

## SECTION C — CHEMISTRY; METALLURGY

- C23 COATING METALLIC MATERIAL; COATING MATERIAL WITH METALLIC MATERIAL; CHEMICAL SURFACE TREATMENT; DIFFUSION TREATMENT OF METALLIC MATERIAL; COATING BY VACUUM EVAPORATION, BY SPUTTERING, BY ION IMPLANTATION OR BY CHEMICAL VAPOUR DEPOSITION, IN GENERAL; INHIBITING CORROSION OF METALLIC MATERIAL OR INCRUSTATION IN GENERAL**
- C23C COATING METALLIC MATERIAL; COATING MATERIAL WITH METALLIC MATERIAL; SURFACE TREATMENT OF METALLIC MATERIAL BY DIFFUSION INTO THE SURFACE, BY CHEMICAL CONVERSION OR SUBSTITUTION; COATING BY VACUUM EVAPORATION, BY SPUTTERING, BY ION IMPLANTATION OR BY CHEMICAL VAPOUR DEPOSITION, IN GENERAL** (applying liquids or other fluent materials to surfaces in general B05; making metal-coated products by extrusion B21C 23/22; covering with metal by connecting pre-existing layers to articles, see the relevant places, e.g. B21D 39/00, B23K; working of metal by the action of a high concentration of electric current on a workpiece using an electrode B23H; metallising of glass C03C; metallising mortars, concrete, artificial stone, ceramics or natural stone C04B 41/00; paints, varnishes, lacquers C09D; enamelling of, or applying a vitreous layer to, metals C23D; inhibiting corrosion of metallic material or incrustation in general C23F; treating metal surfaces or coating of metals by electrolysis or electrophoresis C25D, C25F; single-crystal film growth C30B; by metallising textiles D06M 11/83; decorating textiles by locally metallising D06Q 1/04; details of scanning-probe apparatus, in general G01Q; manufacture of semiconductor devices H01L; manufacture of printed circuits H05K) **[4]**

**Note(s)**

In this subclass, an operation is considered as pretreatment or after-treatment when it is specially adapted for, but quite distinct from, the coating process concerned and constitutes an independent operation. If an operation results in the formation of a permanent sub- or upper layer, it is not considered as pretreatment or after-treatment and is classified as a multi-coating process.

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**Coating by applying the coating material in the molten state [4]**

- 2/00 Hot-dipping or immersion processes for applying the coating material in the molten state without affecting the shape; Apparatus therefor [4]**
- 2/02 • Pretreatment of the material to be coated, e.g. for coating on selected surface areas (C23C 2/30 takes precedence) **[4]**
- 2/04 • characterised by the coating material **[4]**
- 2/06 • • Zinc or cadmium or alloys based thereon **[4]**
- 2/08 • • Tin or alloys based thereon **[4]**
- 2/10 • • Lead or alloys based thereon **[4]**
- 2/12 • • Aluminium or alloys based thereon **[4]**
- 2/14 • Removing excess of molten coatings; Controlling or regulating the coating thickness (controlling or regulating thickness in general G05D 5/02) **[4]**
- 2/16 • • using fluids under pressure, e.g. air knives **[4]**

- 2/18 • • • Removing excess of molten coatings from elongated material **[4]**
- 2/20 • • • • Strips; Plates **[4]**
- 2/22 • • by rubbing, e.g. using knives **[4]**
- 2/24 • • using magnetic or electric fields **[4]**
- 2/26 • After-treatment (C23C 2/14 takes precedence) **[4]**
- 2/28 • • Thermal after-treatment, e.g. treatment in oil bath **[4]**
- 2/30 • Fluxes or coverings on molten baths (C23C 2/22 takes precedence) **[4]**
- 2/32 • using vibratory energy applied to the bath or substrate (C23C 2/14 takes precedence) **[4]**
- 2/34 • characterised by the shape of the material to be treated (C23C 2/14 takes precedence) **[4]**
- 2/36 • • Elongated material **[4]**
- 2/38 • • • Wires; Tubes **[4]**
- 2/40 • • • Plates; Strips **[4]**

