

# CPC COOPERATIVE PATENT CLASSIFICATION

## H ELECTRICITY

(NOTE omitted)

### H10 SEMICONDUCTOR DEVICES; ELECTRIC SOLID-STATE DEVICES NOT OTHERWISE PROVIDED FOR

#### H10N ELECTRIC SOLID-STATE DEVICES NOT OTHERWISE PROVIDED FOR

##### NOTE

In this subclass, the periodic system used is the I to VIII group system indicated in the Periodic Table under Note (3) of section [C](#).

##### Thermoelectric or thermomagnetic devices

**10/00** Thermoelectric devices comprising a junction of dissimilar materials, i.e. devices exhibiting Seebeck or Peltier effects (integrated devices or assemblies of multiple devices [H10N 19/00](#))

- 10/01 . Manufacture or treatment
- 10/10 . operating with only the Peltier or Seebeck effects
- 10/13 . . characterised by the heat-exchanging means at the junction
- 10/17 . . characterised by the structure or configuration of the cell or thermocouple forming the device
- 10/80 . Constructional details
- 10/81 . . Structural details of the junction
- 10/813 . . . the junction being separable, e.g. using a spring
- 10/817 . . . the junction being non-separable, e.g. being cemented, sintered or soldered
- 10/82 . . Interconnections
- 10/85 . . Thermoelectric active materials
- 10/851 . . . comprising inorganic compositions
- 10/852 . . . . comprising tellurium, selenium or sulfur
- 10/853 . . . . comprising arsenic, antimony or bismuth ([H10N 10/852](#) takes precedence)
- 10/854 . . . . comprising only metals ([H10N 10/852](#), [H10N 10/853](#) take precedence)
- 10/855 . . . . comprising compounds containing boron, carbon, oxygen or nitrogen
- 10/8552 . . . . . {the compounds being superconducting}
- 10/8556 . . . . . {comprising compounds containing germanium or silicon}
- 10/856 . . . comprising organic compositions
- 10/857 . . . comprising compositions changing continuously or discontinuously inside the material

**15/00** Thermoelectric devices without a junction of dissimilar materials; Thermomagnetic devices, e.g. using the Nernst-Ettingshausen effect (integrated devices or assemblies of multiple devices [H10N 19/00](#))

- 15/10 . Thermoelectric devices using thermal change of the dielectric constant, e.g. working above and below the Curie point
- 15/15 . . {Thermoelectric active materials}

- 15/20 . Thermomagnetic devices using thermal change of the magnetic permeability, e.g. working above and below the Curie point

**19/00** Integrated devices, or assemblies of multiple devices, comprising at least one thermoelectric or thermomagnetic element covered by groups [H10N 10/00](#) - [H10N 15/00](#)

- 19/101 . {Multiple thermocouples connected in a cascade arrangement}

##### Piezoelectric, electrostrictive or magnetostrictive devices

**30/00** Piezoelectric or electrostrictive devices (integrated devices or assemblies of multiple devices [H10N 39/00](#))

- 30/01 . Manufacture or treatment
- 30/02 . . Forming enclosures or casings
- 30/03 . . Assembling devices that include piezoelectric or electrostrictive parts
- 30/04 . . Treatments to modify a piezoelectric or electrostrictive property, e.g. polarisation characteristics, vibration characteristics or mode tuning
- 30/045 . . . by polarising
- 30/05 . . Manufacture of multilayered piezoelectric or electrostrictive devices, or parts thereof, e.g. by stacking piezoelectric bodies and electrodes
- 30/053 . . . by integrally sintering piezoelectric or electrostrictive bodies and electrodes
- 30/057 . . . by stacking bulk piezoelectric or electrostrictive bodies and electrodes
- 30/06 . . Forming electrodes or interconnections, e.g. leads or terminals
- 30/063 . . . Forming interconnections, e.g. connection electrodes of multilayered piezoelectric or electrostrictive parts
- 30/067 . . . Forming single-layered electrodes of multilayered piezoelectric or electrostrictive parts
- 30/07 . . Forming of piezoelectric or electrostrictive parts or bodies on an electrical element or another base
- 30/071 . . . Mounting of piezoelectric or electrostrictive parts together with semiconductor elements, or other circuit elements, on a common substrate
- 30/072 . . . by laminating or bonding of piezoelectric or electrostrictive bodies
- 30/073 . . . . by fusion of metals or by adhesives

