

CPC**COOPERATIVE PATENT CLASSIFICATION****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, laquers [C09D](#); enamelling of, or applying a vitreous layer to, metals [C23D](#); inhibiting corrosion of metallic material or incrustation in general [C23F](#); single-crystal film growth [C30B](#); manufacture of semiconductor devices [H01L](#); manufacture of printed circuits [H05K](#))

NOTE

In this subclass, an operation is considered as pre-treatment 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 pre-treatment or after-treatment and is classified as a multi-coating process.

WARNING

The following IPC groups are not used in the CPC scheme. Subject matter covered by these groups is classified in the following CPC groups:

- [C23C 14/36](#) - [C23C 14/44](#) covered by [C23C 14/34](#) and subgroups.
- [C23C 18/28](#) covered by [C23C 18/2006](#) - [C23C 18/2093](#)

Coating by applying the coating material in the molten state (casting [B22D](#), e.g. [B22D 19/08](#), [B22D 23/04](#), [B29](#); built-up welding [B23K](#), e.g. [B23K 5/18](#), [B23K 9/04](#))

C23C 2/00

Hot-dipping or immersion processes for applying the coating material in the molten state without affecting the shape; Apparatus therefor

[C23C 2/003](#)

- {Apparatus, e.g. crucibles, heating devices}

[C23C 2/006](#)

- {Pattern or selective deposit without pre-treatment of the material to be coated}

[C23C 2/02](#)

- Pre-treatment of the material to be coated, e.g. for coating on selected surface areas ([C23C 2/30](#) takes precedence)

[C23C 2/04](#)

- characterised by the coating material

[C23C 2/06](#)

- . Zinc or cadmium or alloys based thereon

[C23C 2/08](#)

- . Tin or alloys based thereon

[C23C 2/10](#)

- . Lead or alloys based thereon

[C23C 2/12](#)

- . Aluminium or alloys based thereon

- C23C 2/14
 - Removing excess of molten coatings; Controlling or regulating the coating thickness ([controlling or regulating thickness in general G05D 5/02](#))
- C23C 2/16
 - . using fluids under pressure, e.g. air knives
- C23C 2/18
 - . . Removing excess of molten coatings from elongated material
- C23C 2/185
 - {Tubes; Wires}
- C23C 2/20
 - Strips; Plates
- C23C 2/22
 - . by rubbing, e.g. using knives, {e.g. rubbing solids}
- C23C 2/24
 - . using magnetic or electric fields
- C23C 2/26
 - After-treatment ([C23C 2/14 takes precedence](#))
- C23C 2/265
 - . {by applying solid particles to the molten coating}
- C23C 2/28
 - . Thermal aftertreatment, e.g. treatment in oil bath
- C23C 2/285
 - . . {for remelting the coating}
- C23C 2/30
 - Fluxes or coverings on molten baths ([C23C 2/22 takes precedence](#))
- C23C 2/32
 - using vibratory energy applied to the bath or substrate ([C23C 2/14 takes precedence](#))
- C23C 2/34
 - characterised by the shape of the material to be treated ([C23C 2/14 takes precedence](#))
- C23C 2/36
 - . Elongated material
- C23C 2/38
 - . . Wires; Tubes
- C23C 2/385
 - {Tubes of specific length}
- C23C 2/40
 - . . . Plates; Strips
- C23C 2/405
 - {Plates of specific length}
- C23C 4/00**

Coating by spraying the coating material in the molten state, e.g. by flame, plasma or electric discharge ([spraying guns B05B](#); [making alloys containing fibres or filaments by thermal spraying of metal C22C 47/16](#); [plasma guns H05H](#))
- C23C 4/005
 - {Pattern or selective deposit without pre-treatment of the material to be coated}
- C23C 4/02
 - Pre-treatment of the material to be coated, e.g. for coating on selected surface areas
- C23C 4/04
 - characterised by the coating material
- C23C 4/06
 - . Metallic material {e.g. mixture of metallic alloys and hard particles like SiC and WC ([C23C 4/085 takes precedence](#))}
- C23C 4/065
 - . . . {containing non-metal elements, e.g. C, Si, B, P or As, as free particles}
- C23C 4/08
 - . . containing only metal elements
- C23C 4/085
 - {MCrAl or MCrAlY type alloys where M = Ni,Co,Fe}
- C23C 4/10
 - . Oxides, borides, carbides, nitrides, silicides or mixtures thereof
- C23C 4/105
 - . . . {Oxides}
- C23C 4/12
 - characterised by the method of spraying
- C23C 4/121
 - . {Spraying molten metal}
- C23C 4/122
 - . {utilising detonation (apparatus for spraying by means of detonations in general [B05B 7/0006](#))}
- C23C 4/124
 - . {utilising flame spraying (apparatus for spraying by means of flame in general [B05B 7/20](#))}

- C23C 4/125 . . {utilising wire arc spraying (apparatus for spraying by means of electric arc in general [B05B 7/22](#))}
- C23C 4/127 . . {utilising plasma spraying (plasma torches in general [H05H 1/26](#), apparatus for spraying by means of electric arc in general [B05B 7/22](#))}
- C23C 4/128 . . {Spraying in vacuum or in an inert gas chamber}
- C23C 4/14 . . for covering elongated material
- C23C 4/16 . . . Wires; Tubes
- C23C 4/18 . After-treatment
- C23C 4/185 . . {Separation of the coating from the substrate}

C23C 6/00 Coating by casting molten material on the substrate

Solid state diffusion into metallic material surfaces

- C23C 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)**
- C23C 8/02 . Pre-treatment of the material to be coated ([C23C 8/04](#) takes precedence)
- C23C 8/04 . Treatment of selected surface areas, e.g. using masks
- C23C 8/06 . using gases ([C23C 8/36](#) takes precedence)
- C23C 8/08 . . onyl one element being applied
- C23C 8/10 . . . Oxidising
- C23C 8/12 using elemental oxygen or ozone
- C23C 8/14 Oxidising of ferrous surfaces
- C23C 8/16 using oxygen-containing compounds, e.g. water, carbon dioxide
- C23C 8/18 oxidising of ferrous surfaces
- C23C 8/20 . . . Carburising
- C23C 8/22 of ferrous surfaces
- C23C 8/24 . . . Nitriding
- C23C 8/26 of ferrous surfaces
- C23C 8/28 . . more than one element being applied in one step
- C23C 8/30 . . . Carbo-nitriding
- C23C 8/32 of ferrous surfaces
- C23C 8/34 . . more than one element being applied in more than one step
- C23C 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](#))
- C23C 8/38 . . . Treatment of ferrous surfaces
- C23C 8/40 . using liquids, e.g. salt baths, liquid suspensions
- C23C 8/42 . . only one element being applied
- C23C 8/44 . . . Carburising
- C23C 8/46 of ferrous surfaces