**4/00 Coating by spraying the coating material in the molten state, e.g. by flame, plasma or electric discharge** (built-up welding B23K, e.g. B23K 5/18, B23K 9/04; spraying guns B05B; making alloys containing fibres or filaments by thermal spraying of metal C22C 47/16; plasma guns H05H) [4]

4/02 • Pretreatment of the material to be coated, e.g. for coating on selected surface areas [4]

4/04 • characterised by the coating material [4]

4/06 • • Metallic material [4]

4/08 • • • containing only metal elements [4]

4/10 • • Oxides, borides, carbides, nitrides, silicides or mixtures thereof [4]

4/12 • characterised by the method of spraying [4]

4/14 • • for covering elongated material [4]

4/16 • • • Wires; Tubes [4]

4/18 • After-treatment [4]

**6/00 Coating by casting molten material on the substrate** [4]

#### Solid state diffusion into metallic material surfaces [4]

**8/00 Solid state diffusion of only non-metal elements into metallic material surfaces** (diffusion of silicon C23C 10/00); **Chemical surface treatment of metallic material by reaction of the surface with a reactive gas, leaving reaction products of surface material in the coating, e.g. conversion coatings, passivation of metals** (C23C 14/00 takes precedence) [4]

8/02 • Pretreatment of the material to be coated (C23C 8/04 takes precedence) [4]

8/04 • Treatment of selected surface areas, e.g. using masks [4]

8/06 • using gases [4]

8/08 • • only one element being applied [4]

8/10 • • • Oxidising [4]

8/12 • • • • using elemental oxygen or ozone [4]

8/14 • • • • • Oxidising of ferrous surfaces [4]

8/16 • • • • using oxygen-containing compounds, e.g. H<sub>2</sub>O, CO<sub>2</sub> [4]

8/18 • • • • • Oxidising of ferrous surfaces [4]

8/20 • • • Carburising [4]

8/22 • • • • of ferrous surfaces [4]

8/24 • • • Nitriding [4]

8/26 • • • • of ferrous surfaces [4]

8/28 • • more than one element being applied in one step [4]

8/30 • • • Carbo-nitriding [4]

8/32 • • • • of ferrous surfaces [4]

8/34 • • more than one element being applied in more than one step [4]

8/36 • • using ionised gases, e.g. ionitriding (discharge tubes with provision for introducing objects or material to be exposed to the discharge H01J 37/00) [4]

8/38 • • • Treatment of ferrous surfaces [4]

8/40 • using liquids, e.g. salt baths, liquid suspensions [4]

8/42 • • only one element being applied [4]

8/44 • • • Carburising [4]

8/46 • • • • of ferrous surfaces [4]

8/48 • • • Nitriding [4]

8/50 • • • • of ferrous surfaces [4]

8/52 • • more than one element being applied in one step [4]

8/54 • • • Carbo-nitriding [4]

8/56 • • • • of ferrous surfaces [4]

8/58 • • more than one element being applied in more than one step [4]

8/60 • using solids, e.g. powders, pastes (using liquid suspensions of solids C23C 8/40) [4]

8/62 • • only one element being applied [4]

8/64 • • • Carburising [4]

8/66 • • • • of ferrous surfaces [4]

8/68 • • • Boronising [4]

8/70 • • • • of ferrous surfaces [4]

8/72 • • more than one element being applied in one step [4]

8/74 • • • Carbo-nitriding [4]

8/76 • • • • of ferrous surfaces [4]

8/78 • • more than one element being applied in more than one step [4]

8/80 • After-treatment [4]

**10/00 Solid state diffusion of only metal elements or silicon into metallic material surfaces** [4]

10/02 • Pretreatment of the material to be coated (C23C 10/04 takes precedence) [4]

10/04 • Diffusion into selected surface areas, e.g. using masks [4]

10/06 • using gases [4]

10/08 • • only one element being diffused [4]

10/10 • • • Chromising [4]

10/12 • • • • of ferrous surfaces [4]

10/14 • • more than one element being diffused in one step [4]

10/16 • • more than one element being diffused in more than one step [4]

10/18 • using liquids, e.g. salt baths, liquid suspensions [4]

