

When placing a mandatory classification in Class 257, a cross-reference classification is normally made in at least one of the appended E-subclasses.

1 **BULK EFFECT DEVICE**

- 2 ..Bulk effect switching in amorphous material
- 3 ..With means to localize region of conduction (e.g., "pore" structure)
- 4 ..With specified electrode composition or configuration
- 5 ..In array
- 6 ..Intervalley transfer (e.g., Gunn effect)
- 7 ..In monolithic integrated circuit
- 8 ..Three or more terminal device
- 9 **THIN ACTIVE PHYSICAL LAYER WHICH IS (1) AN ACTIVE POTENTIAL WELL LAYER THIN ENOUGH TO ESTABLISH DISCRETE QUANTUM ENERGY LEVELS OR (2) AN ACTIVE BARRIER LAYER THIN ENOUGH TO PERMIT QUANTUM MECHANICAL TUNNELING OR (3) AN ACTIVE LAYER THIN ENOUGH TO PERMIT CARRIER TRANSMISSION WITH SUBSTANTIALLY NO SCATTERING (E.G., SUPERLATTICE QUANTUM WELL, OR BALLISTIC TRANSPORT DEVICE)**
- 10 ..Low workfunction layer for electron emission (e.g., photocathode electron emissive layer)
- 11 ..Combined with a heterojunction involving a III-V compound
- 12 ..Heterojunction
- 13 ..Incoherent light emitter
- 14 ..Quantum well
- 15 ...Superlattice
- 16 Of amorphous semiconductor material
- 17 With particular barrier dimension
- 18 Strained layer superlattice
- 19 Si x Ge 1-x
- 20 Field effect device
- 21 Light responsive structure

- 22 With specified semiconductor materials
- 23 ...Current flow across well
- 24 ...Field effect device
- 25 ...Employing resonant tunneling
- 26 ..Ballistic transport device
- 27 ...Field effect transistor
- 28 ..Non-heterojunction superlattice (e.g., doping superlattice or alternating metal and insulator layers)
- 29 ..Ballistic transport device (e.g., hot electron transistor)
- 30 ..Tunneling through region of reduced conductivity
- 31 ..Josephson
- 32 ...Particular electrode material
- 33 High temperature (i.e., >300 Kelvin)
- 34 ...Weak link (e.g., narrowed portion of superconductive line)
- 35 ...Particular barrier material
- 36 ...With additional electrode to control conductive state of Josephson junction
- 37 ..At least one electrode layer of semiconductor material
- 38 ...Three or more electrode device
- 39 ..Three or more electrode device
- 40 **ORGANIC SEMICONDUCTOR MATERIAL**
- 41 **POINT CONTACT DEVICE**
- 42 **SEMICONDUCTOR IS SELENIUM OR TELLURIUM IN ELEMENTAL FORM**
- 43 **SEMICONDUCTOR IS AN OXIDE OF A METAL (E.G., CUO, ZNO) OR COPPER SULFIDE**
- 44 **WITH METAL CONTACT ALLOYED TO ELEMENTAL SEMICONDUCTOR TYPE PN JUNCTION IN NONREGENERATIVE STRUCTURE**
- 45 ..Elongated alloyed region (e.g., thermal gradient zone melting, TGZM)
- 46 ..In pn junction tunnel diode (Esaki diode)
- 47 ..In bipolar transistor structure
- 48 **TEST OR CALIBRATION STRUCTURE**
- 49 **NON-SINGLE CRYSTAL, OR RECRYSTALLIZED, SEMICONDUCTOR MATERIAL FORMS PART OF ACTIVE JUNCTION (INCLUDING FIELD-INDUCED ACTIVE JUNCTION)**

50	.Non-single crystal, or recrystallized, active junction adapted to be electrically shorted (e.g., "anti-fuse" element)	65	.Non-single crystal, or recrystallized, material containing non-dopant additive, or alloy of semiconductor materials (e.g., Ge x Si 1- x, polycrystalline silicon with dangling bond modifier)
51	.Non-single crystal, or recrystallized, material forms active junction with single crystal material (e.g., monocrystal to polycrystal pn junction or heterojunction)	66	.Field effect device in non-single crystal, or recrystallized, Semiconductor material
52	.Amorphous semiconductor material	67	..In combination with device formed in single crystal semiconductor material (e.g., stacked FETs)
53	..Responsive to nonelectrical external signals (e.g., light)	68	...Capacitor element in single crystal semiconductor (e.g., DRAM)
54	...With Schottky barrier to amorphous material	69	...Field effect transistor in single crystal material, complementary to that in non-single crystal, or recrystallized, material (e.g., CMOS)
55	...Amorphous semiconductor is alloy or contains material to change band gap (e.g., Si x Ge 1-x , SiN y)	70	...Recrystallized semiconductor material
56	...With impurity other than hydrogen to passivate dangling bonds (e.g., halide)	71	..In combination with capacitor element (e.g., DRAM)
57	..Field effect device in amorphous semiconductor material	72	..In array having structure for use as imager or display, or with transparent electrode
58	...With impurity other than hydrogen to passivate dangling bonds (e.g., halide)	73	.Schottky barrier to polycrystalline semiconductor material
59	...In array having structure for use as imager or display, or with transparent electrode	74	.Plural recrystallized semiconductor layers (e.g., "3-dimensional integrated circuit")
60	...With field electrode under or on a side edge of amorphous semiconductor material (e.g., vertical current path)	75	.Recrystallized semiconductor material
61	...With heavily doped regions contacting amorphous semiconductor material (e.g., heavily doped source and drain)	76	SPECIFIED WIDE BAND GAP (1.5eV) SEMICONDUCTOR MATERIAL OTHER THAN GaAsP OR GaAlAs
62	..With impurity other than hydrogen to passivate dangling bonds (e.g., halide)	77	.Diamond or silicon carbide
63	.Amorphous semiconductor is alloy or contains material to change band gap (e.g., Si x Ge 1-x , SiN y)	78	.II-VI compound
64	.Non-single crystal, or recrystallized, material with specified crystal structure (e.g., specified crystal size or orientation)	79	INCOHERENT LIGHT EMITTER STRUCTURE
		80	.In combination with or also constituting light responsive device
		81	..With specific housing or contact structure