- C23C 8/48 . . . Nitriding
- C23C 8/50 of ferrous surfaces
- C23C 8/52 . . more than one element being applied in one step
- C23C 8/54 . . . Carbo-nitriding
- C23C 8/56 of ferrous surfaces
- C23C 8/58 . . more than one element being applied in more than one step
- C23C 8/60 . using solids, e.g. powders, pastes ([using liquid suspensions of solids C23C 8/40](#))
- C23C 8/62 . . only one element being applied
- C23C 8/64 . . . Carburising
- C23C 8/66 of ferrous surfaces
- C23C 8/68 . . . Boronising
- C23C 8/70 of ferrous surfaces
- C23C 8/72 . . more than one element being applied in one step
- C23C 8/74 . . . Carbo-nitriding
- C23C 8/76 of ferrous surfaces
- C23C 8/78 . . more than one element being applied in more than one step
- C23C 8/80 . After-treatment

C23C 10/00 Solid state diffusion of only metal elements or silicon into metallic material surfaces

- C23C 10/02 . Pretreatment of the material to be coated ([C23C 10/04 takes precedence](#))
- C23C 10/04 . Diffusion into selected surface areas, e.g. using masks
- C23C 10/06 . using gases
- C23C 10/08 . . only one element being diffused
- C23C 10/10 . . . Chromising
- C23C 10/12 of ferrous surfaces
- C23C 10/14 . . more than one element being diffused in one step
- C23C 10/16 . . more than one element being diffused in more than one step
- C23C 10/18 . using liquids, e.g. salt baths, liquid suspensions
- C23C 10/20 . . only one element being diffused
- C23C 10/22 . . . Metal melt containing the element to be diffused
- C23C 10/24 . . . Salt bath containing the element to be diffused
- C23C 10/26 . . more than one element being diffused
- C23C 10/28 . using solids, e.g. powders, pastes
- C23C 10/30 . . using a layer of powder or paste on the surface ([using liquid suspensions of solids C23C 10/18](#))
- C23C 10/32 . . . Chromising
- C23C 10/34 . . Embedding in a powder mixture, i.e. pack cementation
- C23C 10/36 . . . only one element being diffused
- C23C 10/38 Chromising

- C23C 10/40 of ferrous surfaces
- C23C 10/42 in the presence of volatile transport additives, e.g. halogenated substances
- C23C 10/44 Siliconising
- C23C 10/46 of ferrous surfaces
- C23C 10/48 Aluminising
- C23C 10/50 of ferrous surfaces
- C23C 10/52 more than one element being diffused in one step
- C23C 10/54 Diffusion of at least chromium
- C23C 10/56 and at least aluminium
- C23C 10/58 more than one element being diffused in more than one step
- C23C 10/60 After-treatment
- C23C 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**
- C23C 12/02 Diffusion in one step

Coating by vacuum evaporation, by sputtering or by ion implantation

- C23C 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](#))
- C23C 14/0005 {Separation of the coating from the substrate}
- C23C 14/001 {Coating on a liquid substrate}
- C23C 14/0015 {characterized by the colour of the layer}
- C23C 14/0021 {Reactive sputtering or evaporation}
- C23C 14/0026 {Activation or excitation of reactive gases outside the coating chamber}
- C23C 14/0031 {Bombardment of substrates by reactive ion beams}
- C23C 14/0036 {Reactive sputtering}
- C23C 14/0042 {Controlling partial pressure or flow rate of reactive or inert gases with feedback of measurements}
- C23C 14/0047 {Activation or excitation of reactive gases outside the coating chamber}
- C23C 14/0052 {Bombardment of substrates by reactive ion beams}
- C23C 14/0057 {using reactive gases other than O₂, H₂O, N₂, NH₃ or CH₄}
- C23C 14/0063 {characterised by means for introducing or removing gases}
- C23C 14/0068 {characterised by means for confinement of gases or sputtered material, e.g. screens, baffles}
- C23C 14/0073 {by exposing the substrates to reactive gases intermittently}
- C23C 14/0078 {by moving the substrates between spatially separate sputtering and reaction stations}
- C23C 14/0084 {Producing gradient compositions}
- C23C 14/0089 {in metallic mode}
- C23C 14/0094 {in transition mode}

- C23C 14/02 . Pre-treatment of the material to be coated ([C23C 14/04 takes precedence](#))
- C23C 14/021 . . {Cleaning or etching treatments}
- C23C 14/022 . . . {by means of bombardment with energetic particles or radiation}
- C23C 14/024 . . {Deposition of sublayers, e.g. to promote adhesion of the coating ([C23C 14/027 takes precedence](#))}
- C23C 14/025 . . . {Metallic sublayers}
- C23C 14/027 . . {Graded interfaces}
- C23C 14/028 . . {Physical treatment to alter the texture of the substrate surface, e.g. grinding, polishing}
- C23C 14/04 . Coating on selected surface areas, e.g. using masks
- C23C 14/042 . . {using masks}
- C23C 14/044 . . . {using masks to redistribute rather than totally prevent coating, e.g. producing thickness gradient}
- C23C 14/046 . . {Coating cavities or hollow spaces, e.g. interior of tubes; Infiltration of porous substrates}
- C23C 14/048 . . {using irradiation by energy or particles}
- C23C 14/06 . characterised by the coating material ([C23C 14/0021](#) , [C23C 14/04 take precedence](#))
- C23C 14/0605 . . {Carbon}
- C23C 14/0611 . . . {Diamond}
- C23C 14/0617 . . {AIII BV compounds, where A is Al, Ga, In or Tl and B is N, P, As, Sb or Bi}
- C23C 14/0623 . . {Sulfides, selenides or tellurides}
- C23C 14/0629 . . . {of zinc, cadmium or mercury}
- C23C 14/0635 . . {Carbides}
- C23C 14/0641 . . {Nitrides ([C23C 14/0617 takes precedence](#))}
- C23C 14/0647 . . . {Boron nitride}
- C23C 14/0652 . . . {Silicon nitride}
- C23C 14/0658 . . . {Carbon nitride}
- C23C 14/0664 . . {Carbonitrides}
- C23C 14/067 . . {Borides}
- C23C 14/0676 . . {Oxynitrides}
- C23C 14/0682 . . {Silicides}
- C23C 14/0688 . . {Cermets, e.g. mixtures of metal and one or more of carbides, nitrides, oxides or borides}
- C23C 14/0694 . . {Halides}
- C23C 14/08 . . Oxides ([C23C 14/10 takes precedence](#))
- C23C 14/081 . . . {of aluminium, magnesium or beryllium}
- C23C 14/082 . . . {of alkaline earth metals}
- C23C 14/083 . . . {of refractory metals or yttrium}
- C23C 14/085 . . . {of iron group metals}
- C23C 14/086 . . . {of zinc, germanium, cadmium, indium, tin, thallium or bismuth}
- C23C 14/087 . . . {of copper or solid solutions thereof}