10/20 • • only one element being diffused [4]

10/22 • • • Metal melt containing the element to be diffused [4]

10/24 • • • Salt bath containing the element to be diffused [4]

10/26 • • more than one element being diffused [4]

10/28 • using solids, e.g. powders, pastes [4]

10/30 • • using a layer of powder or paste on the surface (using liquid suspensions of solids C23C 10/18) [4]

10/32 • • • Chromising [4]

10/34 • • Embedding in a powder mixture, i.e. pack cementation [4]

10/36 • • • only one element being diffused [4]

10/38 • • • • Chromising [4]

10/40 • • • • • of ferrous surfaces [4]

10/42 • • • • • in the presence of volatile transport additives, e.g. halogenated substances [4]

10/44 • • • • Siliconising [4]

10/46 • • • • • of ferrous surfaces [4]

10/48 • • • • • Aluminising [4]

10/50 • • • • • of ferrous surfaces [4]

10/52 • • • more than one element being diffused in one step [4]

10/54 • • • • Diffusion of at least chromium [4]

10/56 • • • • • and at least aluminium [4]

10/58 • • • more than one element being diffused in more than one step [4]

10/60 • After-treatment [4]

**12/00 Solid state diffusion of at least one non-metal element other than silicon and at least one metal element or silicon into metallic material surfaces [4]**

12/02 • Diffusion in one step [4]

**Coating by vacuum evaporation, by sputtering or by ion implantation [4]**

**14/00 Coating by vacuum evaporation, by sputtering or by ion implantation of the coating forming material** (discharge tubes with provision for introducing objects or material to be exposed to the discharge H01J 37/00) [4]

- 
- 14/02 • Pretreatment of the material to be coated (C23C 14/04 takes precedence) [4]
  - 14/04 • Coating on selected surface areas, e.g. using masks [4]
  - 14/06 • characterised by the coating material (C23C 14/04 takes precedence) [4]
  - 14/08 • • Oxides (C23C 14/10 takes precedence) [4]
  - 14/10 • • Glass or silica [4]
  - 14/12 • • Organic material [4]
  - 14/14 • • Metallic material, boron or silicon [4]
  - 14/16 • • • on metallic substrates or on substrates of boron or silicon [4]
  - 14/18 • • • on other inorganic substrates [4]
  - 14/20 • • • on organic substrates [4]
  - 14/22 • characterised by the process of coating [4]
  - 14/24 • • Vacuum evaporation [4]
  - 14/26 • • • by resistance or inductive heating of the source [4]
  - 14/28 • • • by wave energy or particle radiation (C23C 14/32-C23C 14/48 take precedence) [4]
  - 14/30 • • • • by electron bombardment [4]
  - 14/32 • • • • by explosion; by evaporation and subsequent ionisation of the vapours (C23C 14/34-C23C 14/48 take precedence) [4]
  - 14/34 • • Sputtering [4]
  - 14/35 • • • by application of a magnetic field, e.g. magnetron sputtering [5]
  - 14/36 • • • Diode sputtering (C23C 14/35 takes precedence) [4, 5]
  - 14/38 • • • • by direct current glow discharge [4]
  - 14/40 • • • • with alternating current discharge, e.g. high-frequency discharge [4]
  - 14/42 • • • Triode sputtering (C23C 14/35 takes precedence) [4, 5]
  - 14/44 • • • • by application of high frequencies and additional direct voltages [4]
  - 14/46 • • • by ion beam produced by an external ion source (C23C 14/40 takes precedence) [4]
  - 14/48 • • Ion implantation [4]
  - 14/50 • • Substrate holders [4]
  - 14/52 • • Means for observation of the coating process [4]
  - 14/54 • • Controlling or regulating the coating process (controlling or regulating in general G05) [4]
  - 14/56 • • Apparatus specially adapted for continuous coating; Arrangements for maintaining the vacuum, e.g. vacuum locks [4]
  - 14/58 • After-treatment [4]

**Chemical deposition or plating by decomposition; Contact plating [4]**

**16/00 Chemical coating by decomposition of gaseous compounds, without leaving reaction products of surface material in the coating, i.e. chemical vapour deposition (CVD) processes** (reactive sputtering or vacuum evaporation C23C 14/00) [4]

