COOPERATIVE PATENT CLASSIFICATION

H ELECTRICITY
(NOTE omitted)

H01 BASIC ELECTRIC ELEMENTS
(NOTE omitted)

H01S DEVICES USING THE PROCESS OF LIGHT AMPLIFICATION BY STIMULATED EMISSION OF RADIATION [LASER] TO AMPLIFY OR GENERATE LIGHT; DEVICES USING STIMULATED EMISSION OF ELECTROMAGNETIC RADIATION IN WAVE RANGES OTHER THAN OPTICAL

NOTE
This subclass covers:

a. devices using the stimulated emission of radiation by excited atoms or molecules to amplify or generate coherent monochromatic electromagnetic radiation;

b. functions as modulating, demodulating, controlling or stabilising such coherent monochromatic electromagnetic radiation.

WARNINGS

1. The following IPC groups are not in the CPC scheme. The subject matter for these IPC groups is classified in the following CPC groups:
   H01S 3/098 covered by H01S 3/08018, H01S 3/11 and s.gr.

2. In this subclass non-limiting references (in the sense of paragraph 39 of the Guide to the IPC) may still be displayed in the scheme.

1/00 Masers, i.e. devices using stimulated emission of electromagnetic radiation in the microwave range

1/005 . [using a relativistic beam of charged particles, e.g. electron cyclotron maser, gyrotron]

1/02 . solid

1/04 . liquid

1/06 . Gaseous [i.e. beam masers]

3/00 Lasers, i.e. devices using stimulated emission of electromagnetic radiation in the infrared, visible or ultraviolet wave range (semiconductors lasers H01S 5/00)

3/0007 . [Applications not otherwise provided for (working metals or other materials by laser beam B23K 26/00; using photons to produce a reactive propulsive thrust F03H 3/00; optical recording of measured values in general G01D 15/14; optics in general G02B; holographic processes or apparatus G03H; optical marking or sensing of data record carriers G06K 7/10 - G06K 7/14, G06K 15/12; injection heating of plasma by laser H05H 1/22; acceleration of neutral particles by electromagnetic wave pressure H05H 3/04)]

3/0014 . [Monitoring arrangements not otherwise provided for (photometry G01J 1/00, e.g. G01J 1/4257; radiation pyrometry G01J 5/00; measuring coherence of light G01J 9/00; measuring wavelength of light G01J 9/00, e.g. G01J 9/0256; measuring optical pulses G01J 11/00; calorimetrically measuring power of laser beams G01K 17/003)]

3/005 . [Optical devices external to the laser cavity, specially adapted for lasers, e.g. for homogenisation of the beam or for manipulating laser pulses, e.g. pulse shaping (shaping laser beam for working metal or other materials B23K 26/06; optical elements, systems or apparatus in general G02B)]

3/0057 . [Temporal shaping, e.g. pulse compression, frequency chirping (soliton generation and propagation G02F 1/3513, H01S 3/063 and H01S 3/108)]

3/0064 . [Anti-reflection devices, e.g. optical isolaters (absorbing layers for marking or protecting purposes in laser working B23K 26/50; magneto-optical non-reciprocal devices G02F 1/093, G02F 1/0955)]

3/0071 . [Beam steering, e.g. whereby a mirror outside the cavity is present to change the beam direction]

3/0078 . [Frequency filtering]

3/0085 . [Modulating the output, i.e. the laser beam is modulated outside the laser cavity]

3/0092 . [Nonlinear frequency conversion, e.g. second harmonic generation [SHG] or sum- or difference-frequency generation outside the laser cavity (nonlinear frequency conversion per se G02F 1/35)]

3/002 . [Constructional details (tubings or packages of fibre lasers H01S 3/06704)]

3/0022 . [of liquid lasers]

3/0025 . [of solid state lasers, e.g. housings or mountings]

3/0027 . [comprising a special atmosphere inside the housing]

3/003 . [of gas laser discharge tubes]

3/00305 . [Selection of materials for the tube or the coatings thereon]
Accommodation of active medium therein; Shape of construction or shape of optical resonators; Construction or shape of active medium

Cooling arrangements

Means for obtaining or maintaining the desired gas pressure within the tube, e.g. by gettering, replenishing; Means for circulating the gas, e.g. for equalising the pressure within the tube ((H01S 3/031 takes precedence))

Electrodes, e.g. special shape, configuration or composition

Anodes or particular adaptations thereof

Cathodes or particular adaptations thereof

Auxiliary electrodes, e.g. for pre-ionisation or triggering, or particular adaptations thereof

(Shape)

Helical shape

[Compositions, materials or coatings]

Cooling arrangements

[Optical elements being part of laser resonator, e.g. windows, mirrors, lenses]

[for liquid lasers]

Air- or gas cooling, e.g. by dry nitrogen

Conductive cooling, e.g. by heat sinks or thermo-electric elements

Liquid cooling, e.g. by water

Radiative cooling, e.g. by anti-Stokes scattering in the active medium

for gas lasers ((H01S 3/0401 takes precedence))

for solid state lasers ((H01S 3/0401 takes precedence))

Construction or shape of optical resonators; Accommodation of active medium therein; Shape of active medium

Construction or shape of active medium

Crystal lasers or glass lasers ((H01S 3/063 takes precedence))

[in the form of a plate or disc]

with polygonal cross-section, e.g. slab, prism ((H01S 3/0604 takes precedence))

Laser crystal with a hole, e.g. a hole or bore for housing a flashlamp or a mirror

with elliptical or circular cross-section and elongated shape, e.g. rod

[Non-homogeneous structure ((H01S 3/07 takes precedence))]

Shape of end-face

having a varying composition or cross-section in a specific direction

Coatings, e.g. AR, HR, passivation layer

Coatings on the end-faces, e.g. input/output surfaces of the laser light

Antireflective [AR]

Coatings on surfaces other than the end-faces

the resonator being monolithic, e.g. microlaser

Waveguide lasers, [i.e. whereby the dimensions of the waveguide are of the order of the light wavelength (waveguide gas lasers H01S 3/0315)]