- 30/074 . . . by depositing piezoelectric or electrostrictive layers, e.g. aerosol or screen printing
- 30/076 . . . . by vapour phase deposition
- 30/077 . . . . by liquid phase deposition
- 30/078 . . . . . by sol-gel deposition
- 30/079 . . . . using intermediate layers, e.g. for growth control
- 30/08 . . Shaping or machining of piezoelectric or electrostrictive bodies
- 30/081 . . . by coating or depositing using masks, e.g. lift-off
- 30/082 . . . by etching, e.g. lithography
- 30/084 . . . by moulding or extrusion
- 30/085 . . . by machining
- 30/086 . . . . by polishing or grinding
- 30/088 . . . . by cutting or dicing
- 30/089 . . . . by punching
- 30/09 . . Forming piezoelectric or electrostrictive materials
- 30/092 . . . Forming composite materials
- 30/093 . . . Forming inorganic materials
- 30/095 . . . . by melting
- 30/097 . . . . by sintering
- 30/098 . . . Forming organic materials
- 30/101 . {with electrical and mechanical input and output, e.g. having combined actuator and sensor parts}
- 30/20 . with electrical input and mechanical output, e.g. functioning as actuators or vibrators
- 30/202 . . {using longitudinal or thickness displacement combined with bending, shear or torsion displacement}
- 30/2023 . . . {having polygonal or rectangular shape}
- 30/2027 . . . {having cylindrical or annular shape}
- 30/204 . . {using bending displacement, e.g. unimorph, bimorph or multimorph cantilever or membrane benders}
- 30/2041 . . . {Beam type}
- 30/2042 . . . . {Cantilevers, i.e. having one fixed end}
- 30/2043 . . . . . {connected at their free ends, e.g. parallelogram type}
- 30/2044 . . . . . {having multiple segments mechanically connected in series, e.g. zig-zag type}
- 30/2045 . . . . . {adapted for in-plane bending displacement}
- 30/2046 . . . . . {adapted for multi-directional bending displacement}
- 30/2047 . . . {Membrane type}
- 30/2048 . . . . {having non-planar shape}
- 30/206 . . {using only longitudinal or thickness displacement, e.g.  $d_{33}$  or  $d_{31}$  type devices}
- 30/208 . . {using shear or torsion displacement, e.g.  $d_{15}$  type devices}
- 30/30 . with mechanical input and electrical output, e.g. functioning as generators or sensors
- 30/302 . . {Sensors}
- 30/304 . . {Beam type}
- 30/306 . . . {Cantilevers}
- 30/308 . . {Membrane type}
- 30/40 . with electrical input and electrical output, e.g. functioning as transformers
- 30/50 . having a stacked or multilayer structure
- 30/501 . . {having a non-rectangular cross-section in a plane parallel to the stacking direction, e.g. polygonal or trapezoidal in side view}
- 30/503 . . {having a non-rectangular cross-section in a plane orthogonal to the stacking direction, e.g. polygonal or circular in top view}
- 30/505 . . . {the cross-section being annular}
- 30/506 . . {having a cylindrical shape and having stacking in the radial direction, e.g. coaxial or spiral type rolls}
- 30/508 . . {adapted for alleviating internal stress, e.g. cracking control layers}
- 30/60 . having a coaxial cable structure
- 30/702 . {based on piezoelectric or electrostrictive fibres}
- 30/704 . {based on piezoelectric or electrostrictive films or coatings}
- 30/706 . . {characterised by the underlying bases, e.g. substrates}
- 30/708 . . . {Intermediate layers, e.g. barrier, adhesion or growth control buffer layers}
- 30/80 . Constructional details
- 30/802 . . {Circuitry or processes for operating piezoelectric or electrostrictive devices not otherwise provided for, e.g. drive circuits}
- 30/804 . . . {for piezoelectric transformers}
- 30/85 . . Piezoelectric or electrostrictive active materials
- 30/852 . . . {Composite materials, e.g. having 1-3 or 2-2 type connectivity}
- 30/853 . . . Ceramic compositions
- 30/8536 . . . . {Alkaline earth metal based oxides, e.g. barium titanates}
- 30/8542 . . . . {Alkali metal based oxides, e.g. lithium, sodium or potassium niobates}
- 30/8548 . . . . {Lead-based oxides}
- 30/8554 . . . . . {Lead-zirconium titanate [PZT] based}
- 30/8561 . . . . {Bismuth-based oxides}
- 30/857 . . . Macromolecular compositions
- 30/87 . . Electrodes or interconnections, e.g. leads or terminals
- 30/871 . . . {Single-layered electrodes of multilayer piezoelectric or electrostrictive devices, e.g. internal electrodes}
- 30/872 . . . {Interconnections, e.g. connection electrodes of multilayer piezoelectric or electrostrictive devices}
- 30/874 . . . . {embedded within piezoelectric or electrostrictive material, e.g. via connections}
- 30/875 . . . {Further connection or lead arrangements, e.g. flexible wiring boards, terminal pins}
- 30/877 . . . {Conductive materials}
- 30/878 . . . . {the principal material being non-metallic, e.g. oxide or carbon based}
- 30/88 . . Mounts; Supports; Enclosures; Casings
- 30/883 . . . {Additional insulation means preventing electrical, physical or chemical damage, e.g. protective coatings}
- 30/886 . . . {Additional mechanical prestressing means, e.g. springs}
- 35/00** **Magnetostrictive devices** (integrated devices or assemblies of multiple devices [H10N 39/00](#))
- 35/01 . Manufacture or treatment
- 35/101 . {with mechanical input and electrical output, e.g. generators, sensors}
- 35/80 . Constructional details