- 16/01 • on temporary substrates, e.g. on substrates subsequently removed by etching [7]
- 16/02 • Pretreatment of the material to be coated (C23C 16/04 takes precedence) [4]
- 16/04 • Coating on selected surface areas, e.g. using masks [4]
- 16/06 • characterised by the deposition of metallic material [4]
- 16/08 • • from metal halides [4]
- 16/10 • • • Deposition of chromium only [4]
- 16/12 • • • Deposition of aluminium only [4]
- 16/14 • • • Deposition of only one other metal element [4]
- 16/16 • • • from metal carbonyl compounds [4]
- 16/18 • • • from metallo-organic compounds [4]
- 16/20 • • • Deposition of aluminium only [4]
- 16/22 • characterised by the deposition of inorganic material, other than metallic material [4]
- 16/24 • • Deposition of silicon only [4]
- 16/26 • • Deposition of carbon only [4]
- 16/27 • • • Diamond only [7]
- 16/28 • • Deposition of only one other non-metal element [4]
- 16/30 • • Deposition of compounds, mixtures or solid solutions, e.g. borides, carbides, nitrides [4]
- 16/32 • • • Carbides [4]
- 16/34 • • • Nitrides [4]
- 16/36 • • • Carbo-nitrides [4]
- 16/38 • • • Borides [4]
- 16/40 • • • Oxides [4]
- 16/42 • • • Silicides [4]
- 16/44 • characterised by the method of coating (C23C 16/04 takes precedence) [4]
- 16/442 • • using fluidised bed processes [7]
- 16/448 • • characterised by the method used for generating reactive gas streams, e.g. by evaporation or sublimation of precursor materials [7]
- 16/452 • • • by activating reactive gas streams before introduction into the reaction chamber, e.g. by ionization or by addition of reactive species [7]
- 16/453 • • • passing the reaction gases through burners or torches, e.g. atmospheric pressure CVD (C23C 16/513 takes precedence; for flame or plasma spraying of coating material in the molten state C23C 4/00) [7]
- 16/455 • • characterised by the method used for introducing gases into the reaction chamber or for modifying gas flows in the reaction chamber [7]
- 16/458 • • characterised by the method used for supporting substrates in the reaction chamber [7]
- 16/46 • • characterised by the method used for heating the substrate (C23C 16/48, C23C 16/50 take precedence) [4]
- 16/48 • • by irradiation, e.g. photolysis, radiolysis, particle radiation [4]
- 16/50 • • using electric discharges [4]
- 16/503 • • • using dc or ac discharges [7]
- 16/505 • • • using radio frequency discharges [7]

- 16/507 • • • • using external electrodes, e.g. in tunnel type reactors [7]
- 16/509 • • • • using internal electrodes [7]
- 16/511 • • • • using microwave discharges [7]
- 16/513 • • • • using plasma jets [7]
- 16/515 • • • • using pulsed discharges [7]
- 16/517 • • • • using a combination of discharges covered by two or more of groups C23C 16/503-C23C 16/515 [7]
- 16/52 • • Controlling or regulating the coating process (controlling or regulating in general G05) [4]
- 16/54 • • Apparatus specially adapted for continuous coating [4]
- 16/56 • After-treatment [4]

**18/00 Chemical coating by decomposition of either liquid compounds or solutions of the coating forming compounds, without leaving reaction products of surface material in the coating** (chemical surface reaction C23C 8/00, C23C 22/00); **Contact plating** [4]

#### Note(s)

This group covers also suspensions containing reactive liquids and non-reactive solid particles.

