. Verneuil	15/28	• • using weight changes of the crystal or the melt,
11/10	method [3]		e.g. flotation methods [3]
11/12	Vaporous components, e.g. vapour-liquid-solid-	15/30	• Mechanisms for rotating or moving either the melt or
11/12	growth [3]		the crystal (flotation methods C30B 15/28) [3]
11/14	characterised by the seed, e.g. its crystallographic	15/32	• Seed holders, e.g. chucks [3]
11/14	orientation [3]	15/34	Edge-defined film-fed crystal growth using dies or
	onemation [b]		slits [3]
13/00	Single-crystal growth by zone-melting; Refining by	15/36	<ul> <li>characterised by the seed, e.g. its crystallographic</li> </ul>
	zone-melting (C30B 17/00 takes precedence; by		orientation [3]
	changing the cross-section of the treated solid	17/00	Single expectal arough on to a conduction remains in
	C30B 15/00; under a protective fluid C30B 27/00; for	17/00	Single-crystal growth on to a seed which remains in the melt during growth, e.g. Nacken-Kyropoulos
	the growth of homogeneous polycrystalline material		method (C30B 15/00 takes precedence) [3]
	with defined structure C30B 28/00; zone-refining of		method (C50D 15/00 takes precedence) [5]
	specific materials, <u>see</u> the relevant subclasses for the	19/00	Liquid-phase epitaxial-layer growth [3]
	materials) <b>[3, 5]</b>	19/02	• using molten solvents, e.g. flux [3]
13/02	<ul> <li>Zone-melting with a solvent, e.g. travelling solvent</li> </ul>	19/04	<ul> <li>the solvent being a component of the crystal</li> </ul>
	process [3]	13/04	composition [3]
13/04	<ul> <li>Homogenisation by zone-levelling [3]</li> </ul>	19/06	• Reaction chambers; Boats for supporting the melt;
13/06	<ul> <li>the molten zone not extending over the whole cross-</li> </ul>	13/00	Substrate holders [3]
	section [3]	19/08	
13/08	<ul> <li>adding crystallising materials or reactants forming it</li> </ul>		Heating of the reaction chamber or the substrate [3]  Controlling and Indian (controlling a controlling a con
	in situ to the molten zone [3]	19/10	• Controlling or regulating (controlling or regulating in
13/10	<ul> <li>with addition of doping materials [3]</li> </ul>	10/12	general G05) [3]
13/12	• • • in the gaseous or vapour state [3]	19/12	<ul> <li>characterised by the substrate [3]</li> </ul>
13/14	Crucibles or vessels [3]	21/00	Unidirectional solidification of eutectic materials [3]
13/16	Heating of the molten zone [3]		
13/18	the heating element being in contact with, or	21/02	by normal casting or gradient freezing [3]
.J, 1U	immersed in, the molten zone [3]	21/04	by zone-melting [3]     by zone-melting [3]
13/20	by induction, e.g. hot wire technique	21/06	<ul> <li>by pulling from a melt [3]</li> </ul>
10/40	(C30B 13/18 takes precedence) [3]		
13/22	<ul> <li>by irradiation or electric discharge [3]</li> </ul>	Single or	ystal growth from vapours [3]
13/24	• • using electromagnetic waves [3]	Single-Cr	<del>λοιτα Ετομια τιστα καδοπτο [ο]</del>
		23/00	Single-crystal growth by condensing evaporated or
13/26	Stirring of the molten zone [3]     Controlling or regulating [3]		sublimed materials [3]
13/28	Controlling or regulating [3]  Cabilly a second all and the controlling of the contr	23/02	• Epitaxial-layer growth [3]
13/30	Stabilisation or shape controlling of the molten	,	1

23/04

23/06

• • Pattern deposit, e.g. by using masks [3]

or the materials to be evaporated [3]