- 35/85 . . Magnetostrictive active materials
- 39/00** **Integrated devices, or assemblies of multiple devices, comprising at least one piezoelectric, electrostrictive or magnetostrictive element covered by groups [H10N 30/00](#) – [H10N 35/00](#)**

**Galvanomagnetic or similar magnetic-effect devices**

- 50/00** **Galvanomagnetic devices ([Hall-effect devices H10N 52/00](#); integrated devices or assemblies of multiple devices [H10N 59/00](#))**
- 50/01 . Manufacture or treatment
- 50/10 . Magnetoresistive devices
- 50/20 . Spin-polarised current-controlled devices ([magnetoresistive devices H10N 50/10](#))
- 50/80 . Constructional details
- 50/85 . . Materials of the active region
- 52/00** **Hall-effect devices ([integrated devices or assemblies of multiple devices H10N 59/00](#))**
- 52/01 . Manufacture or treatment
- 52/101 . {Semiconductor Hall-effect devices}
- 52/80 . Constructional details
- 52/85 . . Materials of the active region
- 59/00** **Integrated devices, or assemblies of multiple devices, comprising at least one galvanomagnetic or Hall-effect element covered by groups [H10N 50/00](#) - [H10N 52/00](#) (MRAM devices [H10B 61/00](#))**

**Superconducting devices**

- 60/00** **Superconducting devices ([integrated devices or assemblies of multiple devices H10N 69/00](#))**
- 60/01 . Manufacture or treatment
- 60/0128 . . {of composite superconductor filaments ([comprising copper oxide H10N 60/0268](#))}
- 60/0156 . . {of devices comprising Nb or an alloy of Nb with one or more of the elements of group IVB, e.g. titanium, zirconium or hafnium}
- 60/0184 . . {of devices comprising intermetallic compounds of type A-15, e.g. Nb<sub>3</sub>Sn}
- 60/0212 . . {of devices comprising molybdenum chalcogenides}
- 60/0241 . . {of devices comprising nitrides or carbonitrides}
- 60/0268 . . {of devices comprising copper oxide}
- 60/0296 . . . {Processes for depositing or forming copper oxide superconductor layers}
- 60/0324 . . . . {from a solution}
- 60/0352 . . . . {from a suspension or slurry, e.g. screen printing or doctor blade casting}
- 60/0381 . . . . {by evaporation, e.g. MBE}
- 60/0408 . . . . {by sputtering}
- 60/0436 . . . . {by chemical vapour deposition [CVD]}
- 60/0464 . . . . . {by metalloorganic chemical vapour deposition [MOCVD]}
- 60/0492 . . . . {by thermal spraying, e.g. plasma deposition}
- 60/0521 . . . . {by pulsed laser deposition, e.g. laser sputtering}
- 60/0548 . . . . {by deposition and subsequent treatment, e.g. oxidation of pre-deposited material}
- 60/0576 . . . . {characterised by the substrate}