- 18/02 • by thermal decomposition [4]
- 18/04 • • Pretreatment of the material to be coated (C23C 18/06 takes precedence) [4]
- 18/06 • • Coating on selected surface areas, e.g. using masks [4]
- 18/08 • • characterised by the deposition of metallic material [4]
- 18/10 • • • Deposition of aluminium only [4]
- 18/12 • • characterised by the deposition of inorganic material other than metallic material [4]
- 18/14 • Decomposition by irradiation, e.g. photolysis, particle radiation [4]
- 18/16 • by reduction or substitution, i.e. electroless plating (C23C 18/54 takes precedence) [4]
- 18/18 • • Pretreatment of the material to be coated [4]
- 18/20 • • • of organic surfaces, e.g. resins [4]
- 18/22 • • • • Roughening, e.g. by etching [4]
- 18/24 • • • • • using acid aqueous solutions [4]
- 18/26 • • • • • using organic liquids [4]
- 18/28 • • • • Sensitising or activating [4]
- 18/30 • • • • • Activating [4]
- 18/31 • • Coating with metals [5]
- 18/32 • • • Coating with one of iron, cobalt or nickel; Coating with mixtures of phosphorus or boron with one of these metals [4, 5]
- 18/34 • • • • using reducing agents [4, 5]
- 18/36 • • • • • using hypophosphites [4, 5]
- 18/38 • • • Coating with copper [4, 5]
- 18/40 • • • • using reducing agents [4, 5]
- 18/42 • • • Coating with noble metals [4, 5]
- 18/44 • • • • using reducing agents [4, 5]
- 18/48 • • Coating with alloys [4, 5]
- 18/50 • • • with alloys based on iron, cobalt or nickel (C23C 18/32 takes precedence) [4, 5]
- 18/52 • • using reducing agents for coating with metallic material not provided for in a single one of groups C23C 18/32-C23C 18/50 [4]
- 18/54 • Contact plating, i.e. electroless electrochemical plating [4]

**20/00 Chemical coating by decomposition of either solid compounds or suspensions of the coating forming compounds, without leaving reaction products of surface material in the coating** (chemical surface reaction C23C 8/00, C23C 22/00) [4]

#### Note(s)

This group covers also suspensions containing non-reactive liquids and reactive solid particles.

- 20/02 • Coating with metallic material [4]
- 20/04 • • with metals [4]
- 20/06 • Coating with inorganic material, other than metallic material [4]
- 20/08 • • with compounds, mixtures or solid solutions, e.g. borides, carbides, nitrides [4]

**22/00 Chemical surface treatment of metallic material by reaction of the surface with a reactive liquid, leaving reaction products of surface material in the coating, e.g. conversion coatings, passivation of metals** (wash primers C09D 5/12) [4]

#### Note(s)

1. This group covers also suspensions containing reactive liquids and non-reactive solid particles.
2. Rejuvenating of the bath is classified in the appropriate place for the specific bath composition.

#### Note(s)

In groups C23C 22/02-C23C 22/86, in the absence of an indication to the contrary, classification is made in the last appropriate place.

- 22/02 • using non-aqueous solutions [4]
- 22/03 • • containing phosphorus compounds [4]
- 22/04 • • containing hexavalent chromium compounds [4]
- 22/05 • using aqueous solutions [5]
- 22/06 • • using aqueous acidic solutions with pH < 6 [4, 5]
- 22/07 • • • containing phosphates [4, 5]
- 22/08 • • • • Orthophosphates [4, 5]
- 22/10 • • • • • containing oxidants [4, 5]
- 22/12 • • • • • containing zinc cations [4, 5]
- 22/13 • • • • • containing also nitrate or nitrite anions [4, 5]
- 22/14 • • • • • containing also chlorate anions [4, 5]
- 22/16 • • • • • containing also peroxy-compounds [4, 5]
- 22/17 • • • • • containing also organic acids [4, 5]
- 22/18 • • • • • containing manganese cations [4, 5]
- 22/20 • • • • • containing aluminium cations [4, 5]
- 22/22 • • • • • containing alkaline earth metal cations [4, 5]
- 22/23 • • • • Condensed phosphates [4, 5]
- 22/24 • • • containing hexavalent chromium compounds [4, 5]
- 22/26 • • • • containing also organic compounds [4, 5]
- 22/27 • • • • • Acids [4, 5]
- 22/28 • • • • • Macromolecular compounds [4, 5]
- 22/30 • • • • containing also trivalent chromium [4, 5]
- 22/32 • • • • containing also pulverulent metals [4, 5]
- 22/33 • • • • containing also phosphates [4, 5]
- 22/34 • • • containing fluorides or complex fluorides [4, 5]
- 22/36 • • • • containing also phosphates [4, 5]
- 22/37 • • • • containing also hexavalent chromium compounds [4, 5]