- C23C 14/088 . . . {of the type ABO_3 with A representing alkali, alkaline earth metal or Pb and B representing a refractory or rare earth metal}
- C23C 14/10 . . Glass or silica
- C23C 14/12 . . Organic material
- C23C 14/14 . . Metallic material, boron or silicon
- C23C 14/16 . . . on metallic substrates or on substrates of boron or silicon
- C23C 14/165 {by cathodic sputtering}
- C23C 14/18 . . . on other inorganic substrates
- C23C 14/185 {by cathodic sputtering}
- C23C 14/20 . . . on organic substrates
- C23C 14/205 {by cathodic sputtering}
- C23C 14/22 . . characterised by the process of coating
- C23C 14/221 . . {Ion beam deposition ([C23C 14/46](#), [C23C 14/48](#) take precedence)}
- C23C 14/223 . . {specially adapted for coating particles}
- C23C 14/225 . . {Oblique incidence of vaporised material on substrate}
- C23C 14/226 . . . {in order to form films with columnar structure}
- C23C 14/228 . . {Gas flow assisted PVD deposition}
- C23C 14/24 . . Vacuum evaporation
- C23C 14/243 . . . {Crucibles for source material ([C23C 14/28](#), [C23C 14/30](#) take precedence)}
- C23C 14/246 . . . {Replenishment of source material}
- C23C 14/26 . . . by resistance or inductive heating of the source
- C23C 14/28 . . . by wave energy or particle radiation ([C23C 14/32](#) to [C23C 14/48](#) take precedence)
- C23C 14/30 by electron bombardment
- C23C 14/32 . . . by explosion; by evaporation and subsequent ionisation of the vapours {e.g. ion-plating} ([C23C 14/34](#) to [C23C 14/48](#) take precedence)
- C23C 14/325 {Electric arc evaporation}
- C23C 14/34 . . Sputtering
- C23C 14/3407 . . . {Cathode assembly for sputtering apparatus, e.g. Target}
- C23C 14/3414 {Metallurgical or chemical aspects of target preparation, e.g. casting, powder metallurgy}
- C23C 14/3421 {using heated targets}
- C23C 14/3428 {using liquid targets}
- C23C 14/3435 . . . {Applying energy to the substrate during sputtering}
- C23C 14/3442 {using an ion beam}
- C23C 14/345 {using substrate bias}
- C23C 14/3457 . . . {using other particles than noble gas ions ([C23C 14/0036](#), [C23C 14/46](#) take precedence)}
- C23C 14/3464 . . . {using more than one target ([C23C 14/56](#) takes precedence)}
- C23C 14/3471 . . . {Introduction of auxiliary energy into the plasma}
- C23C 14/3478 {using electrons, e.g. triode sputtering}

- C23C 14/3485 . . . {using pulsed power to the target}
- C23C 14/3492 . . . {Variation of parameters during sputtering}
- C23C 14/35 . . . by application of a magnetic field, e.g. magnetron sputtering
{(C23C 14/3457 takes precedence)}
- C23C 14/351 {using a magnetic field in close vicinity to the substrate}
- C23C 14/352 {using more than one target (C23C 14/56 takes precedence)}
- C23C 14/354 {Introduction of auxiliary energy into the plasma}
- C23C 14/355 {using electrons, e.g. triode sputtering}
- C23C 14/357 {Microwaves, e.g. electron cyclotron resonance enhanced sputtering}
- C23C 14/358 {Inductive energy}
- C23C 14/46 . . . by ion beam produced by an external ion source
- C23C 14/48 . . Ion implantation
- C23C 14/50 . . Substrate holders
- C23C 14/505 . . . {for rotation of the substrates}
- C23C 14/52 . . Means for observation of the coating process
- C23C 14/54 . . Controlling or regulating the coating process (controlling or regulating in general G05)
- C23C 14/541 . . . {Heating or cooling of the substrates}
- C23C 14/542 . . . {Controlling the film thickness or evaporation rate}
- C23C 14/543 {using measurement on the vapor source}
- C23C 14/544 {using measurement in the gas phase}
- C23C 14/545 {using measurement on deposited material}
- C23C 14/546 {using crystal oscillators}
- C23C 14/547 {using optical methods}
- C23C 14/548 . . . {Controlling the composition}
- C23C 14/56 . . Apparatus specially adapted for continuous coating; Arrangements for maintaining the vacuum, e.g. vacuum locks
- C23C 14/562 . . . {for coating elongated substrates}
- C23C 14/564 . . . {Means for minimising impurities in the coating chamber such as dust, moisture, residual gases}
- C23C 14/566 {using a load-lock chamber}
- C23C 14/568 . . . {Transferring the substrates through a series of coating stations
(C23C 14/562 takes precedence)}
- C23C 14/58 . . After-treatment
- C23C 14/5806 . . {Thermal treatment}
- C23C 14/5813 . . . {using lasers}
- C23C 14/582 . . . {using electron bombardment}
- C23C 14/5826 . . {Plasma treatment}
- C23C 14/5833 . . . {Ion beam bombardment}
- C23C 14/584 . . {Non-reactive treatment}
- C23C 14/5846 . . {Reactive treatment}

- C23C 14/5853 . . . {Oxidation}
- C23C 14/586 . . . {Nitriding}
- C23C 14/5866 . . . {Treatment with sulfur, selenium or tellurium}
- C23C 14/5873 . . {Removal of material}
- C23C 14/588 . . . {by mechanical treatment}
- C23C 14/5886 . . {Mechanical treatment (involving removal of material [C23C 14/588](#))}
- C23C 14/5893 . . {Mixing of deposited material}

Chemical deposition or plating by decomposition; Contact plating (solid state diffusion [C23C 8/00](#) to [C23C 12/00](#))

- C23C 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](#))
- C23C 16/003 . {Coating on a liquid substrate}
 - C23C 16/006 . {characterized by the colour of the layer}
 - C23C 16/01 . on temporary substrates, e.g. substrates subsequently removed by etching
 - C23C 16/02 . Pretreatment of the material to be coated ([C23C 16/04](#) takes precedence)
 - C23C 16/0209 . . {by heating}
 - C23C 16/0218 . . . {in a reactive atmosphere ([C23C 16/0227](#) takes precedence)}
 - C23C 16/0227 . . {by cleaning or etching}
 - C23C 16/0236 . . . {by etching with a reactive gas}
 - C23C 16/0245 . . . {by etching with a plasma}
 - C23C 16/0254 . . {Physical treatment to alter the texture of the surface, e.g. scratching or polishing}
 - C23C 16/0263 . . . {Irradiation with laser or particle beam}
 - C23C 16/0272 . . {Deposition of sub-layers, e.g. to promote the adhesion of the main coating}
 - C23C 16/0281 . . . {of metallic sub-layers ([C23C 16/029](#) takes precedence)}
 - C23C 16/029 . . . {Graded interfaces}
 - C23C 16/04 . Coating on selected surface areas, e.g. using masks
 - C23C 16/042 . . {using masks}
 - C23C 16/045 . . {Coating cavities or hollow spaces, e.g. interior of tubes; Infiltration of porous substrates}
 - C23C 16/047 . . {using irradiation by energy or particles}
 - C23C 16/06 . characterised by the deposition of metallic material
 - C23C 16/08 . . from metal halides
 - C23C 16/10 . . . Deposition of chromium only
 - C23C 16/12 . . . Deposition of aluminium only
 - C23C 16/14 . . . Deposition of only one other metal element
 - C23C 16/16 . . from metal carbonyl compounds
 - C23C 16/18 . . from metallo-organic compounds