- 60/0604 . . . . . {Monocrystalline substrates, e.g. epitaxial growth}
- 60/0632 . . . . . {Intermediate layers, e.g. for growth control}
- 60/0661 . . . {Processes performed after copper oxide formation, e.g. patterning}
- 60/0688 . . . . {Etching}
- 60/0716 . . . . {Passivating}
- 60/0744 . . . {Manufacture or deposition of electrodes}
- 60/0772 . . . {Processes including the use of non-gaseous precursors}
- 60/0801 . . . {Manufacture or treatment of filaments or composite wires}
- 60/0828 . . . {Introducing flux pinning centres}
- 60/0856 . . {of devices comprising metal borides, e.g. MgB<sub>2</sub>}
- 60/0884 . . {Treatment of superconductor layers by irradiation, e.g. ion-beam, electron-beam, laser beam or X-rays}
- 60/0912 . . {of Josephson-effect devices}
- 60/0941 . . . {comprising high-T<sub>c</sub> ceramic materials}
- 60/10 . Junction-based devices
- 60/11 . . {Single-electron tunnelling devices}
- 60/12 . . Josephson-effect devices
- 60/124 . . . {comprising high-T<sub>c</sub> ceramic materials}
- 60/126 . . . {comprising metal borides, e.g. MgB<sub>2</sub>}
- 60/128 . . {having three or more electrodes, e.g. transistor-like structures}
- 60/20 . Permanent superconducting devices
- 60/202 . . {comprising metal borides, e.g. MgB<sub>2</sub>}
- 60/203 . . {comprising high-T<sub>c</sub> ceramic materials}
- 60/205 . . {having three or more electrodes, e.g. transistor-like structures ([H10N 60/128](#) takes precedence)}
- 60/207 . . . {Field effect devices}
- 60/208 . . {based on Abrikosov vortices}
- 60/30 . Devices switchable between superconducting and normal states
- 60/35 . . Cryotrons
- 60/355 . . . Power cryotrons
- 60/80 . Constructional details
- 60/805 . . {for Josephson-effect devices}
- 60/81 . . Containers; Mountings
- 60/815 . . . {for Josephson-effect devices}
- 60/82 . . Current path
- 60/83 . . Element shape
- 60/84 . . Switching means for devices switchable between superconducting and normal states
- 60/85 . . Superconducting active materials
- 60/851 . . . {Organic superconductors}
- 60/853 . . . . {Fullerene superconductors, e.g. soccer ball-shaped allotropes of carbon, e.g. C<sub>60</sub> or C<sub>94</sub>}
- 60/855 . . . {Ceramic superconductors}
- 60/857 . . . . {comprising copper oxide}
- 60/858 . . . . . {having multilayered structures, e.g. superlattices}
- 60/99 . {Alleged superconductivity}
- 69/00** **Integrated devices, or assemblies of multiple devices, comprising at least one superconducting element covered by group [H10N 60/00](#)**

**Other electric solid-state devices****70/00 Solid-state devices having no potential barriers, and specially adapted for rectifying, amplifying, oscillating or switching (integrated devices or assemblies of multiple devices [H10N 79/00](#))**