Thin film lasers in which light propagates in the plane of the thin film

provided with a periodic structure, e.g. using distributed feed-back, grating couplers (controlling, e.g. modulating distributed feed-back lasers H01S 3/102)

Integrated lateral waveguide, e.g. the active waveguide is integrated on a substrate made by Si on insulator technology (Si/SiO₂)

Fibre lasers

Housings; Packages

Constructional details of the fibre, e.g. compositions, cross-section, shape or tapering (optical fibres as passive waveguides G02B 6/02)

Polarising fibre; Polarisar

Fibre compositions (per se C03C 13/04)or doping with active elements (lasing materials in general H01S 3/14)

Non-uniform radial doping

Fibre characterized by a specific dispersion, e.g. for pulse shaping in soliton lasers or for dispersion compensating [DCF]

Peculiar transverse fibre profile

Fibre having more than one cladding

Fibre having multiple non-coaxial cores, e.g. multiple active cores or separate cores for pump and gain

Photonic crystal fibre, i.e. the fibre having a photonic bandgap

Tapering of the fibre, core or active region

Resonators including a grating structure, e.g. distributed Bragg reflectors [DBR] or distributed feedback [DBF] fibre lasers

(Fibre amplifiers ((H01S 3/06708 takes precedence))

(Tandem amplifiers)

having a specific amplification band

(C-band amplifiers, i.e. amplification in the range of about 1530 nm to 1560 nm)

(L-band amplifiers, i.e. amplification in the range of about 1560 nm to 1610 nm)

(S-band amplifiers, i.e. amplification in the range of about 1450 nm to 1530 nm)
H01S

3/06779 . . . . . [with optical power limiting]
3/06783 . . . . . [Amplifying coupler]
3/06787 . . . . . [Bidirectional amplifier]
3/06791 . . . . . (Fibre ring lasers (fibre laser gyroscopes G01C 19/72))
3/06795 . . . . . (with superfluorescent emission, e.g. amplified spontaneous emission sources for fibre laser gyroimeters (fibre laser gyroimeters per se G01C 19/72))
3/07 . . . . . consisting of a plurality of parts, e.g. segments (H01S 3/067 takes precedence)
3/073 . . . . . (Gas lasers comprising separate discharge sections in one cavity, e.g. hybrid lasers (tandem arrangements of separate gas lasers H01S 3/2366))
3/076 . . . . . (Folded-path lasers)
3/08 . . . . . Construction or shape of optical resonators or components thereof (waveguide lasers H01S 3/066)
3/08004 . . . . . (incorporating a dispersive element, e.g. a prism for wavelength selection (H01S 3/0811, H01S 3/08022 take precedence))
3/08009 . . . . . (using a diffraction grating)
3/08013 . . . . . (Resonator comprising a fibre, e.g. for modifying dispersion or repetition rate (the active medium being a fibre H01S 3/067))
3/08018 . . . . . (Mode suppression)
3/08022 . . . . . (Longitudinal mode control, e.g. specifically multimode)
3/08027 . . . . . (by a filter, e.g. a Fabry-Perot filter is used for wavelength setting)
3/08031 . . . . . (Single-mode emission)
3/08036 . . . . . (by a dispersive, polarising or birefringent element placed in the cavity, e.g. a Fabry-Perot etalon, tilted plate)
3/0804 . . . . . (Transverse or lateral mode control, e.g. specifically multimode)
3/08045 . . . . . (Single-mode emission)
3/0805 . . . . . (by apertures, e.g. pinholes, knife-edges, apodizers)
3/08054 . . . . . (Passive cavity elements acting on the polarization, e.g. a polarizer for branching or walk-off compensation (quarter-wave plates in a Q-switch laser H01S 3/1124, H01S 3/115))
3/08059 . . . . . (Constructional details of the reflector, e.g. shape (mirrors in general G02B 5/08; mountings for mirrors G02B 7/18))
3/08063 . . . . . (Graded reflectivity, e.g. variable reflectivity mirror)
3/08068 . . . . . (Holes; Stepped surface; Special cross-section)
3/08072 . . . . . (Thermal lensing or thermally induced birefringence; Compensation thereof)
3/08077 . . . . . (Pump induced waveguiding, i.e. the pump induces refractive index change in the laser medium to guide the amplified light, e.g. gain- or loss-guiding or thermally induced refractive index change)
3/08081 . . . . . (Unstable resonators)
3/08086 . . . . . (Multiple-wavelength emission)
3/0809 . . . . . (Two-wavelength emission)
3/08095 . . . . . (Zig-zag travelling beam through the active medium)
3/081 . . . . . comprising more than two reflectors (folded-path gas lasers H01S 3/076)
3/0811 . . . . . (incorporating a dispersive element, e.g. a prism for wavelength selection)
3/0812 . . . . . (using a diffraction grating)
3/0813 . . . . . (Configuration of resonator)
3/0815 . . . . . (having 3 reflectors, e.g. V-shaped resonators)
3/0816 . . . . . (having 4 reflectors, e.g. Z-shaped resonators)
3/0817 . . . . . (having 5 reflectors, e.g. W-shaped resonators)
3/0818 . . . . . (Unstable resonators)
3/082 . . . . . defining a plurality of resonators, e.g. for mode selection (single longitudinal mode control H01S 3/08022)
3/0823 . . . . . (incorporating a dispersive element, e.g. a prism for wavelength selection)
3/0826 . . . . . (using a diffraction grating)
3/083 . . . . . (Ring lasers (fibre ring lasers H01S 3/0679))
3/0835 . . . . . (Gas ring lasers)
3/086 . . . . . (One or more reflectors having variable properties or positions for initial adjustment of the resonator (varying a parameter of the laser output during operation H01S 3/10; stabilisation of the laser output H01S 3/13))
3/09 . . . . . Processes or apparatus for excitation, e.g. pumping
3/0903 . . . . . (Free-electron laser)
3/0906 . . . . . (Electrical, electrochemical, or electron-beam pumping of a dye laser)
3/091 . . . . . using optical pumping
3/0912 . . . . . (Electronics or drivers for the pump source, i.e. details of drivers or circuitry specific for laser pumping (laser diode drivers H01S 5/042))
3/0915 . . . . . by incoherent light
3/09155 . . . . . (by cathodo-luminescence)
3/092 . . . . . of flash lamp (H01S 3/0937 takes precedence ; flash lamps per se H01J 61/80; circuit arrangements for operating flash lamps in general H05B 41/30)
3/093 . . . . . focusing or directing the excitation energy into the active medium
3/0931 . . . . . (Imaging pump cavity, e.g. elliptical)
3/0933 . . . . . of a semiconductor, e.g. light emitting diode
3/0937 . . . . . produced by exploding or combustible material
3/094 . . . . . by coherent light