82	...Discrete light emitting and light responsive devices	106	.Reverse bias tunneling structure (e.g., "backward" diode, true Zener diode)
83	..Light coupled transistor structure	107	REGENERATIVE TYPE SWITCHING DEVICE (E.G., SCR, COMFET, THYRISTOR)
84	..Combined in integrated structure	108	.Controlled by nonelectrical, nonoptical external signal (e.g., magnetic field, pressure, thermal)
85	...With heterojunction	109	.Having only two terminals and no control electrode (gate), e.g., Shockley diode
86	.Active layer of indirect band gap semiconductor	110	..More than four semiconductor layers of alternating conductivity types (e.g., pnpnpn structure, 5 layer bidirectional diacs, etc.)
87	..With means to facilitate electron-hole recombination (e.g., isoelectronic traps such as nitrogen in GaP)	111	..Triggered by V BO overvoltage means
88	.Plural light emitting devices (e.g., matrix, 7-segment array)	112	..With highly-doped breakdown diode trigger
89	..Multi-color emission	113	.With light activation
90	...With heterojunction	114	..With separate light detector integrated on chip with regenerative switching device
91	..With shaped contacts or opaque masking	115	..With electrical trigger signal amplification means (e.g., amplified gate, "pilot thyristor", etc.)
92	..Alphanumeric segmented array	116	..With light conductor means (e.g., light fiber or light pipe) integral with device or device enclosure or package
93	..With electrical isolation means in integrated circuit structure	117	...In groove or with thinned semiconductor portion
94	.With heterojunction	118	..With groove or thinned light sensitive portion
95	..With contoured external surface (e.g., dome shape to facilitate light emission)	119	.Bidirectional rectifier with control electrode (gate) (e.g., Triac)
96	..Plural heterojunctions in same device	120	..Six or more semiconductor layers of alternating conductivity types (e.g., npnpnpn structure)
97	...More than two heterojunctions in same device	121	..With diode or transistor in reverse path
98	.With reflector, opaque mask, or optical element (e.g., lens, optical fiber, index of refraction matching layer, luminescent material layer, filter) integral with device or device enclosure or package	122	..Lateral
99	.With housing or contact structure	123	..With trigger signal amplification (e.g., amplified gate)
100	.Encapsulated	124	..Combined with field effect transistor structure
101	.With particular dopant concentration or concentration profile (e.g., graded junction)	125	...Controllable emitter shunting
102	.With particular dopant material (e.g., zinc as dopant in GaAs)		
103	.With particular semiconductor material		
104	TUNNELING PN JUNCTION (E.G., ESAKI DIODE) DEVICE		
105	.In three or more terminal device		

126	..With means to separate a device into sections having different conductive polarity	152	..Cathode emitter or cathode electrode feature
127	...Guard ring or groove	153	..Gate region or electrode feature
128	..Having overlapping sections of different conductive polarity	154	.With resistive region connecting separate sections of device
129	..With means to increase reverse breakdown voltage	155	.With switching speed enhancement means (e.g., Schottky contact)
130	..Switching speed enhancement means	156	..Having deep level dopants or recombination centers
131	...Recombination centers or deep level dopants	157	.With integrated trigger signal amplification means (e.g., amplified gate, "pilot thyristor", etc.)
132	.Five or more layer unidirectional structure	158	..Three or more amplification stages
133	.Combined with field effect transistor	159	..Transistor as amplifier
134	..J-FET (junction field effect transistor)	160	..With distributed amplified current
135	...Vertical (i.e., where the source is located above the drain or vice versa)	161	..With a turn-off diode
136	Enhancement mode (e.g., so-called SITs)	162	.Lateral structure
137	..Having controllable emitter shunt	163	.Emitter region feature
138	...Having gate turn off (GTO) feature	164	..Multi-emitter region (e.g., emitter geometry or emitter ballast resistor)
139	..With extended latchup current level (e.g., COMFET device)	165	...Laterally symmetric regions
140	...Combined with other solid-state active device in integrated structure	166	...Radially symmetric regions
141	...Lateral structure, i.e., current flow parallel to main device surface	167	.Having at least four external electrodes
142	..Having impurity doping for gain reduction	168	.With means to increase breakdown voltage
143	...Having anode shunt means	169	..High resistivity base layer
144	...Cathode emitter or cathode electrode feature	170	..Surface feature (e.g., guard ring, groove, mesa, etc.)
145	...Low impedance channel contact extends below surface	171	...Edge feature (e.g., beveled edge)
146	.Combined with other solid-state active device in integrated structure	172	.With means to lower "ON" voltage drop
147	.With extended latchup current level (e.g., gate turn off "GTO" device)	173	.Device protection (e.g., from overvoltage)
148	..Having impurity doping for gain reduction	174	..Rate of rise of current (e.g., dI/dt)
149	..Having anode shunt means	175	.With means to control triggering (e.g., gate electrode configuration, Zener diode firing, dV/Dt control, transient control by ferrite bead, etc.)
150	..With specified housing or external terminal	176	..Located in an emitter-gate region
151	...External gate terminal structure or composition	177	.With housing or external electrode