• • Heating of the deposition chamber, the substrate,

• • Stabilisation or shape controlling of the molten

• Mechanisms for moving either the charge or the

zone, e.g. by concentrators, by electromagnetic

fields; Controlling the section of the crystal  $\[ \mathbf{3} \]$ 

13/30

13/32

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heater [3]

23/08	• • by condensing ionised vapours (by reactive sputtering C30B 25/06) [3]	29/26	<ul> <li>• • • with formula BMe<sub>2</sub>O<sub>4</sub>, wherein B is Mg, Ni, Co, Al, Zn or Cd and Me is Fe, Ga, Sc, Cr, Co, or Al [3]</li> </ul>
25/00	Single-crystal growth by chemical reaction of reactive gases, e.g. chemical vapour deposition growth [3]	29/28	• • • • with formula A <sub>3</sub> Me <sub>5</sub> O <sub>12</sub> , wherein A is a rare earth metal and Me is Fe, Ga, Sc, Cr, Co or Al, e.g. garnets [3]
25/02	Epitaxial-layer growth [3]	29/30	• • • Niobates; Vanadates; Tantalates [3]
25/04	<ul> <li>Pattern deposit, e.g. by using masks [3]</li> </ul>	29/32	• • • • Titanates; Germanates; Molybdates;
25/06	<ul> <li>• by reactive sputtering [3]</li> </ul>		Tungstates [3]
25/08	<ul> <li>Reaction chambers; Selection of materials</li> </ul>	29/34	• • Silicates [3]
	therefor [3]	29/36	• • Carbides [3]
25/10	Heating of the reaction chamber or the	29/38	• • Nitrides [3]
05 (40	substrate [3]	29/40	• • A <sub>III</sub> B <sub>V</sub> compounds [3]
25/12	Substrate holders or susceptors [3]  Find and additional and a susceptors [3]  The decade and a susceptor for the susceptor [3]  The decade and a susceptor for the susceptor [3]  The decade and a susceptor for the susceptor [3]  The decade and a susceptor for the susceptor [3]  The decade and a susceptor for the susceptor [3]  The decade and a susceptor for the susceptor [3]  The decade and a susceptor for the susceptor [3]  The decade and a susceptor for the susceptor [3]  The decade and a susceptor for the susceptor [3]  The decade and a susceptor for the susceptor [3]  The decade and a susceptor for the susceptor [3]  The decade and a susceptor for the susceptor [3]  The decade and a susceptor for the susceptor [3]  The decade and a susceptor for the susceptor [3]  The decade and a susceptor for the sus	29/42	• • • Gallium arsenide [3]
25/14	<ul> <li>Feed and outlet means for the gases; Modifying the flow of the reactive gases [3]</li> </ul>	29/44	• • • Gallium phosphide [3]
25/16	Controlling or regulating (controlling or regulating)	29/46	Sulfur-, selenium- or tellurium-containing
25/10	in general G05) [3]	20 / 40	compounds [3]
25/18	• • characterised by the substrate [3]	29/48 29/50	• • • A <sub>II</sub> B <sub>VI</sub> compounds [3]
25/20	• • • the substrate being of the same materials as the	29/50 29/52	• • • Cadmium sulfide [3]
	epitaxial layer [3]	29/52	<ul><li> • Alloys [3]</li><li> • Organic compounds [3]</li></ul>
25/22	<ul> <li>Sandwich processes [3]</li> </ul>	29/56	• • Tartrates [3]
		29/58	Macromolecular compounds [3]
		29/60	<ul> <li>characterised by shape [3]</li> </ul>
27/00	Single-crystal growth under a protective fluid [3]	29/62	<ul><li>• Whiskers or needles [3]</li></ul>
27/02	by pulling from a melt [3]	29/64	• • Flat crystals, e.g. plates, strips, disks [5]
		29/66	<ul> <li>Crystals of complex geometrical shape, e.g. tubes,</li> </ul>
28/00	Production of homogeneous polycrystalline material with defined structure [5]	29/68	cylinders [5]  • Crystals with laminate structure, e.g.
28/02	• directly from the solid state [5]		"superlattices" [5]