NOTE

Groups H01S 3/094003 - H01S 3/094088 take precedence over groups H01S 3/09941 - H01S 3/09947

3/094003 . . . . . (the pumped medium being a fibre)
3/094007 . . . . . (Cladding pumping, i.e. pump light propagating in a clad surrounding the active core)
3/094011 . . . . . (with bidirectional pumping, i.e. with injection of the pump light from both two ends of the fibre)
3/094015 . . . . . (with pump light recycling, i.e. with reinjection of the unused pump light back into the fiber, e.g. by reflectors or circulators)
3/094019 . . . . (Side pumped fibre, whereby pump light is coupled laterally into the fibre via an optical component like a prism, or a grating, or via V-groove coupling)

3/094023 . . . . (with ASE light recycling, with re injection of the ASE light back into the fiber, e.g. by reflectors or circulators)

3/094026 . . . . (for synchronously pumping, e.g. for mode locking)

3/09403 . . . . (Cross-pumping, e.g. Förster process involving intermediate medium for excitation transfer)

3/094034 . . . . (the pumped medium being a dye)

3/094038 . . . . (End pumping)

3/094042 . . . . (of a fibre laser)

3/094046 . . . . (of a Raman fibre laser)

3/094049 . . . . (Guiding of the pump light)

3/094053 . . . . (Fibre coupled pump, e.g. delivering pump light using a fibre or a fibre bundle)

3/094057 . . . . (by tapered duct or homogenized light pipe, e.g. for concentrating pump light)

3/094061 . . . . (Shared pump, i.e. pump light of a single pump source is used to pump plural gain media in parallel)

3/094065 . . . . (Single-mode pumping)

3/094069 . . . . (Multi-mode pumping)

3/094073 . . . . (Non-polarized pump, e.g. depolarizing the pump light for Raman lasers)

3/094076 . . . . (Pulsed or modulated pumping (H01S 3/104 takes precedence))

3/09408 . . . . (Pump redundancy)

3/094084 . . . . (with pump light recycling, i.e. with re injection of the unused pump light, e.g. by reflectors or circulators)

3/094088 . . . . (with ASE light recycling, i.e. with re injection of the ASE light, e.g. by reflectors or circulators)

3/094092 . . . . (Upconversion pumping)

3/094096 . . . . (Multi-wavelength pumping)

3/0941 . . . . of a laser diode

3/09415 . . . . (the pumping beam being parallel to the lasing mode of the pumped medium, e.g. end-pumping)

3/0943 . . . . of a gas laser

3/0947 . . . . of an organic dye laser

3/095 . . . . using chemical or thermal pumping

3/09505 . . . . (involving photochemical reactions, e.g. photodissociation (iodine lasers H01S 3/2215))

3/0951 . . . . by increasing the pressure in the laser gas medium

3/0953 . . . . Gas dynamic lasers, i.e. with expansion of the laser gas medium to supersonic flow speeds

3/0955 . . . . using pumping by high energy particles (H01S 3/0903, H01S 3/0906, H01S 3/09707 take precedence)

3/0957 . . . . by high energy nuclear particles

3/0959 . . . . by an electron beam

3/097 . . . . by gas discharge of a gas laser

3/09702 . . . . (Details of the driver electronics and electric discharge circuits)

3/09705 . . . . (with particular means for stabilising the discharge)

3/09707 . . . . (using an electron or ion beam (free-electron laser H01S 3/0903))

3/0971 . . . . transversely excited (H01S 3/0975 takes precedence)

3/09713 . . . . (with auxiliary ionisation, e.g. double discharge excitation)

3/09716 . . . . (by ionising radiation)

3/0973 . . . . having a travelling wave passing through the active medium

3/0975 . . . . using inductive or capacitive excitation

3/0977 . . . . having auxiliary ionisation means (H01S 3/09713 takes precedence)

3/09775 . . . . (by ionising radiation)

3/0979 . . . . Gas dynamic lasers, i.e. with expansion of the laser gas medium to supersonic flow speeds

3/10 . Controlling the intensity, frequency, phase, polarisation or direction of the emitted radiation, e.g. switching, gating, modulating or demodulating

NOTE

Group H01S 3/10007 takes precedence over groups H01S 3/102 - H01S 3/104

3/10007 . . . . (in optical amplifiers)

3/1001 . . . . (by controlling the optical pumping)

3/10013 . . . . (by controlling the temperature of the active medium)

3/10015 . . . . (by monitoring or controlling, e.g. attenuating, the input signal)

3/10023 . . . . (by functional association of additional optical elements, e.g. filters, gratings, reflectors)

3/1003 . . . . (tunable optical elements, e.g. acousto-optic filters, tunable gratings)

3/10038 . . . . (Amplitude control)

3/10046 . . . . (Pulse repetition rate control (H01S 3/11 takes precedence))

3/10053 . . . . (Phase control)

3/10061 . . . . (Polarization control)

3/10069 . . . . (Memorized or pre-programmed characteristics, e.g. look-up table [LUT])

3/10076 . . . . (using optical phase conjugation, e.g. phase conjugate reflection)

3/10084 . . . . (Frequency control by seeding)

3/10092 . . . . (Coherent seed, e.g. injection locking)

3/101 . . . . Lasers provided with means to change the location from which, or the direction in which, laser radiation is emitted