178	..With means to avoid stress between electrode and active device (e.g., thermal expansion matching of electrode to semiconductor)	200	.Heterojunction formed between semiconductor materials which differ in that they belong to different periodic table groups (e.g., Ge (group IV) - GaAs (group III-V) or InP (group III-V) - CdTe (group II-VI))
179	...With malleable electrode (e.g., silver electrode layer)		
180	..Stud mount		
181	..With large area flexible electrodes in press contact with opposite sides of active semiconductor chip and surrounded by an insulating element, (e.g., ring)	201	.Between different group IV-VI or II-VI or III-V compounds other than GaAs/GaAlAs
182	...With lead feedthrough means on side of housing	202	GATE ARRAYS
183	HETEROJUNCTION DEVICE	203	.With particular chip input/output means
183.1	.Charge transfer device	204	.Having specific type of active device (e.g., CMOS)
184	.Light responsive structure	205	..With bipolar transistors or with FETs of only one channel conductivity type (e.g., enhancement-depletion FETs)
185	..Staircase (including graded composition) device	206	..Particular layout of complementary FETs with regard to each other
186	..Avalanche photodetection structure	207	.With particular power supply distribution means
187	..Having transistor structure	208	.With particular signal path connections
188	..Having narrow energy band gap (<<1eV) layer (e.g., PbSnTe, HgCdTe, etc.)	209	..Programmable signal paths (e.g., with fuse elements, laser programmable, etc)
189	...Layer is a group III-V semiconductor compound	210	..With wiring channel area
190	.With lattice constant mismatch (e.g., with buffer layer to accommodate mismatch)	211	..Multi-level metallization
191	.Having graded composition	212	CONDUCTIVITY MODULATION DEVICE (E.G., UNIJUNCTION TRANSISTOR, DOUBLE-BASE DIODE, CONDUCTIVITY-MODULATED TRANSISTOR)
192	.Field effect transistor		
194	..Doping on side of heterojunction with lower carrier affinity (e.g., high electron mobility transistor (HEMT))	213	FIELD EFFECT DEVICE
195	...Combined with diverse type device	214	.Charge injection device
196	.Both semiconductors of the heterojunction are the same conductivity type (i.e., either n or p)	215	.Charge transfer device
197	.Bipolar transistor	216	..Majority signal carrier (e.g., buried or bulk channel, or peristaltic)
198	..Wide band gap emitter	217	...Having a conductive means in direct contact with channel (e.g., non-insulated gate)
199	.Avalanche diode (e.g., so-called "Zener" diode having breakdown voltage greater than 6 volts, including heterojunction IMPATT type microwave diodes)	218	...High resistivity channel (e.g., accumulation mode) or surface channel (e.g., transfer of signal charge occurs at the surface of the semiconductor) or minority carriers at input (i.e., surface channel input)
		219	...Impurity concentration variation

220	Vertically within channel (e.g., profiled)	240	..Changing width or direction of channel (e.g., meandering channel)
221	Along the length of the channel (e.g., doping variations for transfer directionality)	241	..Multiple channels (e.g., converging or diverging or parallel channels)
222	...Responsive to non-electrical external signal (e.g., imager)	242	..Vertical charge transfer
223	Having structure to improve output signal (e.g., antiblooming drain)	243	..Channel confinement
224	...Channel confinement	244	..Comprising a groove
225	..Non-electrical input responsive (e.g., light responsive imager, input programmed by size of storage sites for use as a read-only memory, etc.)	245	..Structure for applying electric field into device (e.g., resistive electrode, acoustic traveling wave in channel)
226	...Sensor element and charge transfer device are of different materials or on different substrates (e.g., "hybrid")	246	...Phase structure (e.g., doping variations to provide asymmetry for 2-phase operation; more than four phases or "electrode per bit")
227	...With specified dopant (e.g., photoionizable, "extrinsic" detectors for infrared)	247	Uniphase or virtual phase structure
228	...Light responsive, back illuminated	248	2-phase
229	...Having structure to improve output signal (e.g., exposure control structure)	249	...Electrode structures or materials
230	With blooming suppression structure	250	Plural gate levels
231	...2-dimensional area architecture	251	..Substantially incomplete signal charge transfer (e.g., bucket brigade)
232	Having alternating strips of sensor structures and register structures (e.g., interline imager)	252	..Responsive to non-optical, non-electrical signal
233	Sensors not overlaid by electrode (e.g., photodiodes)	253	..Chemical (e.g., ISFET, CHEMFET)
234	...Single strip of sensors (e.g., linear imager)	254	..Physical deformation (e.g., strain sensor, acoustic wave detector)
235	..Electrical input	255	..With current flow along specified crystal axis (e.g., axis of maximum carrier mobility)
236	...Signal applied to field effect electrode	256	..Junction field effect transistor (unipolar transistor)
237	Charge-presetting/linear input type (e.g., fill and spill)	257	..Light responsive or combined with light responsive device
238	...Input signal responsive to signal charge in charge transfer device (e.g., regeneration or feedback)	258	...In imaging array
239	..Signal charge detection type (e.g., floating diffusion or floating gate non-destructive output)	259	..Elongated active region acts as transmission line or distributed active element (e.g., "transmission line" field effect transistor)
		260	..Same channel controlled by both junction and insulated gate electrodes, or by both Schottky barrier and pn junction gates (e.g., "taper isolated" memory cell)