- 22/38 • • • • containing also phosphates [4, 5]
- 22/40 • • • containing molybdates, tungstates or vanadates [4, 5]
- 22/42 • • • • containing also phosphates [4, 5]
- 22/43 • • • • containing also hexavalent chromium compounds [4, 5]
- 22/44 • • • • containing also fluorides or complex fluorides [4, 5]
- 22/46 • • • containing oxalates [4, 5]
- 22/47 • • • • containing also phosphates [4, 5]
- 22/48 • • • not containing phosphates, hexavalent chromium compounds, fluorides or complex fluorides, molybdates, tungstates, vanadates or oxalates [4, 5]
- 22/50 • • • • Treatment of iron or alloys based thereon [4, 5]
- 22/52 • • • • Treatment of copper or alloys based thereon [4, 5]
- 22/53 • • • • Treatment of zinc or alloys based thereon [4, 5]
- 22/54 • • • • Treatment of refractory metals or alloys based thereon [4, 5]
- 22/56 • • • • Treatment of aluminium or alloys based thereon [4, 5]
- 22/57 • • • • Treatment of magnesium or alloys based thereon [4, 5]
- 22/58 • • • • Treatment of other metallic material [4, 5]
- 22/60 • • using alkaline aqueous solutions with pH > 8 [4, 5]
- 22/62 • • • Treatment of iron or alloys based thereon [4, 5]
- 22/63 • • • Treatment of copper or alloys based thereon [4, 5]
- 22/64 • • • Treatment of refractory metals or alloys based thereon [4, 5]
- 22/66 • • • Treatment of aluminium or alloys based thereon [4, 5]
- 22/67 • • • • with solutions containing hexavalent chromium [4, 5]
- 22/68 • • using aqueous solutions with pH between 6 and 8 [4, 5]
- 22/70 • using melts [4]
- 22/72 • • Treatment of iron or alloys based thereon [4]
- 22/73 • characterised by the process [4]
- 22/74 • • for obtaining burned-in conversion coatings [4]
- 22/76 • • Applying the liquid by spraying [4]
- 22/77 • • Controlling or regulating of the coating process (controlling or regulating in general G05) [4]
- 22/78 • Pretreatment of the material to be coated [4]
- 22/80 • • with solutions containing titanium or zirconium compounds [4]
- 22/82 • After-treatment [4]
- 22/83 • • Chemical after-treatment [4]
- 22/84 • • Dyeing [4]
- 22/86 • Regeneration of coating baths [4]
- 24/00 Coating starting from inorganic powder** (spraying of the coating material in molten state C23C 4/00; solid state diffusion C23C 8/00-C23C 12/00; manufacture of composite layers, workpieces or articles by sintering metallic powder B22F 7/00; friction welding B23K 20/12) [4]
  - 24/02 • by application of pressure only [4]
  - 24/04 • • Impact or kinetic deposition of particles [4]
  - 24/06 • • Compressing powdered coating material, e.g. by milling [4]
  - 24/08 • by application of heat or pressure and heat (C23C 24/04 takes precedence) [4]
  - 24/10 • • with intermediate formation of a liquid phase in the layer [4]
- 26/00 Coating not provided for in groups C23C 2/00-C23C 24/00 [4]**
  - 26/02 • applying molten material to the substrate (applying melts to surfaces, in general B05) [4]
- 28/00 Coating for obtaining at least two superposed coatings either by methods not provided for in a single one of main groups C23C 2/00-C23C 26/00, or by combinations of methods provided for in subclasses C23C and C25D [4]**
  - 28/02 • only coatings of metallic material [4]
  - 28/04 • only coatings of inorganic non-metallic material [4]
- 30/00 Coating with metallic material characterised only by the composition of the metallic material, i.e. not characterised by the coating process** (C23C 26/00, C23C 28/00 take precedence) [4]