3/102 . . . . by controlling the active medium, e.g. by controlling the processes or apparatus for excitation (H01S 3/13 takes precedence)

3/1022 . . . . (by controlling the optical pumping)

3/1024 . . . . (for pulse generation)

3/1026 . . . . (Controlling the active medium by translation or rotation, e.g. to remove heat from that part of the active medium that is situated on the resonator axis)

3/1028 . . . . (by controlling the temperature)

3/104 . . . . in gas lasers

3/105 . . . . by controlling the mutual position or the reflecting properties of the reflectors of the cavity, e.g. by controlling the cavity length (H01S 3/1076), H01S 3/13 takes precedence)

3/1051 . . . . (one of the reflectors being of the type using frustrated reflection)

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3/1053 . . . [Control by pressure or deformation]
3/1055 . . . one of the reflectors being constituted by a diffraction grating
3/106 . . . by controlling a device placed within the cavity
{ (H01S 3/106) , H01S 3/13 take precedence }
3/1061 . . . [using a variable absorption device]
3/1062 . . . [using a controlled passive interferometer, e.g. a Fabry-Perot etalon]
3/1063 . . . [using a solid state device provided with at least one potential jump barrier]
3/1065 . . . [using liquid crystals]
3/1066 . . . [using a magneto-optical device]
3/1067 . . . [using pressure or deformation]
3/1068 . . . [using an acousto-optical device]
3/107 . . . using an electro-optical device, e.g. exhibiting Pockels- or Kerr-effect
{ (H01S 3/106L, H01S 3/1063, H01S 3/1065 take precedence) }
3/1075 . . . [for optical deflection]
3/108 . . . [using a non-linear optical device, e.g. exhibiting Brillouin- or Raman-scattering]
{ (mode locking using a non-linear element H01S 3/1112) }
3/1083 . . . [using parametric generation]
3/1086 . . . [using scattering effects, e.g. Raman or Brillouin effect]
3/109 . . . Frequency multiplying, e.g. harmonic generation
3/1095 . . . [self doubling, e.g. lasing and frequency doubling by the same active medium]
3/11 . . . [Pulse generation, e.g. Q-switching, mode locking]
3/1103 . . . [Cavity dumping]
3/1106 . . . [Mode locking]
3/1109 . . . [Active mode locking]
3/1112 . . . [Passive mode locking]
3/1115 . . . [using a saturable absorber (Q-switching by saturable absorbers H01S 3/113)]
3/1118 . . . . . . [Solid state absorber, e.g. SESAM]
3/1121 . . . [Harmonically mode locking lasers, e.g. modulation frequency equals multiple integers or a fraction of the resonator roundtrip time]
3/1124 . . . [Q-switching using magneto-optical devices]
3/1127 . . . [Q-switching using pulse transmission mode [PTM]]
3/113 . . . [Q-switching] using bleachable or solarising media
3/115 . . . [Q-switching] using electro-optical devices
3/117 . . . [Q-switching] using acousto-optical devices
3/121 . . . [Q-switching] using mechanical devices
3/123 . . . Rotating mirror
3/125 . . . Rotating prism
3/127 . . . Plural Q-switches
3/13 . . . Stabilisation of laser output parameters, e.g. frequency, amplitude

**NOTE**

Group H01S 3/1301 takes precedence over groups H01S 3/131 - H01S 3/134

3/1301 . . . [in optical amplifiers]
3/13013 . . . [by controlling the optical pumping]
3/13017 . . . [by controlling the temperature of the active medium]

3/1302 . . . [by all-optical means, e.g. gain-clamping]
3/1303 . . . [by using a passive reference, e.g. absorption cell (H01S 3/139 takes precedence)]
3/1304 . . . [by using an active reference, e.g. second laser, klystron or other standard frequency source (H01S 3/139 takes precedence; automatic control of electronic generators H03L 7/00)]
3/1305 . . . [Feedback control systems]
3/1306 . . . [Stabilisation of the amplitude]
3/1307 . . . [Stabilisation of the phase]
3/1308 . . . [Stabilisation of the polarisation]
3/131 . . . by controlling the active medium, e.g. by controlling the processes or apparatus for excitation
3/1312 . . . [by controlling the optical pumping]
3/1315 . . . [by gain saturation]
3/1317 . . . [by controlling the temperature]
3/134 . . . [in gas lasers]
3/136 . . . by controlling a device placed within the cavity
3/137 . . . [for stabilising of frequency]
3/139 . . . [by controlling the mutual position or the reflecting properties of the reflectors of the cavity, e.g. by controlling the cavity length]
3/1392 . . . [by using a passive reference, e.g. absorption cell (H01S 3/1396, H01S 3/1398 take precedence)]
3/1394 . . . [by using an active reference, e.g. second laser, klystron or other standard frequency source]
3/1396 . . . [by using two modes present, e.g. Zeeman splitting (H01S 3/1398 takes precedence)]
3/1398 . . . [by using a supplementary modulation of the output]
3/14 . . . characterised by the material used as the active medium
3/16 . . . Solid materials
3/1601 . . . [characterised by an active (lasing) ion]
3/1603 . . . [rare earth]
3/1605 . . . [terbium]
3/1606 . . . [dysprosium]
3/1608 . . . [erbium]
3/161 . . . [holmium]
3/1611 . . . [neodymium]
3/1613 . . . [praseodymium]
3/1615 . . . [samarium]
3/1616 . . . [tellurium]
3/1618 . . . [ytterbium]
3/162 . . . [transition metal]
3/1621 . . . [cobalt]
3/1623 . . . [chromium, e.g. Alexandrite]
3/1625 . . . [titanium]
3/1626 . . . [uranium]
3/1628 . . . [characterised by a semiconducting matrix]
3/163 . . . [characterised by a crystal matrix]
3/1631 . . . [aluminate]
3/1633 . . . [BeAl₂O₃, i.e. Chrysoberyl]
3/1635 . . . [LaMgAl₁₁O₂₁ (LNA, Lanthanum Magnesium Hexaluminate)]
3/1636 . . . [Al₂O₃ (Sapphire)]
3/1638 . . . [YAlO₃ (YALO or YAP, Yttrium Aluminium Perovskite)]
3/164 . . . [garnet]
Gases
Liquids