28/04	• from liquids [5]	30/00	Production of single crystals or homogeneous
28/06	by normal freezing or freezing under temperature gradient [5]	30700	polycrystalline material with defined structure characterised by the action of electric or magnetic
28/08	• • by zone-melting [5]		fields, wave energy or other specific physical
28/10 28/12	<ul><li> by pulling from a melt [5]</li><li> directly from the gas state [5]</li></ul>		conditions [5]
28/14	<ul> <li>by chemical reaction of reactive gases [5]</li> </ul>		Note(s)
			When classifying in this group, classification is also
29/00	Single crystals or homogeneous polycrystalline material with defined structure characterised by the material or by their shape [3, 5]		made in groups C30B 1/00-C30B 28/00 according to the process of crystal growth.
	material of by their shape [5, 5]	30/02	<ul> <li>using electric fields, e.g. electrolysis [5]</li> </ul>
	Note(s)	30/04	<ul> <li>using magnetic fields [5]</li> </ul>
	1. In groups C30B 29/02-C30B 29/54, in the	30/06	<ul> <li>using mechanical vibrations [5]</li> </ul>
	<ul><li>absence of an indication to the contrary, a material is classified in the last appropriate place.</li><li>Attention is drawn to Note (3) after the title of</li></ul>	30/08	• in conditions of zero-gravity or low gravity [5]
	section C, which Note indicates to which version of the periodic table of chemical elements the IPC refers.		eatment of single crystals or homogeneous talline material with defined structure [3, 5]
29/02	• Elements [3]	31/00	Diffusion or doping processes for single crystals or
29/04	• • Diamond [3]		homogeneous polycrystalline material with defined
29/06	• • Silicon [3]		structure; Apparatus therefor [3, 5]
29/08	• • Germanium [3]	31/02	• by contacting with diffusion materials in the solid
29/10	<ul> <li>Inorganic compounds or compositions [3]</li> </ul>	21 /04	state [3]
29/12	• • Halides [3]	31/04	<ul> <li>by contacting with diffusion materials in the liquid state [3]</li> </ul>
29/14	• • Phosphates [3]	31/06	<ul><li>by contacting with diffusion material in the gaseous</li></ul>
29/16	• • Oxides [3]	31/00	state (C30B 31/18 takes precedence) [3]
29/18	• • • Quartz [3]	31/08	<ul> <li>the diffusion materials being a compound of the</li> </ul>
29/20	• • • Aluminium oxides [3]		elements to be diffused [3]
29/22	• • • Complex oxides [3]	31/10	<ul> <li>Reaction chambers; Selection of materials</li> </ul>
29/24	• • • with formula AMeO <sub>3</sub> , wherein A is a rare		therefor [3]
	earth metal and Me is Fe, Ga, Sc, Cr, Co, or	31/12	Heating of the reaction chamber [3]
	Al, e.g. ortho ferrites [3]	31/14	Substrate holders or susceptors [3]
		31/16	<ul> <li>Feed and outlet means for the gases; Modifying the flow of the gases [3]</li> </ul>

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# C30B

31/18 31/20 31/22	<ul> <li>Controlling or regulating [3]</li> <li>Doping by irradiation with electromagnetic waves or by particle radiation [3]</li> <li>by ion-implantation [3]</li> </ul>	33/06 33/08 33/10 33/12	<ul> <li>Joining of crystals [5]</li> <li>Etching [5]</li> <li>in solutions or melts [5]</li> <li>in gas atmosphere or plasma [5]</li> </ul>
33/00 33/02 33/04	<ul> <li>After-treatment of single crystals or homogeneous polycrystalline material with defined structure (C30B 31/00 takes precedence) [3, 5]</li> <li>Heat treatment (C30B 33/04, C30B 33/06 take precedence) [5]</li> <li>using electric or magnetic fields or particle radiation [5]</li> </ul>	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]

4 IPC (2011.01), Section C