- 70/011 . {Manufacture or treatment of multistable switching devices}
- 70/021 . . {Formation of switching materials, e.g. deposition of layers}
- 70/023 . . . {by chemical vapor deposition, e.g. MOCVD, ALD}
- 70/026 . . . {by physical vapor deposition, e.g. sputtering}
- 70/028 . . . {by conversion of electrode material, e.g. oxidation}
- 70/041 . . {Modification of switching materials after formation, e.g. doping ([shaping H10N 70/061](#))}
- 70/043 . . . {by implantation}
- 70/046 . . . {by diffusion, e.g. photo-dissolution}
- 70/061 . . {Shaping switching materials}
- 70/063 . . . {by etching of pre-deposited switching material layers, e.g. lithography}
- 70/066 . . . {by filling of openings, e.g. damascene method}
- 70/068 . . . {by processes specially adapted for achieving sub-lithographic dimensions, e.g. using spacers}
- 70/10 . Solid-state travelling-wave devices
- 70/151 . {Charge density wave transport devices}
- 70/20 . Multistable switching devices, e.g. memristors
- 70/231 . . {based on solid-state phase change, e.g. between amorphous and crystalline phases, Ovshinsky effect}
- 70/235 . . . {between different crystalline phases, e.g. cubic and hexagonal}
- 70/24 . . {based on migration or redistribution of ionic species, e.g. anions, vacancies}
- 70/245 . . . {the species being metal cations, e.g. programmable metallization cells}
- 70/25 . . {based on bulk electronic defects, e.g. trapping of electrons}
- 70/253 . . {having three or more electrodes, e.g. transistor-like devices}
- 70/257 . . {having switching assisted by radiation or particle beam, e.g. optically controlled devices}
- 70/801 . {Constructional details of multistable switching devices}
- 70/821 . . {Device geometry}
- 70/823 . . . {adapted for essentially horizontal current flow, e.g. bridge type devices}
- 70/826 . . . {adapted for essentially vertical current flow, e.g. sandwich or pillar type devices}
- 70/8265 . . . . {on sidewalls of dielectric structures, e.g. mesa-shaped or cup-shaped devices}
- 70/828 . . . {Current flow limiting means within the switching material region, e.g. constrictions}
- 70/841 . . {Electrodes}
- 70/8413 . . . {adapted for resistive heating}
- 70/8416 . . . {adapted for supplying ionic species}
- 70/8418 . . . {adapted for focusing electric field or current, e.g. tip-shaped}
- 70/861 . . {Thermal details}
- 70/8613 . . . {Heating or cooling means other than resistive heating electrodes, e.g. heater in parallel}

- 70/8616 . . . {Thermal insulation means}
- 70/881 . . {Switching materials}
- 70/882 . . . {Compounds of sulfur, selenium or tellurium, e.g. chalcogenides}
- 70/8822 . . . . {Sulfides, e.g. CuS}
- 70/8825 . . . . {Selenides, e.g. GeSe}
- 70/8828 . . . . {Tellurides, e.g. GeSbTe}
- 70/883 . . . {Oxides or nitrides}
- 70/8833 . . . . {Binary metal oxides, e.g. TaO<sub>x</sub>}
- 70/8836 . . . . {Complex metal oxides, e.g. perovskites, spinels}
- 70/884 . . . {based on at least one element of group IIIA, IVA or VA, e.g. elemental or compound semiconductors ([compounds of sulfur, selenium or tellurium, e.g. chalcogenides H10N 70/882; oxides or nitrides H10N 70/883](#))}
- 70/8845 . . . . {Carbon or carbides}

**79/00 Integrated devices, or assemblies of multiple devices, comprising at least one solid-state element covered by group [H10N 70/00](#) (ReRAM devices [H10B 63/00](#); PCRAM devices [H10B 63/10](#))****80/00 Bulk negative-resistance effect devices (integrated devices or assemblies of multiple devices [H10N 89/00](#))**

- 80/01 . {Manufacture or treatment}
- 80/10 . Gunn-effect devices
- 80/103 . . {controlled by electromagnetic radiation}
- 80/107 . . {Gunn diodes}

**89/00 Integrated devices, or assemblies of multiple devices, comprising at least one bulk negative resistance effect element covered by group [H10N 80/00](#)**

- 89/02 . {Gunn-effect integrated devices}

**97/00 Electric solid-state thin-film or thick-film devices, not otherwise provided for****99/00 Subject matter not provided for in other groups of this subclass**

- 99/03 . {Devices using Mott metal-insulator transition, e.g. field-effect transistor-like devices}
- 99/05 . {Devices based on quantum mechanical effects, e.g. quantum interference devices or metal single-electron transistors}