{ Iodine compounds or atomic iodine } including an organic dye ions, e.g. Nd } including a chelate { , e.g. including atoms or promoters as further dopants } the active element forms one component of a { Liquid crystal active layer } { Ceramics } Josephson junctions } { Plastic } Liquids

3/2222 . . . [Neon, e.g. in helium-neon (He-Ne) systems]
3/223 . . . the active gas being polyatomic, i.e. containing more than one atom (H01S 3/227 takes precedence)
3/2232 . . . [Carbon dioxide (CO₂) or monoxide [CO]]
3/2235 . . . [Dye vapour]
3/2237 . . . [Molecular nitrogen (N₂), e.g. in noble gas-N₂ systems]
3/225 . . . comprising an excimer or exciplex
3/2251 . . . [ArF, i.e. argon fluoride is comprised for lasing around 193 nm]
3/2253 . . . [XeCl, i.e. xenon chloride is comprised for lasing around 308 nm]
3/2255 . . . [XeF, i.e. xenon fluoride is comprised for lasing around 351 nm]
3/2256 . . . [KrF, i.e. krypton fluoride is comprised for lasing around 248 nm]
3/2258 . . . [F₂, i.e. molecular fluoride is comprised for lasing around 157 nm]
3/227 . . . Metal vapour
3/23 . . . Arrangements of two or more lasers not provided for in groups H01S 3/02 - H01S 3/22, e.g. tandem arrangements of separate active media
3/2308 . . . [Amplifier arrangements, e.g. MOPA ]
3/2316 . . . [Cascaded amplifiers]
3/2325 . . . [Multi-pass amplifiers, e.g. regenerative amplifiers]
3/2333 . . . [Double-pass amplifiers]
3/2341 . . . [Four pass amplifiers]
3/235 . . . [Regenerative amplifiers]
3/2358 . . . [comprising dyes as the active medium]
3/2366 . . . [comprising a gas as the active medium (H01S 3/10092, H01S 3/2383 take precedence )]
3/2375 . . . [Hybrid lasers (H01S 3/07 takes precedence )]
3/2383 . . . [Parallel arrangements]
3/2391 . . . [emitting at different wavelengths]
3/30 . . . using scattering effects, e.g. stimulated Brillouin or Raman effects
3/302 . . . [in an optical fibre]
3/305 . . . [in a gas]
3/307 . . . [in a liquid]

4/00 Devices using stimulated emission of electromagnetic radiation in wave ranges other than those covered by groups H01S 1/00, H01S 3/00 or H01S 5/00, e.g. phonon masers, X-ray lasers or gamma-ray lasers

5/00 Semiconductor lasers (superluminescent diodes (H01L 33/0045))

NOTE
Attention is drawn to Special Rules of classification at C07F, which Special Rules indicate to which version of the periodic table of chemical elements CPC refers. In this group, the Periodic System used is the 8 group system indicated by Roman numerals in the Periodic Table thereunder.

5/0014 . . . [Measuring characteristics or properties thereof (measuring techniques per se G01J, G01K, G01N, G01R ])
5/0021 . . . [Degradation or life time measurements]
5/0028 . . . [Laser diodes used as detectors]
5/0035 . . . [Simulations of laser characteristics]
5/0042 . . . [On wafer testing, e.g. lasers are tested before separating wafer into chips]
5/005 . . . [Optical devices external to the laser cavity, specially adapted therefor, e.g. for homogenisation or merging of the beams or for manipulating laser pulses, e.g. pulse shaping (H01S 5/026, H01S 5/18388 take precedence)]
5/0057 . . . [Temporal shaping, e.g. pulse compression, frequency chirping]
5/0064 . . . [Anti-reflection devices, e.g. optical isolators]
5/0071 . . . [Beam steering, e.g. whereby a mirror outside the cavity is present to change the beam direction]
5/0078 . . . [Frequency filtering]
5/0085 . . . [Modulating the output, i.e. the laser beam is modulated outside the laser cavity]
5/0092 . . . [Nonlinear frequency conversion, e.g. second harmonic generation [SHG] or sum- or difference-frequency generation outside the laser cavity (nonlinear frequency conversion per se G02F 1/35)]
5/02 . Structural details or components not essential to laser action
5/0201 . . . [Separation of the wafer into individual elements, e.g. by dicing, cleaving, etching or directly during growth]
5/0202 . . . [Cleaving]
5/0203 . . . [Etching]
5/0205 . . . [during growth of the semiconductor body]
5/0206 . . . [Substrates, e.g. growth, shape, material, removal or bonding: (specific crystal orientation H01S 5/2302)]
5/0207 . . . [Substrates having a special shape]
5/0208 . . . [Semi-insulating substrates]
5/021 . . . [Silicon based substrates]
5/0211 . . . [Substrates made of ternary or quaternary compounds]
5/0212 . . . [with a graded composition]
5/0213 . . . [Sapphire, quartz or diamond based substrates]
5/0215 . . . [Bonding to the substrate]
5/0216 . . . [using an intermediate compound, e.g. a glue or solder]
5/0217 . . . [Removal of the substrate]
5/0218 . . . [Substrates comprising semiconducting materials from different groups of the periodic system than the active layer]
5/022 . Mountings; Housings
5/02204 . . . [including a getter material to absorb contaminations]
5/02208 . . . [Shape of the housing]
5/02212 . . . [Can-type, e.g. TO-9 housing with emission along or parallel to symmetry axis]
5/02216 . . . [Butterfly-type, i.e. the housing is generally flat]
5/0222 . . . [filled with special gases]
5/0224 . . . [Oxygen is contained in the housing, e.g. to avoid contamination of the light emitting facet]
5/02228 . . . [filled with a resin, or the complete housing being made of resin]
5/02232 . . . [filled with a liquid (H01S 5/0243 takes precedence)]
5/02236 . . . [Mounts or sub-mounts (H01S 5/02476 takes precedence)]
5/0224 . . . [Up-side down mounting, e.g. flip-chip or epi-side down mounted laser]
5/02244 . . . [Lead-frames, e.g. the laser is mounted on a lead frame or on a stem]
5/02248 . . . [Mechanically integrated components on a mount or an optical microbench, e.g. optical components, detectors, etc.]
5/02252 . . . [Relative positioning of laser diode and optical components, e.g. grooves in the mount to fix an optical fibre or a lens]
5/02256 . . . [Details of fixing the laser diode on the mount]
5/0226 . . . [using an adhesive]
5/02264 . . . [by clamping]
5/02268 . . . [Positioning, e.g. using marks for positioning of the laser diode]
5/02272 . . . [using soldering]
5/02276 . . . [Wire-bonding details]
5/0228 . . . [Out-coupling light]
5/02284 . . . [with an optical fibre]
5/02288 . . . [with a lens]
5/02292 . . . [with a beam deflecting element]
5/02296 . . . [Details of a window, e.g. special materials or special orientation for back-reflecting light to a detector inside the housing]
5/024 . . . Cooling arrangements (H01S 5/0261 takes precedence)
5/02407 . . . [Active cooling, e.g. the laser temperature is controlled by a thermo-electric cooler or water cooling]
5/02415 . . . [by using a thermo-electric cooler [TEC], e.g. Peltier element]
5/02423 . . . [Liquid cooling, e.g. a liquid cools a mount of the laser]
5/0243 . . . [Laser is immersed in the coolant, i.e. the whole laser chip is immersed in the liquid for cooling]
5/02438 . . . [Characterized by cooling of elements other than the laser chip, e.g. an optical element being part of an external cavity or a collimating lens]
5/02446 . . . [Cooling being separate from the laser chip cooling]
5/02453 . . . [Heating, e.g. the laser is heated for stabilisation against temperature fluctuations of the environment (H01S 5/0612 takes precedence, for monolithically integrated heaters see also H01S 5/0261)]
5/02461 . . . [Structure or details of the laser chip to manipulate the heat flow, e.g. passive layers in the chip with a low heat conductivity]
5/02469 . . . [Passive cooling, e.g. where heat is removed by the housing as a whole or by a heat pipe without any active cooling element like a TEC]
5/02476 . . . [Heat spreaders, i.e. improving heat flow between laser chip and heat dissipating elements]
5/02484 . . . [Sapphire or diamond heat spreaders]
5/02492 . . . [CuW heat spreaders]
5/026 . Monolithically integrated components, e.g. waveguides, monitoring photo-detectors, drivers (stabilisation of output H01S 5/06)
5/0261 . . . [Non-optical elements, e.g. laser driver components, heaters \(\text{H01S } 5/0265\) takes precedence]