C23C 16/20	. . . Deposition of aluminium only
C23C 16/22	. characterised by the deposition of inorganic material, other than metallic material
C23C 16/24	. . Deposition of silicon only
C23C 16/26	. . Deposition of carbon only
C23C 16/27	. . . Diamond only
C23C 16/271	. . . . {using hot filaments}
C23C 16/272	. . . . {using DC, AC or RF discharges}
C23C 16/274	. . . . {using microwave discharges}
C23C 16/275	. . . . {using combustion torches}
C23C 16/276	. . . . {using plasma jets}
C23C 16/277	. . . . {using other elements in the gas phase besides carbon and hydrogen; using other elements besides carbon, hydrogen and oxygen in case of use of combustion torches; using other elements besides carbon, hydrogen and inert gas in case of use of plasma jets}
C23C 16/278	. . . . {doping or introduction of a secondary phase in the diamond}
C23C 16/279	. . . . {control of diamond crystallography}
C23C 16/28	. . Deposition of only one other non-metal element
C23C 16/30	. . Deposition of compounds, mixtures or solid solutions, e.g. borides, carbides, nitrides
C23C 16/301	. . . {AIII BV compounds, where A is Al, Ga, In or Tl and B is N, P, As, Sb or Bi}
C23C 16/303	. . . . {Nitrides}
C23C 16/305	. . . . {Sulfides, selenides, or tellurides}
C23C 16/306	. . . . {AII BVI compounds, where A is Zn, Cd or Hg and B is S, Se or Te}
C23C 16/308	. . . {Oxynitrides}
C23C 16/32	. . . Carbides
C23C 16/325	. . . . {Silicon carbide}
C23C 16/34	. . . Nitrides {(C23C 16/303 takes precedence)}
C23C 16/342	. . . . {Boron nitride}
C23C 16/345	. . . . {Silicon nitride}
C23C 16/347	. . . . {Carbon nitride}
C23C 16/36	. . . Carbonitrides
C23C 16/38	. . . Borides
C23C 16/40	. . . Oxides
C23C 16/401	. . . . {containing silicon}
C23C 16/402	. . . . . {Silicon dioxide}
C23C 16/403	. . . . {of aluminium, magnesium or beryllium}
C23C 16/404	. . . . {of alkaline earth metals}
C23C 16/405	. . . . {of refractory metals or yttrium}
C23C 16/406	. . . . {of iron group metals}
C23C 16/407	. . . . {of zinc, germanium, cadmium, indium, tin, thallium or bismuth}

- C23C 16/408 {of copper or solid solutions thereof}
- C23C 16/409 {of the type ABO_3 with A representing alkali, alkaline earth metal or lead and B representing a refractory metal, nickel, scandium or a lanthanide}
- C23C 16/42 . . . Silicides
- C23C 16/44 . characterised by the method of coating ([C23C 16/04 takes precedence](#))
- C23C 16/4401 . . {Means for minimising impurities, e.g. dust, moisture or residual gas, in the reaction chamber}
- C23C 16/4402 . . . {Reduction of impurities in the source gas}
- C23C 16/4404 . . . {Coatings or surface treatment on the inside of the reaction chamber or on parts thereof}
- C23C 16/4405 . . . {Cleaning of reactor or parts inside the reactor by using reactive gases}
- C23C 16/4407 . . . {Cleaning of reactor or reactor parts by using wet or mechanical methods}
- C23C 16/4408 . . . {by purging residual gases from the reaction chamber or gas lines}
- C23C 16/4409 . . . {characterised by sealing means}
- C23C 16/4411 . . {Cooling of the reaction chamber walls ([C23C 16/45572 takes precedence](#))}
- C23C 16/4412 . . {Details relating to the exhausts, e.g. pumps, filters, scrubbers, particle traps}
- C23C 16/4414 . . {Electrochemical vapour deposition [EVD]}
- C23C 16/4415 . . {Acoustic wave CVD}
- C23C 16/4417 . . {Methods specially adapted for coating powder}
- C23C 16/4418 . . {Methods for making free-standing articles ([C23C 16/01 takes precedence](#))}
- C23C 16/442 . . using fluidised bed process
- C23C 16/448 . . characterised by the method used for generating reactive gas streams, e.g. by evaporation or sublimation of precursor materials
- C23C 16/4481 . . . {by evaporation using carrier gas in contact with the source material ([C23C 16/4486 takes precedence](#))}
- C23C 16/4482 {by bubbling of carrier gas through liquid source material}
- C23C 16/4483 {using a porous body}
- C23C 16/4485 . . . {by evaporation without using carrier gas in contact with the source material ([C23C 16/4486 takes precedence](#))}
- C23C 16/4486 . . . {by producing an aerosol and subsequent evaporation of the droplets or particles}
- C23C 16/4487 . . . {by using a condenser}
- C23C 16/4488 . . . {by in situ generation of reactive gas by chemical or electrochemical reaction}
- C23C 16/452 . . . by activating reactive gas streams before {their} introduction into the reaction chamber, e.g. by {ionisation} or addition of reactive species
- C23C 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](#))
- C23C 16/455 . . characterised by the method used for introducing gases into reaction chamber or for modifying gas flows in reaction chamber
- C23C 16/45502 . . . {Flow conditions in reaction chamber}