261	..Junction gate region free of direct electrical connection (e.g., floating junction gate memory cell structure)	284	...Schottky gate in groove
262	..Combined with insulated gate field effect transistor (IGFET)	285	..With profiled channel dopant concentration or profiled gate region dopant concentration (e.g., maximum dopant concentration below surface)
263	..Vertical controlled current path	286	..With non-uniform channel thickness or width
264	...Enhancement mode or with high resistivity channel (e.g., doping of 10 15 cm ⁻³ or less)	287	..With multiple channels or channel segments connected in parallel, or with channel much wider than length between source and drain (e.g., power JFET)
265	...In integrated circuit	288	.Having insulated electrode (e.g., MOSFET, MOS diode)
266	...With multiple parallel current paths (e.g., grid gate)	289	..Significant semiconductor chemical compound in bulk crystal (e.g., GaAs)
267	With Schottky barrier gate	290	..Light responsive or combined with light responsive device
268	..Enhancement mode	291	...Imaging array
269	...With means to adjust barrier height (e.g., doping profile)	292	Photodiodes accessed by FETs
270	..Plural, separately connected, gates control same channel region	293	Photoresistors accessed by FETs, or photodetectors separate from FET chip
271	..Load element or constant current source (e.g., with source to gate connection)	294	With shield, filter, or lens
272	..Junction field effect transistor in integrated circuit	295	..With ferroelectric material layer
273	...With bipolar device	296	..Insulated gate capacitor or insulated gate transistor combined with capacitor (e.g., dynamic memory cell)
274	...Complementary junction field effect transistors	297	...With means for preventing charge leakage due to minority carrier generation (e.g., alpha generated soft error protection or "dark current" leakage protection)
275	...Microwave integrated circuit (e.g., microstrip type)	298	...Capacitor for signal storage in combination with non-volatile storage means
276	With contact or heat sink extending through hole in semiconductor substrate, or with electrode suspended over substrate (e.g., air bridge)	299	...Structure configured for voltage converter (e.g., charge pump, substrate bias generator)
277	With capacitive or inductive elements	300	...Capacitor coupled to, or forms gate of, insulated gate field effect transistor (e.g., non-destructive readout dynamic memory cell structure)
278	..With devices vertically spaced in different layers of semiconductor material (e.g., "3-dimensional" integrated circuit)	301	...Capacitor in trench
279	..Pn junction gate in compound semiconductor material (e.g., GaAs)	302	Vertical transistor
280	..With Schottky gate	303	Stacked capacitor
281	...Schottky gate to silicon semiconductor		
282	...Gate closely aligned to source region		
283	With groove or overhang for alignment		

304	Storage node isolated by dielectric from semiconductor substrate	324	...Multiple insulator layers (e.g., MNOS structure)
305	With means to insulate adjacent storage nodes (e.g., channel stops or field oxide)	325	Non-homogeneous composition insulator layer (e.g., graded composition layer or layer with inclusions)
306	...Stacked capacitor	326	...With additional, non-memory control electrode or channel portion (e.g., accessing field effect transistor structure)
307	Parallel interleaved capacitor electrode pairs (e.g., interdigitized)	327	..Short channel insulated gate field effect transistor
308	With capacitor electrodes connection portion located centrally thereof (e.g., fin electrodes with central post)	328	...Vertical channel or double diffused insulated gate field effect device provided with means to protect against excess voltage (e.g., gate protection diode)
309	With increased effective electrode surface area (e.g., tortuous path, corrugated, or textured electrodes)	329	...Gate controls vertical charge flow portion of channel (e.g., VMOS device)
310	...With high dielectric constant insulator (e.g., Ta ₂ O ₅)	330	Gate electrode in groove
311	...Storage Node isolated by dielectric from semiconductor substrate	331	Plural gate electrodes or grid shaped gate electrode
312	...Voltage variable capacitor (i.e., capacitance varies with applied voltage)	332	Gate electrode self-aligned with groove
313	...Inversion layer capacitor	333	With thick insulator to reduce gate capacitance in non-channel areas (e.g., thick oxide over source or drain region)
314	..Variable threshold (e.g., floating gate memory device)	334	In integrated circuit structure
315	...With floating gate electrode	335	...Active channel region has a graded dopant concentration decreasing with distance from source region (e.g., double diffused device, DMOS transistor)
316	With additional contacted control electrode	336	...With lightly doped portion of drain region adjacent channel (e.g., LDD structure)
317	With irregularities on electrode to facilitate charging or discharging of floating electrode	337	In integrated circuit structure
318	Additional control electrode is doped region in semiconductor substrate	338	With complementary field effect transistor
319	Plural additional contacted control electrodes	339	...With means to increase breakdown voltage
320	Separate control electrodes for charging and for discharging floating electrode	340	...With means (other than self-alignment of the gate electrode) to decrease gate capacitance (e.g., shield electrode)
321	With thin insulator region for charging or discharging floating electrode by quantum mechanical tunneling	341	Plural sections connected in parallel (e.g., power MOSFET)
322	With charging or discharging by control voltage applied to source or drain region (e.g., by avalanche breakdown of drain junction)		
323	With means to facilitate light erasure		