5/0262 . . . [Photo-diodes, e.g. transceiver devices, bidirectional devices \(\text{H01S } 5/0265\) takes precedence]

5/0264 . . . [for monitoring the laser-output]

5/0265 . . . [Intensity modulators (intra-cavity modulators \(\text{H01S } 5/0625\) )]

5/0267 . . . [Integrated focusing lens \(\text{H01S } 5/18388\) takes precedence]

5/0268 . . . [Integrated waveguide grating router, e.g. emission of a multi-wavelength laser array is combined by a "dragon router"]

5/028 . . Coatings \{ Treatment of the laser facets, e.g. etching, passivation layers or reflecting layers \}

5/0281 . . . [Coatings made of semiconductor materials]

5/0282 . . . [Passivation layers or treatments]

5/0283 . . . [Optically inactive semiconductor materials]

5/0284 . . . [Coatings with a temperature dependent reflectivity]

5/0285 . . . [Coatings with a controllable reflectivity]

5/0286 . . . [Coatings with a reflectivity that is not constant over the facets, e.g. apertures]

5/0287 . . . [Facet reflectivity]

5/0288 . . . . [Detuned facet reflectivity, i.e. reflectivity peak is different from gain maximum]

5/04 . Processes or apparatus for excitation, e.g. pumping, \{ e.g. by electron beams \} \(\text{H01S } 5/06\) takes precedence

5/041 . . . [Optical pumping]

5/042 . . . Electrical excitation \{ Circuits therefor (monolithically integrated laser drive components \(\text{H01S } 5/0261\) )

5/0421 . . . [characterised by the semiconducting contacting layers \(\text{electrodes } 5/0425\) ]

5/0422 . . . . [with n- and p-contacts on the same side of the active layer]

5/0424 . . . . [lateral current injection]

5/0425 . . . . [Electrodes, e.g. characterised by the structure]

5/04252 . . . . [characterised by the material]

5/04253 . . . . [having specific optical properties, e.g. transparent electrodes]

5/04254 . . . . [characterised by the shape]

5/04256 . . . . [characterised by the configuration]

5/04257 . . . . [having positive and negative electrodes on the same side of the substrate]

5/0427 . . . [for applying modulation to the laser]

5/0428 . . . [for applying pulses to the laser]

5/06 . . . Arrangements for controlling the laser output parameters, e.g. by operating on the active medium

5/0601 . . . [comprising an absorbing region \(\text{H01S } 5/0604, \text{H01S } 5/0607, \text{H01S } 5/0615\) and \(\text{H01S } 5/065\) take precedence; bistable laser devices in general \(G02F\ 3/026\) ]

5/0602 . . . [which is an unpumped part of the active layer]

5/0604 . . . [comprising a non-linear region, e.g. generating harmonics of the laser frequency]

5/0605 . . . [Self doubling, e.g. lasing and frequency doubling by the same active medium]

5/0607 . . . [by varying physical parameters other than the potential of the electrodes, e.g. by an electric or magnetic field, mechanical deformation, pressure, light, temperature]

5/0608 . . . [controlled by light, e.g. optical switch]

5/0609 . . . [acting on an absorbing region, e.g. wavelength converters]

5/0611 . . . . [wavelength converters]

5/0612 . . . . [controlled by temperature]

5/0614 . . . . [controlled by electric field, i.e. whereby an additional electric field is used to tune the bandgap, e.g. using the Stark-effect]