C23C 16/45504	. . . .	{Laminar flow}
C23C 16/45506	. . . .	{Turbulent flow}
C23C 16/45508	. . . .	{Radial flow}
C23C 16/4551	. . . .	{Jet streams}
C23C 16/45512	. . .	{Premixing before introduction in the reaction chamber}
C23C 16/45514	. . .	{Mixing in close vicinity to the substrate}
C23C 16/45517	. . .	{Confinement of gases to vicinity of substrate}
C23C 16/45519	. . .	{Inert gas curtains}
C23C 16/45521	. . . .	{the gas, other than thermal contact gas, being introduced the rear of the substrate to flow around its periphery}
C23C 16/45523	. . .	{Pulsed gas flow or change of composition over time}
C23C 16/45525	. . . .	{Atomic layer deposition [ALD]}
C23C 16/45527	. . . . .	{characterized by the ALD cycle, e.g. different flows or temperatures during half-reactions, unusual pulsing sequence, use of precursor mixtures or auxiliary reactants or activations}
C23C 16/45529	. . . . .	{specially adapted for making a layer stack of alternating different compositions or gradient compositions}
C23C 16/45531	. . . . .	{specially adapted for making ternary or higher compositions}
C23C 16/45534	. . . . .	{Use of auxiliary reactants other than used for contributing to the composition of the main film, e.g. catalysts, activators or scavengers}
C23C 16/45536	. . . . .	{Use of plasma, radiation or electromagnetic fields}
C23C 16/45538	. . . . .	{Plasma being used continuously during the ALD cycle}
C23C 16/4554	. . . . .	{Plasma being used non-continuously in between ALD reactions (C23C 16/56 takes precedence)}
C23C 16/45542	. . . . .	{Plasma being used non-continuously during the ALD reactions}
C23C 16/45544	. . . . .	{characterized by the apparatus}
C23C 16/45546	. . . . .	{specially adapted for a substrate stack in the ALD reactor}
C23C 16/45548	. . . . .	{having arrangements for gas injection at different locations of the reactor for each ALD half-reaction}
C23C 16/45551	. . . . .	{for relative movement of the substrate and the gas injectors or half-reaction reactor compartments}
C23C 16/45553	. . . . .	{characterized by the use of precursors specially adapted for ALD}
C23C 16/45555	. . . . .	{applied in non-semiconductor technology}
C23C 16/45557	. . .	{Pulsed pressure or control pressure}
C23C 16/45559	. . .	{Diffusion of reactive gas to substrate}
C23C 16/45561	. . .	{Gas plumbing upstream of the reaction chamber}
C23C 16/45563	. . .	{Gas nozzles}
C23C 16/45565	. . . .	{Shower nozzles}
C23C 16/45568	. . . .	{Porous nozzles}
C23C 16/4557	. . . .	{Heated nozzles}
C23C 16/45572	. . . .	{Cooled nozzles}

- C23C 16/45574 {Nozzles for more than one gas}
- C23C 16/45576 {Coaxial inlets for each gas}
- C23C 16/45578 {Elongated nozzles, tubes with holes}
- C23C 16/4558 {Perforated rings}
- C23C 16/45582 . . . {Expansion of gas before it reaches the substrate}
- C23C 16/45585 . . . {Compression of gas before it reaches the substrate}
- C23C 16/45587 . . . {Mechanical means for changing the gas flow}
- C23C 16/45589 {Movable means, e.g. fans}
- C23C 16/45591 {Fixed means, e.g. wings, baffles}
- C23C 16/45593 . . . {Recirculation of reactive gases}
- C23C 16/45595 . . . {Atmospheric CVD gas inlets with no enclosed reaction chamber}
- C23C 16/45597 . . . {Reactive back side gas}
- C23C 16/458 . . characterised by the method used for supporting substrates in the reaction chamber
- C23C 16/4581 . . . {characterised by material of construction or surface finish of the means for supporting the substrate}
- C23C 16/4582 . . . {Rigid and flat substrates, e.g. plates or discs ([C23C 16/4581](#) takes precedence)}
- C23C 16/4583 {the substrate being supported substantially horizontally}
- C23C 16/4584 {the substrate being rotated}
- C23C 16/4585 {Devices at or outside the perimeter of the substrate support, e.g. clamping rings, shrouds}
- C23C 16/4586 {Elements in the interior of the support, e.g. electrodes, heating or cooling devices}
- C23C 16/4587 {the substrate being supported substantially vertically}
- C23C 16/4588 {the substrate being rotated}
- C23C 16/46 . . characterised by the method used for heating the substrate ([C23C 16/48](#), [C23C 16/50](#) take precedence)
- C23C 16/463 . . . {Cooling of the substrate}
- C23C 16/466 {using thermal contact gas}
- C23C 16/48 . . by irradiation, e.g. photolysis, radiolysis, particle radiation
- C23C 16/481 . . . {by radiant heating of the substrate}
- C23C 16/482 . . . {using incoherent light, UV to IR, e.g. lamps}
- C23C 16/483 . . . {using coherent light, UV to IR, e.g. lasers}
- C23C 16/484 . . . {using X-ray radiation}
- C23C 16/485 . . . {using synchrotron radiation}
- C23C 16/486 . . . {using ion beam radiation}
- C23C 16/487 . . . {using electron radiation}
- C23C 16/488 . . . {Protection of windows for introduction of radiation into the coating chamber}
- C23C 16/50 . . using electric discharges {(generation and control of plasma in discharge tubes for surface treatment [H01J 37/32](#), [H01J 37/34](#))}

- C23C 16/503 . . . using dc or ac discharges
- C23C 16/505 . . . using radio frequency discharges
- C23C 16/507 using external electrodes, e.g. in tunnel type reactors
- C23C 16/509 using internal electrodes
- C23C 16/5093 {Coaxial electrodes}
- C23C 16/5096 {Flat-bed apparatus}
- C23C 16/511 . . . using microwave discharges
- C23C 16/513 . . . using plasma jets
- C23C 16/515 . . . using pulsed discharges
- C23C 16/517 . . . using a combination of discharges covered by two or more of groups [C23C 16/503](#) to [C23C 16/515](#)
- C23C 16/52 . . Controlling or regulating the coating process ({[C23C 16/45557](#), [C23C 16/279](#) take precedence }; controlling or regulating in general [G05](#))
- C23C 16/54 . . Apparatus specially adapted for continuous coating
- C23C 16/545 . . . {for coating elongated substrates}
- C23C 16/56 . After-treatment

C23C 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

NOTE

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

- C23C 18/02 . by thermal decomposition
- C23C 18/04 . . Pre-treatment of the material to be coated ([C23C 18/06](#) takes precedence)
- C23C 18/06 . . Coating on selected surface areas, e.g. using masks
- C23C 18/08 . . characterised by the deposition of metallic material
- C23C 18/10 . . . Deposition of aluminium only
- C23C 18/12 . . characterised by the deposition of inorganic material other than metallic material

WARNING

Groups [C23C 18/1204](#) to [C23C 18/1295](#) are not complete pending a reorganisation. See also this group

- C23C 18/1204 . . . {inorganic material, e.g. non-oxide and non-metallic such as sulfides, nitrides based compounds}
- C23C 18/1208 {Oxides, e.g. ceramics}
- C23C 18/1212 {Zeolites, glasses}
- C23C 18/1216 {Metal oxides ([C23C 18/1212](#) takes precedence)}
- C23C 18/122 {Inorganic polymers, e.g. silanes, polysilazanes, polysiloxanes}
- C23C 18/1225 . . . {Deposition of multilayers of inorganic material}
- C23C 18/1229 . . . {Composition of the substrate}