342	With means to reduce ON resistance	360	Protection device includes insulated gate transistor structure (e.g., combined with resistor element)
343	All contacts on same surface (e.g., lateral structure)		
344	...With lightly doped portion of drain region adjacent channel (e.g., LDD structure)	361	For operation as bipolar or punchthrough element
345	...With means to prevent sub-surface currents, or with non-uniform channel doping	362	Punchthrough or bipolar element
346	...Gate electrode overlaps the source or drain by no more than depth of source or drain (e.g., self-aligned gate)	363	Including resistor element
		364	..With resistive gate electrode
		365	..With plural, separately connected, gate electrodes in same device
347	..Single crystal semiconductor layer on insulating substrate (SOI)	366	...Overlapping gate electrodes
		367	..Insulated gate controlled breakdown of pn junction (e.g., field plate diode)
348	...Depletion mode field effect transistor	368	..Insulated gate field effect transistor in integrated circuit
349	...With means (e.g., a buried channel stop layer) to prevent leakage current along the interface of the semiconductor layer and the insulating substrate	369	...Complementary insulated gate field effect transistors
		370	Combined with bipolar transistor
350	...Insulated electrode device is combined with diverse type device (e.g., complementary MOSFETs, FET with resistor, etc.)	371	Complementary transistors in wells of opposite conductivity types more heavily doped than the substrate region in which they are formed, e.g., twin wells
351	Complementary field effect transistor structures only (i.e., not including bipolar transistors, resistors, or other components)	372	With means to prevent latchup or parasitic conduction channels
352	...Substrate is single crystal insulator (e.g., sapphire or spinel)	373	With pn junction to collect injected minority carriers to prevent parasitic bipolar transistor action
353	Single crystal islands of semiconductor layer containing only one active device	374	Dielectric isolation means (e.g., dielectric layer in vertical grooves)
354	Including means to eliminate island edge effects (e.g., insulating filling between islands, or ions in island edges)	375	With means to reduce substrate spreading resistance (e.g., heavily doped substrate)
355	..With overvoltage protective means	376	With barrier region of reduced minority carrier lifetime (e.g., heavily doped P+ region to reduce electron minority carrier lifetime, or containing deep level impurity or crystal damage), or with region of high threshold voltage (e.g., heavily doped channel stop region)
356	...For protecting against gate insulator breakdown		
357	In complementary field effect transistor integrated circuit		
358	Including resistor element		
359	As thin film structure (e.g., polysilicon resistor)		

377	With polysilicon interconnections to source or drain regions (e.g., polysilicon laminated with silicide)	394	...With means to prevent parasitic conduction channels
378	...Combined with bipolar transistor	395	Thick insulator portion
379	...Combined with passive components (e.g., resistors)	396	Recessed into semiconductor surface
380	Polysilicon resistor	397	In vertical-walled groove
381	With multiple levels of polycrystalline silicon	398	Combined with heavily doped channel stop portion
382	...With contact to source or drain region of refractory material (e.g., polysilicon, tungsten, or silicide)	399	Combined with heavily doped channel stop portion
383	Contact of refractory or platinum group metal (e.g., molybdenum, tungsten, or titanium)	400	...With heavily doped channel stop portion
384	Including silicide	401	...With specified physical layout (e.g., ring gate, source/drain regions shared between plural FETs, plural sections connected in parallel to form power MOSFET)
385	Multiple polysilicon layers	402	..With permanent threshold adjustment (e.g., depletion mode)
386	...With means to reduce parasitic capacitance	403	...With channel conductivity dopant same type as that of source and drain
387	Gate electrode overlaps at least one of source or drain by no more than depth of source or drain (e.g., self-aligned gate)	404	Non-uniform channel doping
388	Gate electrode consists of refractory or platinum group metal or silicide	405	...With gate insulator containing specified permanent charge
389	With thick insulator over source or drain region	406	Plural gate insulator layers
390	...Matrix or array of field effect transistors (e.g., array of FETs only some of which are completed, or structure for mask programmed read-only memory (ROM))	407	...With gate electrode of controlled workfunction material (e.g., low workfunction gate material)
391	Selected groups of complete field effect devices having different threshold voltages (e.g., different channel dopant concentrations)	408	..Including lightly doped drain portion adjacent channel (e.g., lightly doped drain, LDD device)
392	...Insulated gate field effect transistors of different threshold voltages in same integrated circuit (e.g., enhancement and depletion mode)	409	..With means to increase breakdown voltage (e.g., field shield electrode, guard ring, etc.)
393	...Insulated gate field effect transistor adapted to function as load element for switching insulated gate field effect transistor	410	..Gate insulator includes material (including air or vacuum) other than SiO ₂
		411	...Composite or layered gate insulator (e.g., mixture such as silicon oxynitride)
		412	..Gate electrode of refractory material (e.g., polysilicon or a silicide of a refractory or platinum group metal)
		413	...Polysilicon laminated with silicide