5/0615 . . . . . [Q-switching, i.e. in which the quality factor of the optical resonator is rapidly changed]

5/0617 . . . . . [using memorised or pre-programmed laser characteristics]

5/0618 . . . . . [Details on the linewidth enhancement parameter alpha]

5/062 . . . by varying the potential of the electrodes \(\text{H01S } 5/065\) takes precedence

5/06203 . . . . [Transistor-type lasers \(\text{H01S } 5/068\) takes precedence]

5/06206 . . . . [Controlling the frequency of the radiation, e.g. tunable twin-guide lasers \(\text{TTG}\) ]

5/06209 . . . . . [in single-section lasers \(\text{H01S } 5/068\) takes precedence]

5/06213 . . . . . [Amplitude modulation]

5/06216 . . . . . [Pulse modulation or generation]

5/0622 . . . . . [Controlling the frequency of the radiation]

5/06223 . . . . . . [using delayed or positive feedback]

5/06226 . . . . . . . [Modulation at ultra-high frequencies]

5/0623 . . . . . . . [using the beating between two closely spaced optical frequencies, i.e. heterodyne mixing]

5/06233 . . . . . . . [Controlling other output parameters than intensity or frequency]

5/06236 . . . . . . . [controlling the polarisation, e.g. TM/TE polarisation switching]

5/0624 . . . . . . . [controlling the near- or far field]

5/06243 . . . . . . . [controlling the position or direction of the emitted beam]

5/06246 . . . . . . . [controlling the phase]

5/0625 . . . . . . . . [in multi-section lasers]

5/06251 . . . . . . . . [Amplitude modulation]

5/06253 . . . . . . . . [Pulse modulation]

5/06255 . . . . . . . . [Controlling the frequency of the radiation]

5/06256 . . . . . . . . . [with DBR-structure]

5/06258 . . . . . . . . . [with DFB-structure]

5/065 . . . . . . . . . . Mode locking; Mode suppression; Mode selection \{ Self pulsating\]

5/0651 . . . . . . . . . . [Mode control]

5/0652 . . . . . . . . . . . [Coherence lowering or collapse, e.g. multimode emission by additional input or modulation]

5/0653 . . . . . . . . . . . . [Mode suppression, e.g. specific multimode]

5/0654 . . . . . . . . . . . . . [Single longitudinal mode emission]

5/0655 . . . . . . . . . . . . . . [Single transverse or lateral mode emission]

5/0656 . . . . . . . . . . . . . . . [Seeding, i.e. an additional light input is provided for controlling the laser modes, for example by back-reflecting light from an external optical component \(\text{H01S } 5/14, \text{H01S } 5/4062\) and \(\text{H01S } 5/4006\) take precedence\)]
guide, varying width, thickness or composition of extended or external cavity, coupled cavities, bent-construction or shape of the optical resonator {, e.g. Ring-lasers}

Composition or cross-section in a specific {Comprising an active region having a varying composition or cross-section in a specific

Details on the cavity length {Optical microcavities, e.g. cavity dimensions comparable to the wavelength}

Forward coupled [DFC] structures {forward coupled [DFC] structures}

Stabilising the frequency of the laser {Stabilising the frequency of the laser}

Construction or shape of the optical resonator {, e.g. extended or external cavity, coupled cavities, bent-guide, varying width, thickness or composition of the active region (H01S 5/20 takes precedence)}

Waveguide having a modified shape along the axis, e.g. branched, curved, tapered, voids {Waveguide having a modified shape along the axis, e.g. branched, curved, tapered, voids}

Curved waveguide (H01S 5/1243 takes precedence) {Curved waveguide (H01S 5/1243 takes precedence)}

Tapered waveguide, e.g. spotsize converter (H01S 5/1064 takes precedence) {Tapered waveguide, e.g. spotsize converter (H01S 5/1064 takes precedence)}

Waveguide having a void for insertion of materials to change optical properties {Waveguide having a void for insertion of materials to change optical properties}

Coupled cavities (H01S 5/14 takes precedence) {Coupled cavities (H01S 5/14 takes precedence)}

Extended cavities {Extended cavities}

Coupling to elements in the cavity, e.g. coupling to waveguides adjacent the active region, e.g. forward coupled [DFC] structures {Coupling to elements comprising an optical axis that is not aligned with the optical axis of the active region}

Forward coupled structures [DFC] {Forward coupled structures [DFC]}

Details on the cavity length {Details on the cavity length}

Optical microcavities, e.g. cavity dimensions comparable to the wavelength {Optical microcavities, e.g. cavity dimensions comparable to the wavelength}

Comprising interactions between photons and plasmons, e.g. by a corrugated surface {Comprising interactions between photons and plasmons, e.g. by a corrugated surface}

Comprising a photonic bandgap structure {Comprising a photonic bandgap structure}

Comprising an active region having a varying composition or cross-section in a specific direction {Comprising an active region having a varying composition or cross-section in a specific direction}

Varying composition along the optical axis {Varying composition along the optical axis}

Varying thickness along the optical axis {Varying thickness along the optical axis}

Varying width along the optical axis {Varying width along the optical axis}

[Comprising nanoparticles] {[Comprising nanoparticles]}

[Ring-lasers] {[Ring-lasers]}
Surface-emitting [SE] lasers having a vertical cavity [VCSE-lasers] with window regions comprising non-semiconducting materials with a vertical cavity and blocking layers

{ with window regions made by diffusion or disordering of the active layer}

{ with window regions comprising semiconductor material with a wider bandgap than the active layer}

{ with window regions comprising non-semiconducting materials}

{ with window regions comprising current blocking layers}

Surface-emitting [SE] lasers having a vertical cavity [VCSE-lasers] blocking layers

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{ with window regions comprising current blocking layers}

Surface-emitting [SE] lasers having a vertical cavity [VCSE-lasers] blocking layers

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Surface-emitting [SE] lasers having a vertical cavity [VCSE-lasers] blocking layers

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Surface-emitting [SE] lasers having a vertical cavity [VCSE-lasers] blocking layers