C23C 18/1233	. . . . {Organic substrates}
C23C 18/1237	. . . . . {Composite substrates, e.g. laminated, premixed}
C23C 18/1241	. . . . {Metallic substrates}
C23C 18/1245	. . . . {Inorganic substrates other than metallic}
C23C 18/125	. . . {Process of deposition of the inorganic material}
C23C 18/1254	. . . . {Sol or sol-gel processing}
C23C 18/1258	. . . . {Spray pyrolysis}
C23C 18/1262	. . . . {involving particles, e.g. carbon nanotubes [CNT], flakes}
C23C 18/1266	. . . . . {Particles formed in situ}
C23C 18/127	. . . . . {Preformed particles}
C23C 18/1275	. . . . {performed under inert atmosphere}
C23C 18/1279	. . . . {performed under reactive atmosphere, e.g. oxidising or reducing atmospheres}
C23C 18/1283	. . . . {Control of temperature, e.g. gradual temperature increase, modulation of temperature}
C23C 18/1287	. . . . {with flow inducing means, e.g. ultrasonic}
C23C 18/1291	. . . . {by heating of the substrate}
C23C 18/1295	. . . . {with after-treatment of the deposited inorganic material}
C23C 18/14	. Decomposition by irradiation, e.g. photolysis, particle radiation
C23C 18/16	. by reduction or substitution, e.g. electroless plating (C23C 18/54 takes precedence)
C23C 18/1601	. . {Process or apparatus}
C23C 18/1603	. . . {coating on selected surface areas}
C23C 18/1605	. . . . {by masking}

WARNING

the groups [C23C 18/1605](#) to [C23C 18/1616](#) are not complete, pending reorganisation. See also [C23C 18/1603](#)

C23C 18/1607	. . . . {by direct patterning}
C23C 18/1608	. . . . . {from pretreatment step, i.e. selective pre-treatment}
C23C 18/161	. . . . . {from plating step, e.g. inkjet}
C23C 18/1612	. . . . . {through irradiation means}
C23C 18/1614	. . . . {plating on one side}
C23C 18/1616	. . . . . {interior or inner surface}
C23C 18/1617	. . . {Purification and regeneration of coating baths}
C23C 18/1619	. . . {Apparatus for electroless plating}

WARNING

the groups [C23C 18/1619](#) to [C23C 18/1698](#) are not complete, pending reorganisation. See also [C23C 18/1601](#)

C23C 18/1621	. . . . {Protection of inner surfaces of the apparatus}
C23C 18/1623	. . . . . {through electrochemical processes}

C23C 18/1625	. . . . .	{through chemical processes}
C23C 18/1626	. . . . .	{through mechanical processes}
C23C 18/1628	. . . . .	{Specific elements or parts of the apparatus}
C23C 18/163	. . . . .	{Supporting devices for articles to be coated}
C23C 18/1632	. . . . .	{Features specific for the apparatus, e.g. layout of cells and of its equipment, multiple cells}
C23C 18/1633	. . . . .	{Process of electroless plating}
C23C 18/1635	. . . . .	{Composition of the substrate}
C23C 18/1637	. . . . .	{metallic substrate}
C23C 18/1639	. . . . .	{Substrates other than metallic, e.g. inorganic or organic or non-conductive}
C23C 18/1641	. . . . .	{Organic substrates, e.g. resin, plastic}
C23C 18/1642	. . . . .	{semiconductor (semiconductor H01L 21/288)}
C23C 18/1644	. . . . .	{porous substrates}
C23C 18/1646	. . . . .	{Characteristics of the product obtained}
C23C 18/1648	. . . . .	{Porous product}
C23C 18/165	. . . . .	{Multilayered product (layered product B32B)}
C23C 18/1651	. . . . .	{Two or more layers only obtained by electroless plating}
C23C 18/1653	. . . . .	{Two or more layers with at least one layer obtained by electroless plating and one layer obtained by electroplating}
C23C 18/1655	. . . . .	{Process features}
C23C 18/1657	. . . . .	{Electroless forming, i.e. substrate removed or destroyed at the end of the process}
C23C 18/1658	. . . . .	{with two steps starting with metal deposition followed by addition of reducing agent}
C23C 18/166	. . . . .	{with two steps starting with addition of reducing agent followed by metal deposition}
C23C 18/1662	. . . . .	{Use of incorporated material in the solution or dispersion, e.g. particles, whiskers, wires}
C23C 18/1664	. . . . .	{with additional means during the plating process}
C23C 18/1666	. . . . .	{Ultrasonics}
C23C 18/1667	. . . . .	{Radiant energy, e.g. laser}
C23C 18/1669	. . . . .	{Agitation, e. g. air introduction}
C23C 18/1671	. . . . .	{Electric field}
C23C 18/1673	. . . . .	{Magnetic field}
C23C 18/1675	. . . . .	{Process conditions}
C23C 18/1676	. . . . .	{Heating of the solution}
C23C 18/1678	. . . . .	{Heating of the substrate}
C23C 18/168	. . . . .	{Control of temperature, e.g. temperature of bath, substrate}
C23C 18/1682	. . . . .	{Control of atmosphere}
C23C 18/1683	. . . . .	{Control of electrolyte composition, e.g. measurement, adjustment (regeneration of bath C23C 18/1617)}

C23C 18/1685	. . . . .	{with supercritical condition, e.g. chemical fluid deposition}
C23C 18/1687	. . . . .	{with ionic liquid}
C23C 18/1689	. . . . .	{After-treatment}
C23C 18/1691	. . . . .	{Cooling, e.g. forced or controlled cooling}
C23C 18/1692	. . . . .	{Heat-treatment}
C23C 18/1694	. . . . .	{Sequential heat treatment}
C23C 18/1696	. . . . .	{Control of atmosphere}
C23C 18/1698	. . . . .	{Control of temperature}
C23C 18/18	. .	Pre-treatment of the material to be coated
C23C 18/1803	. . .	{of metallic material surfaces or of a non-specific material surfaces}

WARNING

the groups [C23C 18/1803](#) to [C23C 18/1848](#) are not complete, pending reorganisation. See also [C23C 18/18](#)

C23C 18/1806	. . . . .	{by mechanical pretreatment, e.g. grinding, sanding}
C23C 18/181	. . . . .	{by formation of electrostatic charges, e.g. tribofriction}
C23C 18/1813	. . . . .	{by radiant energy}
C23C 18/1817	. . . . .	{Heat}
C23C 18/182	. . . . .	{Radiation, e.g. UV, laser}
C23C 18/1824	. . . . .	{by chemical pretreatment}
C23C 18/1827	. . . . .	{only one step pretreatment}
C23C 18/1831	. . . . .	{Use of metal, e.g. activation, sensitisation with noble metals}
C23C 18/1834	. . . . .	{Use of organic or inorganic compounds other than metals, e.g. activation, sensitisation with polymers}
C23C 18/1837	. . . . .	{Multistep pretreatment}
C23C 18/1841	. . . . .	{with use of metal first}
C23C 18/1844	. . . . .	{with use of organic or inorganic compounds other than metals, first}
C23C 18/1848	. . . . .	{by electrochemical pretreatment}
C23C 18/1851	. . .	{of surfaces of non-metallic or semiconducting in organic material}
C23C 18/1855	. . . . .	{by mechanical pretreatment, e.g. grinding, sanding}

WARNING

the groups [C23C 18/1855](#) to [C23C 18/1896](#) are not complete, pending reorganisation. See also [C23C 18/18](#)