414	RESPONSIVE TO NON-ELECTRICAL SIGNAL (E.G., CHEMICAL, STRESS, LIGHT, OR MAGNETIC FIELD SENSORS)	436	...With means for increasing light absorption (e.g., redirection of unabsorbed light)
415	..Physical deformation	437	Antireflection coating
416	..Acoustic wave	438	...Avalanche junction
417	..Strain sensors	439	...Containing dopant adapted for photoionization
418	...With means to concentrate stress	440	...With different sensor portions responsive to different wavelengths (e.g., color imager)
419	With thinned central active portion of semiconductor surrounded by thick insensitive portion (e.g. diaphragm type strain gauge)	441	...Narrow band gap semiconductor ($<1\text{eV}$) (e.g., PbSnTe)
420	..Means to reduce sensitivity to physical deformation	442	II-VI compound semiconductor (e.g., HgCdTe)
421	..Magnetic field	443	...Matrix or array (e.g., single line arrays)
422	..With magnetic field directing means (e.g., shield, pole piece, etc.)	444	Light sensor elements overlies active switching elements in integrated circuit (e.g., where the sensor elements are deposited on an integrated circuit)
423	..Bipolar transistor magnetic field sensor (e.g., lateral bipolar transistor)	445	With antiblooming means
424	..Sensor with region of high carrier recombination (e.g., magnetodiode with carriers deflected to recombination region by magnetic field)	446	With specific isolation means in integrated circuit
425	..Magnetic field detector using compound semiconductor material (e.g., GaAs, InSb, etc.)	447	With backside illumination (e.g., having a thinned central area or a non- absorbing substrate)
426	..Differential output (e.g., with offset adjustment means or with means to reduce temperature sensitivity)	448	With particular electrode configuration
427	..Magnetic field sensor in integrated circuit (e.g., in bipolar transistor integrated circuit)	449	...Schottky barrier (e.g., a transparent Schottky metallic layer or a Schottky barrier containing at least one of indium or tin (e.g., SnO_2 , indium tin oxide))
428	..Electromagnetic or particle radiation	450	With doping profile to adjust barrier height
429	..Charged or elementary particles	451	Responsive to light having lower energy (i.e., longer wavelength) than forbidden band gap energy of semiconductor (e.g., by excitation of carriers from metal into semiconductor)
430	...With active region having effective impurity concentration less than 10^{12} atoms/cm ³	452	With edge protection, e.g., doped guard ring or mesa structure
431	..Light	453	With specified Schottky metallic layer
432	...With optical element	454	Schottky metallic layer is a silicide
433	...With housing or encapsulation		
434	With window means		
435	...With optical shield or mask means		

455	Silicide of Platinum group metal	480	.In voltage variable capacitance diode
456	Silicide of refractory metal	481	.Avalanche diode (e.g., so-called "Zener" diode having breakdown voltage greater than 6 volts)
457	With particular contact geometry (e.g., ring or grid)	482	..Microwave transit time device (e.g., IMPATT diode)
458	...PIN detector, including combinations with non-light responsive active devices	483	.With means to prevent edge breakdown
459	...With particular contact geometry (e.g., ring or grid, or bonding pad arrangement)	484	..Guard ring
460	...With backside illumination (e.g., with a thinned central area or non-absorbing substrate)	485	.Specified materials
461	...Light responsive pn junction	486	..Layered (e.g., a diffusion barrier material layer or a silicide layer or a precious metal layer)
462	Phototransistor	487	WITH MEANS TO INCREASE BREAKDOWN VOLTAGE THRESHOLD
463	With particular doping concentration	488	.Field relief electrode
464	With particular layer thickness (e.g., layer less than light absorption depth)	489	..Resistive
465	Geometric configuration of junction (e.g., fingers)	490	..Combined with floating pn junction guard region
466	...External physical configuration of semiconductor (e.g., mesas, grooves)	491	.In integrated circuit
467	.Temperature	492	..With electric field controlling semiconductor layer having a low enough doping level in relationship to its thickness to be fully depleted prior to avalanche breakdown (e.g., RESURF devices)
468	..Semiconductor device operated at cryogenic temperature	493	.With electric field controlling semiconductor layer having a low enough doping level in relationship to its thickness to be fully depleted prior to avalanche breakdown (e.g., RESURF devices)
469	..With means to reduce temperature sensitivity (e.g., reduction of temperature sensitivity of junction breakdown voltage by using a compensating element)	494	.Reverse-biased pn junction guard region
470	..Pn junction adapted as temperature sensor	495	.Floating pn junction guard region
471	SCHOTTKY BARRIER	496	.With physical configuration of semiconductor surface to reduce electric field (e.g., reverse bevels, double bevels, stepped mesas, etc.)
472	.To compound semiconductor	497	PUNCHTHROUGH STRUCTURE DEVICE (E.G., PUNCHTHROUGH TRANSISTOR, CAMEL BARRIER DIODE)
473	..With specified Schottky metal	498	.Punchthrough region fully depleted at zero external applied bias voltage (e.g., camel barrier or planar doped barrier devices, or so-called "Bipolar SIT" devices)
474	.As active junction in bipolar transistor (e.g., Schottky collector)		
475	.With doping profile to adjust barrier height		
476	.In integrated structure		
477	..With bipolar transistor		
478	...Plural Schottky barriers with different barrier heights		
479	...Connected across base-collector junction of transistor (e.g., Baker clamp)		