{ with window regions made by diffusion or disordering of the active layer}

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Surface-emitting [SE] lasers having a vertical cavity [VCSE-lasers] blocking layers

{ with window regions made by diffusion or disordering of the active layer}

{ with window regions comprising non-semiconducting materials}

{ with window regions comprising current blocking layers}

Surface-emitting [SE] lasers having a vertical cavity [VCSE-lasers] blocking layers

{ with window regions made by diffusion or disordering of the active layer}

{ with window regions comprising non-semiconducting materials}

{ with window regions comprising current blocking layers}
used for the active region
Structure or shape of the active region; Materials
heterostructures ([H01S 5/227 takes precedence])

Buried mesa structure { with inner confining structure only between the active layer and the upper electrode}
Buried mesa structure { with inner confining structure between the active layer and the lower electrode}
Buried mesa structure { with a terraced structure}
Buried mesa structure { with a V-grooved active layer}
Buried mesa structure { grown by a mask induced selective growth}
Buried mesa structure { mesa created by etching}
Buried mesa structure { double channel planar buried heterostructure [DCPBH] laser}

having a grooved structure, e.g. V-grooved (or crescent active layer in groove, VSIS laser)
Structure or shape of the active region; Materials used for the active region

employing a field effect structure for inducing charge-carriers, e.g. FET)

[MIS or MOS configurations]

$\text{A}_n\text{B}_m \text{ compounds}$

$\text{A}_n\text{B}_m\text{V}_l \text{ compounds}$

$\text{A}_n\text{V}_m\text{B}_l \text{ compounds}$

$\text{IV} \text{ compounds}$

$\text{Si}$

$\text{SiC}$

$\text{Si}_{\text{porous}}$

$\text{diamond}$

characterised by the doping materials used in the laser structure

$p$-doping

[Ag in II-VI materials]

[using Mg]

[deep levels]

[Diffusion blocking layer, i.e. a special layer blocking diffusion of dopants]

[plane dependent doping]

[using amphoteric doping]

[doping of the active layer]

[doping of barrier layers that confine charge carriers in the laser structure, e.g. the barriers in a quantum well structure (barriers in quantum wells per se [H01S 5/3407])]

[Tunnel junction]

comprising PN junctions, e.g. hetero- or double-heterostructures ([H01S 5/34, H01S 5/36 take precedence])

incorporating bulkstrain effects, e.g. strain compensation, strain related to polarisation

grown on specifically orientated substrates, or using orientation dependent growth

(polar orientation)

[non-polar orientation]

[semi-polar orientation]

[on non-planar substrates to create thickness or compositional variations]

[with an active layer having a graded composition in the growth direction]

[ordering or disordering the natural superlattice in ternary or quaternary materials]

[ordered active layer]

[disordered active layer]

[having intermediate bandgap layers]

[characterised by special cladding layers, e.g. details on band-discontinuities]

[asymmetric cladding layers]

[comprising materials from other groups of the periodic system than the materials of the active layer, e.g. ZnSe claddings and GaAs active layer]

[graded composition cladding layers]

[quantum well or superlattice cladding layers]

[specially strained cladding layers, other than for strain compensation]

[explicitly Al-free cladding layers]

[type-II junctions]

[in $\text{A}_n\text{B}_m\text{V}_l$ compounds, e.g. PbSSe-laser]

[IV compounds]

$\text{Si}$

$\text{SiC}$

$\text{Si}_{\text{porous}}$

$\text{diamond}$

in $\text{A}_n\text{B}_m \text{ compounds}$, e.g. AlGaAs-laser, [InP-based laser]

emitting light at a wavelength less than 900 nm)

[comprising only (Al)GaAs]

[red laser based on InGaN]

[based on InGaN]

[blue laser based on GaN or GaP]

emitting light at a wavelength longer than 1000 nm, e.g. InP-based 1300 nm and 1500 nm lasers]

containing very small amounts, usually less than 1% of an additional III or V compound to decrease the bandgap strongly in a non-linear way by the bowing effect

[InGaAs with small amount of N]

[In(As)N with small amount of P, or In(As)P with small amount of N]

[small amount of Thallium (TI), e.g. GaTIP]

[based on In(Ga)AsP]

in $\text{A}_n\text{B}_m\text{V}_l \text{ compounds}$, e.g. ZnCdSe-laser
Functional characteristics

ASE (amplified spontaneous emission), noise; Reduction thereof.
Suppression of nonlinear conversion, e.g. specific design to suppress for example stimulated brillouin scattering [SBS], mainly in optical fibres in combination with multimode pumping

Gain spectral shaping, flattening

Gain non-linearity, distortion; Compensation thereof

Generation of pulses with special temporal shape or frequency spectrum

.s. solitons

Semiconductor lasers with special structural design for lasing in a specific polarisation mode

.TM polarisation

Semiconductor lasers with special structural design to influence the modes, e.g. specific multimode

.Single longitudinal mode

.Single transverse or lateral mode

Semiconductor lasers comprising special layers

.The laser chip comprising special buffer layers, e.g. dislocation prevention or reduction

.. Specific passivation layers on surfaces other than the emission facet

Semiconductor lasers with special structural design for influencing the near- or far-field

.. for reduction of Astigmatism

.Lasers with a special output beam profile or cross-section, e.g. non-Gaussian

.. with at least one hole in the intensity distribution, e.g. annular or doughnut mode

.. Top hat profile

Amplification / lasing wavelength

NOTE

In group H01S 2302/00 and separated therefrom by a + sign the wavelength in nanometers (nnnn) is indicated.

.THz - lasers, i.e. lasers with emission in the wavelength range of typically 0.1 mm to 1 mm

Pumping wavelength

NOTE

In group H01S 2303/00 and separated therefrom by a + sign the wavelength in nanometers (nnnn) is indicated.

Special growth methods for semiconductor lasers

.MBE

.MOMBE

.MOCVD or MOVPE

.LPE

.CBE

.Pendeo epitaxial lateral overgrowth [ELOG], e.g. for growing GaN based blue laser diodes