C23C 18/1858	. . . . .	{by formation of electrostatic charges, e.g. tribofriction}
C23C 18/1862	. . . . .	{by radiant energy}
C23C 18/1865	. . . . .	{Heat}
C23C 18/1868	. . . . .	{Radiation, e.g. UV, laser}
C23C 18/1872	. . . . .	{by chemical pretreatment}
C23C 18/1875	. . . . .	{only one step pretreatment}
C23C 18/1879	. . . . .	{Use of metal, e.g. activation, sensitisation with noble metals}

C23C 18/1882	. . . . .	{Use of organic or inorganic compounds other than metals, e.g. activation, sensitisation with polymers}
C23C 18/1886	. . . . .	{Multistep pretreatment}
C23C 18/1889	. . . . .	{with use of metal first}
C23C 18/1893	. . . . .	{with use of organic or inorganic compounds other than metals, first}
C23C 18/1896	. . . . .	{by electrochemical pretreatment}
C23C 18/20	. . . . .	of organic surfaces, e.g. resins
C23C 18/2006	. . . . .	{by other methods than those of C23C 18/22 to C23C 18/30 }
C23C 18/2013	. . . . .	{by mechanical pretreatment, e.g. grinding, sanding}

WARNING

the groups [C23C 18/2013](#) to [C23C 18/2093](#) are not complete, pending reorganisation. See also [C23C 18/2006](#)

C23C 18/202	. . . . .	{by formation of electrostatic charges, e.g. tribofriction}
C23C 18/2026	. . . . .	{by radiant energy}
C23C 18/2033	. . . . .	{Heat}
C23C 18/204	. . . . .	{Radiation, e.g. UV, laser}
C23C 18/2046	. . . . .	{by chemical pretreatment}
C23C 18/2053	. . . . .	{only one step pretreatment}
C23C 18/206	. . . . .	{Use of metal other than noble metals and tin, e.g. activation, sensitisation with metals (Sensitising with tin C23C 18/285 , sensitising with noble metals C23C 18/30)}
C23C 18/2066	. . . . .	{Use of organic or inorganic compounds other than metals, e.g. activation, sensitisation with polymers}
C23C 18/2073	. . . . .	{Multistep pretreatment}
C23C 18/208	. . . . .	{with use of metal first}
C23C 18/2086	. . . . .	{with use of organic or inorganic compounds other than metals, first}
C23C 18/2093	. . . . .	{by electrochemical pretreatment}
C23C 18/22	. . . . .	Roughening, e.g. by etching
C23C 18/24	. . . . .	using acid aqueous solutions
C23C 18/26	. . . . .	using organic liquids
C23C 18/28	. . . . .	Sensitising or activating {(not used, see subgroups)}
C23C 18/285	. . . . .	{Sensitising or activating with tin based compound or composition}
C23C 18/30	. . . . .	Activating {or accelerating or sensitising with palladium or other noble metal}
C23C 18/31	. . . . .	Coating with metals
C23C 18/32	. . . . .	Coating with nickel, cobalt or mixtures thereof with phosphorus or boron (C23C 18/50 takes precedence)
C23C 18/34	. . . . .	using reducing agents
C23C 18/36	. . . . .	using hypophosphites
C23C 18/38	. . . . .	Coating with copper

- C23C 18/40 using reducing agents
- C23C 18/405 {Formaldehyde}
- C23C 18/42 Coating with noble metals
- C23C 18/44 using reducing agents
- C23C 18/48 Coating with alloys
- C23C 18/50 with alloys based on iron, cobalt or nickel
- C23C 18/52 using reducing agents for coating with metallic material not provided for in a single one of groups [C23C 18/32](#) to [C23C 18/50](#)
- C23C 18/54 Contact plating, i.e. electroless electrochemical plating

C23C 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](#))

NOTE

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

- C23C 20/02 Coating with metallic material
- C23C 20/04 with metals
- C23C 20/06 Coating with inorganic material, other than metallic material
- C23C 20/08 with compounds, mixtures or solid solutions, e.g. borides, carbides, nitrides

Chemical surface treatment of metallic material by reaction of the surface with a reactive medium (with a reactive gas [C23C 8/00](#))

C23C 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](#))

NOTES

1. This group covers also suspensions containing reactive liquids and non-reactive solid particles.
2. In groups [C23C 22/02](#) to [C23C 22/86](#), in the absence of an indication to the contrary, classification is made in the last appropriate place.
3. Rejuvenating of the bath is classified in the appropriate place for the specific bath composition.

- C23C 22/02 using non-aqueous solutions
- C23C 22/03 containing phosphorus compounds
- C23C 22/04 containing hexavalent chromium compounds
- C23C 22/05 using aqueous solutions
- C23C 22/06 using aqueous acidic solutions with pH less than 6
- C23C 22/07 containing phosphates
- C23C 22/08 Orthophosphates

C23C 22/10	. . . . .	containing oxidants
C23C 22/12	. . . . .	containing zinc cations
C23C 22/13	. . . . .	containing also nitrate or nitrite anions
C23C 22/14	. . . . .	containing also chlorate anions
C23C 22/16	. . . . .	containing also peroxy-compounds
C23C 22/17	. . . . .	containing also organic acids
C23C 22/18	. . . . .	containing manganese cations
C23C 22/182	. . . . .	{containing also zinc cations}
C23C 22/184	. . . . .	{containing also nickel cations}
C23C 22/186	. . . . .	{containing also copper cations}
C23C 22/188	. . . . .	{containing also magnesium cations}
C23C 22/20	. . . . .	containing aluminium cations
C23C 22/22	. . . . .	containing alkaline earth metal cations
C23C 22/23	. . . . .	Condensed phosphates
C23C 22/24	. . . . .	containing hexavalent chromium compounds
C23C 22/26	. . . . .	containing also organic compounds
C23C 22/27	. . . . .	Acids
C23C 22/28	. . . . .	Macromolecular compounds
C23C 22/30	. . . . .	containing also trivalent chromium
C23C 22/32	. . . . .	containing also pulverulent metals
C23C 22/33	. . . . .	containing also phosphates
C23C 22/34	. . . . .	containing fluorides or complex fluorides
C23C 22/36	. . . . .	containing also phosphates
C23C 22/361	. . . . .	{containing titanium, zirconium or hafnium compounds}
C23C 22/362	. . . . .	{containing also zinc cations}
C23C 22/364	. . . . .	{containing also manganese cations}
C23C 22/365	. . . . .	{containing also zinc and nickel cations}
C23C 22/367	. . . . .	{containing alkaline earth metal cations}
C23C 22/368	. . . . .	{containing magnesium cations}
C23C 22/37	. . . . .	containing also hexavalent chromium compounds
C23C 22/38	. . . . .	containing also phosphates
C23C 22/40	. . . . .	containing molybdates, tungstates or vanadates
C23C 22/42	. . . . .	containing also phosphates
C23C 22/43	. . . . .	containing also hexavalent chromium compounds
C23C 22/44	. . . . .	containing also fluorides or complex fluorides
C23C 22/46	. . . . .	containing oxalates
C23C 22/47	. . . . .	containing also phosphates
C23C 22/48	. . . . .	not containing phosphates, hexavalent chromium compounds, fluorides or complex fluorides, molybdates, tungstates, vanadates or oxalates
C23C 22/50	. . . . .	Treatment of iron or alloys based thereon