499	INTEGRATED CIRCUIT STRUCTURE WITH ELECTRICALLY ISOLATED COMPONENTS	514	With active junction abutting groove (e.g., "walled emitter")
500	..Including high voltage or high power devices isolated from low voltage or low power devices in the same integrated circuit	515	With active junction abutting groove (e.g., "walled emitter")
501	..Including dielectric isolation means	516	...With passive component (e.g., resistor, capacitor, etc.)
502	..High power or high voltage device extends completely through semiconductor substrate (e.g., backside collector contact)	517	...With bipolar transistor structure
503	..With contact or metallization configuration to reduce parasitic coupling (e.g., separate ground pads for different parts of integrated circuit)	518	With polycrystalline connecting region (e.g., polysilicon base contact)
504	..Including means for establishing a depletion region throughout a semiconductor layer for isolating devices in different portions of the layer (e.g., "JFET" isolation)	519	...Including heavily doped channel stop region adjacent groove
505	..With polycrystalline semiconductor isolation region in direct contact with single crystal active semiconductor material	520	Conductive filling in dielectric-lined groove (e.g., polysilicon backfill)
506	..Including dielectric isolation means	521	Sides of grooves along major crystal planes (e.g., (111), (100) planes, etc.)
507	..With single crystal insulating substrate (e.g., sapphire)	522	..Air isolation (e.g., beam lead supported semiconductor islands)
508	..With metallic conductor within isolating dielectric or between semiconductor and isolating dielectric (e.g., metal shield layer or internal connection layer)	523	..Isolation by region of intrinsic (undoped) semiconductor material (e.g., including region physically damaged by proton bombardment)
509	..Combined with pn junction isolation (e.g., isoplanar, LOCOS)	524	..Full dielectric isolation with polycrystalline semiconductor substrate
510	...Dielectric in groove	525	...With complementary (nnp and pnp) bipolar transistor structures
511	With complementary (nnp and pnp) bipolar transistor structures	526	..With bipolar transistor structure
512	Complementary devices share common active region (e.g., integrated injection logic, I ² L)	527	...Sides of isolated semiconductor islands along major crystal planes (e.g., (111), (100) planes, etc.)
513	Vertical walled groove	528	..Passive components in ICs
		529	..Including programmable passive component (e.g., fuse)
		530	...Anti-fuse
		531	..Including inductive element
		532	..Including capacitor component
		533	...Combined with resistor to form RC filter structure
		534	...With means to increase surface area (e.g., grooves, ridges, etc.)
		535	...Both terminals of capacitor isolated from substrate

536	..Including resistive element	551	..Including voltage reference element (e.g., avalanche diode, so-called "Zener diode" with breakdown voltage greater than 6 volts or with positive temperature coefficient of breakdown voltage)
537	...Using specific resistive material		
538	Polycrystalline silicon (doped or undoped)		
539	...Combined with bipolar transistor		
540	With compensation for non-linearity (e.g., dynamic isolation pocket bias)	552	..With bipolar transistor structure
541	Pinch resistor	553	...Transistors of same conductivity type (e.g., npn) having different current gain or different operating voltage characteristics
542	Resistor has same doping as emitter or collector of bipolar transistor		
543	Lightly doped junction isolated resistor (e.g., ion implanted resistor)	554	...With connecting region made of polycrystalline semiconductor material (e.g., polysilicon base contact)
544	.With pn junction isolation		
545	..With means to control isolation junction capacitance (e.g., lightly doped layer at isolation junction to increase depletion layer width)	555	...Complementary bipolar transistor structures (e.g., integrated injection logic, I ² L)
546	..With structural means to protect against excess or reversed polarity voltage	556	Including lateral bipolar transistor structure
547	..With structural means to control parasitic transistor action or leakage current	557	.Lateral bipolar transistor structure
548	..At least three regions of alternating conductivity types with dopant concentration gradients decreasing from surface of semiconductor (e.g., "triple-diffused" integrated circuit)	558	..With base region doping concentration step or gradient or with means to increase current gain
549	..With substrate and lightly doped surface layer of same conductivity type, separated by subsurface heavily doped region of opposite conductivity type (e.g., "collector diffused isolation" integrated circuit)	559	..With active region formed along groove or exposed edge in semiconductor
550	..With lightly doped surface layer of one conductivity type on substrate of opposite conductivity type, having plural heavily doped portions of the one conductivity type between the layer and substrate, different ones of the heavily doped portions having differing depths or physical extent	560	..With multiple collectors or emitters
		561	...With different emitter to collector spacings or facing areas
		562	...With auxiliary collector/re-emitter between emitter and output collector (e.g., "Current Hogging Logic" device)
		563	.With multiple separately connected emitter, collector, or base regions in same transistor structure
		564	..Multiple base or collector regions
		565	BIPOLAR TRANSISTOR STRUCTURE
		566	.Plural non-isolated transistor structures in same structure

567	..Darlington configuration (i.e., emitter to collector current of input transistor supplied to base region of output transistor)	583	..With means to reduce transistor action in selected portions of transistor (e.g., heavy base region doping under central web of emitter to prevent secondary breakdown)
568	...More than two Darlington-connected transistors	584	..With housing or contact (i.e., electrode) means
569	...Complementary Darlington-connected transistors	585	.With means to increase inverse gain
570	...With active components in addition to Darlington transistors (e.g., antisaturation diode, bleeder diode connected antiparallel to input transistor base-emitter junction, etc.)	586	.With non-planar semiconductor surface (e.g., groove, mesa, bevel, etc.)
571	...Non-planar structure (e.g., mesa emitter, or having a groove to define resistor)	587	.With specified electrode means
572	...With resistance means connected between transistor base regions	588	..Including polycrystalline semiconductor as connection
573	...With housing or contact structure or configuration	589	.Avalanche transistor
574	..Complementary transistors share common active region (e.g., integrated injection logic, I ² L)	590	.With means to reduce minority carrier lifetime (e.g., region of deep level dopant or region of crystal damage)
575	...Including lateral bipolar transistor structure	591	.With emitter region having specified doping concentration profile (e.g., high-low concentration step)
576	With contacts of refractory material (e.g., polysilicon, silicide of refractory or platinum group metal)	592	.With base region having specified doping concentration profile or specified configuration (e.g., inactive base more heavily doped than active base or base region has constant doping concentration portion (e.g., epitaxial base))
577	.Including additional component in same, non-isolated structure (e.g., transistor with diode, transistor with resistor, etc.)	593	.With means to increase current gain or operating frequency
578	.With enlarged emitter area (e.g., power device)	594	WITH GROOVE TO DEFINE PLURAL DIODES
579	..With separate emitter areas connected in parallel	595	VOLTAGE VARIABLE CAPACITANCE DEVICE
580	...With current ballasting means (e.g., emitter ballasting resistors or base current ballasting means)	596	.With specified dopant profile
581	Thin film ballasting means (e.g., polysilicon resistor)	597	..Retrograde dopant profile (e.g., dopant concentration decreases with distance from rectifying junction)
582	..With current ballasting means (e.g., emitter ballasting resistors or base current ballasting resistors)	598	.With plural junctions whose depletion regions merge to vary voltage dependence
		599	.With means to increase active junction area (e.g., grooved or convoluted surface)
		600	.With physical configuration to vary voltage dependence (e.g., mesa)