- C23C 22/52 Treatment of copper or alloys based thereon
- C23C 22/53 Treatment of zinc or alloys based thereon
- C23C 22/54 Treatment of refractory metals or alloys based thereon
- C23C 22/56 Treatment of aluminium or alloys based thereon
- C23C 22/57 Treatment of magnesium or alloys based thereon
- C23C 22/58 Treatment of other metallic material
- C23C 22/60 . . using alkaline aqueous solutions with pH greater than 8
- C23C 22/62 . . . Treatment of iron or alloys based thereon
- C23C 22/63 . . . Treatment of copper or alloys based thereon
- C23C 22/64 . . . Treatment of refractory metals or alloys based thereon
- C23C 22/66 . . . Treatment of aluminium or alloys based thereon
- C23C 22/67 with solutions containing hexavalent chromium
- C23C 22/68 . . using aqueous solutions with pH between 6 and 8
- C23C 22/70 . using melts
- C23C 22/72 . . Treatment of iron or alloys based thereon
- C23C 22/73 . characterised by the process
- C23C 22/74 . . for obtaining burned-in conversion coatings
- C23C 22/76 . . Applying the liquid by spraying
- C23C 22/77 . . Controlling or regulating of the coating process ([controlling or regulating in general G05](#))
- C23C 22/78 . Pre-treatment of the material to be coated
- C23C 22/80 . . with solutions containing titanium or zirconium compounds
- C23C 22/82 . After-treatment
- C23C 22/83 . . Chemical after-treatment
- C23C 22/84 . . Dyeing
- C23C 22/86 . Regeneration of coating baths
-
- C23C 24/00** **Coating starting from inorganic powder** ([spraying of the coating material in molten state C23C 4/00](#); [solid state diffusion C23C 8/00 to C23C 12/00](#); [manufacture of composite layers, workpieces or articles by sintering metallic powder B22F 7/00](#); [friction welding B23K 20/12](#))
- C23C 24/02 . by application of pressure only
- C23C 24/04 . . Impact or kinetic deposition of particles
- C23C 24/045 . . . {[by trembling using impacting inert media](#)}
- C23C 24/06 . . Compressing powdered coating material, e.g. by milling
- C23C 24/08 . by application of heat or pressure and heat ([C23C 24/04 takes precedence](#))
- C23C 24/082 . . {[without intermediate formation of a liquid in the layer](#)}
- C23C 24/085 . . . {[Coating with metallic material, i.e. metals or metal alloys, optionally comprising hard particles, e.g. oxides, carbides or nitrides](#)}
- C23C 24/087 {[Coating with metal alloys or metal elements only](#)}
- C23C 24/10 . . with intermediate formation of a liquid phase in the layer

C23C 24/103 . . . {Coating with metallic material, i.e. metals or metal alloys, optionally comprising hard particles, e.g. oxides, carbides or nitrides}

C23C 24/106 {Coating with metal alloys or metal elements only}

C23C 26/00 Coating not provided for in groups **C23C 2/00** to **C23C 24/00**

C23C 26/02 . applying molten material to the substrate (applying melts to surfaces, in general [B05](#))

C23C 28/00 Coating for obtaining at least two superposed coatings either by methods not provided for in a single one of groups **C23C 2/00** to **C23C 26/00** or by combinations of methods provided for in subclasses **C23C** and **C25C** or **C25D**

C23C 28/02 . only coatings {only including layers} of metallic material

C23C 28/021 . . {including at least one metal alloy layer}

C23C 28/022 . . . {with at least one MCrAlX layer}

C23C 28/023 . . {only coatings of metal elements only}

C23C 28/025 . . . {with at least one zinc-based layer}

C23C 28/026 . . {including at least one amorphous metallic material layer}

C23C 28/027 . . {including at least one metal matrix material comprising a mixture of at least two metals or metal phases or metal matrix composites, e.g. metal matrix with embedded inorganic hard particles, CERMET, MMC.}

C23C 28/028 . . {Including graded layers in composition or in physical properties, e.g. density, porosity, grain size}

C23C 28/04 . only coatings of inorganic non-metallic material

C23C 28/042 . . {including a refractory ceramic layer, e.g. refractory metal oxides, ZrO₂, rare earth oxides}

C23C 28/044 . . {coatings specially adapted for cutting tools or wear applications.}

C23C 28/046 . . {with at least one amorphous inorganic material layer, e.g. DLC, a-C:H, a-C:Me, the layer being doped or not}

C23C 28/048 . . {with layers graded in composition or physical properties}

C23C 28/30 . {Coatings combining at least one metallic layer and at least one inorganic non-metallic layer}

C23C 28/32 . . {including at least one pure metallic layer}

C23C 28/321 . . . {with at least one metal alloy layer}

C23C 28/3215 {at least one MCrAlX layer}

C23C 28/322 . . . {only coatings of metal elements only}

C23C 28/3225 {with at least one zinc-based layer}

C23C 28/323 . . . {with at least one amorphous metallic material layer}

C23C 28/324 . . . {with at least one metal matrix material layer comprising a mixture of at least two metals or metal phases or a metal-matrix material with hard embedded particles, e.g. WC-Me}

C23C 28/325 . . . {with layers graded in composition or in physical properties}

C23C 28/34 . . {including at least one inorganic non-metallic material layer, e.g. metal carbide, nitride, boride, silicide layer and their mixtures, enamels, phosphates and sulphates}

- C23C 28/341 . . . {with at least one carbide layer}
 - C23C 28/343 . . . {with at least one DLC or an amorphous carbon based layer, the layer being doped or not}
 - C23C 28/345 . . . {with at least one oxide layer}
 - C23C 28/3455 {with a refractory ceramic layer, e.g. refractory metal oxide, ZrO_2 , rare earth oxides or a thermal barrier system comprising at least one refractory oxide layer}
 - C23C 28/347 . . . {with layers adapted for cutting tools or wear applications}
 - C23C 28/36 . . {including layers graded in composition or physical properties}
 - C23C 28/40 . {Coatings including alternating layers following a pattern, a periodic or defined repetition}
 - C23C 28/42 . . {characterized by the composition of the alternating layers}
 - C23C 28/44 . . {characterized by a measurable physical property of the alternating layer or system, e.g. thickness, density, hardness}
 - C23C 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)**
 - C23C 30/005 . {on hard metal substrates}
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- C23C 2222/00** **Aspects relating to chemical surface treatment of metallic material by reaction of the surface with a reactive medium**
 - C23C 2222/10 . Use of solutions containing trivalent chromium but free of hexavalent chromium
 - C23C 2222/20 . Use of solutions containing silanes