- 601 .Plural diodes in same non-isolated structure, or device having three or more terminals
- 602 .With specified housing or contact
- 603 **AVALANCHE DIODE (E.G., SO-CALLED "ZENER" DIODE HAVING BREAKDOWN VOLTAGE GREATER THAN 6 VOLTS)**
- 604 .Microwave transit time device (e.g., IMPATT diode)
- 605 .With means to limit area of breakdown (e.g., guard ring having higher breakdown voltage)
- 606 ..Subsurface breakdown
- 607 **WITH SPECIFIED DOPANT (E.G., PLURAL DOPANTS OF SAME CONDUCTIVITY IN SAME REGION)**
- 608 .Switching device based on filling and emptying of deep energy levels
- 609 .For compound semiconductor (e.g., deep level dopant)
- 610 .Deep level dopant
- 611 ..With specified distribution (e.g., laterally localized, with specified concentration distribution or gradient)
- 612 ..Deep level dopant other than gold or platinum
- 613 **INCLUDING SEMICONDUCTOR MATERIAL OTHER THAN SILICON OR GALLIUM ARSENIDE (GAAS) (E.G., PB X SN 1-X TE)**
- 614 .Group II-VI compound (e.g., CdTe, Hg x Cd 1-x Te)
- 615 .Group III-V compound (e.g., InP)
- 616 .Containing germanium, Ge
- 617 **INCLUDING REGION CONTAINING CRYSTAL DAMAGE**
- 618 **PHYSICAL CONFIGURATION OF SEMICONDUCTOR (E.G., MESA, BEVEL, GROOVE, ETC.)**
- 619 .With thin active central semiconductor portion surrounded by thicker inactive shoulder (e.g., for mechanical support)
- 620 .With peripheral feature due to separation of smaller semiconductor chip from larger wafer (e.g., scribe region, or means to prevent edge effects such as leakage current at peripheral chip separation area)
- 621 .With electrical contact in hole in semiconductor (e.g., lead extends through semiconductor body)
- 622 .Groove
- 623 .Mesa structure (e.g., including undercut or stepped mesa configuration or having constant slope taper)
- 624 ..With low resistance ohmic connection means along exposed mesa edge (e.g., contact or heavily doped region along exposed mesa to reduce "skin effect" losses in microwave diode)
- 625 ..Semiconductor body including mesa is intimately bonded to thick electrical and/or thermal conductor member of larger lateral extent than semiconductor body (e.g., "plated heat sink" microwave diode)
- 626 ..Combined with passivating coating
- 627 .With specified crystal plane or axis
- 628 ..Major crystal plane or axis other than (100), (110), or (111) (e.g., (731) axis, crystal plane several degrees from (100) toward (011), etc.)
- 629 **WITH MEANS TO CONTROL SURFACE EFFECTS**
- 630 .With inversion-preventing shield electrode
- 631 .In compound semiconductor material (e.g., GaAs)
- 632 .Insulating coating
- 633 ..With thermal expansion compensation (e.g., thermal expansion of glass passivant matched to that of semiconductor)
- 634 ..Insulating coating of glass composition containing component to adjust melting or softening temperature (e.g., low melting point glass)
- 635 ..Multiple layers
- 636 ...At least one layer of semi-insulating material
- 637 ...Three or more insulating layers

638	...With discontinuous or varying thickness layer (e.g., layer covers only selected portions of semiconductor)	660	.With means to shield device contained in housing or package from charged particles (e.g., alpha particles) or highly ionizing radiation (i.e., hard X-rays or shorter wavelength)
639	...At least one layer of silicon oxynitride		
640	...At least one layer of silicon nitride	661	SUPERCONDUCTIVE CONTACT OR LEAD
641	Combined with glass layer	662	.Transmission line or shielded
642	...At least one layer of organic material	663	.On integrated circuit
643	Polyimide or polyamide	664	TRANSMISSION LINE LEAD (E.G., STRIPLINE, COAX, ETC.)
644	...At least one layer of glass	665	CONTACTS OR LEADS INCLUDING FUSIBLE LINK MEANS OR NOISE SUPPRESSION MEANS
645	...Insulating layer containing specified electrical charge (e.g., net negative electrical charge)	666	LEAD FRAME
646	..Coating of semi-insulating material (e.g., amorphous silicon or silicon-rich silicon oxide)	667	.With dam or vent for encapsulant
647	..Insulating layer recessed into semiconductor surface (e.g., LOCOS oxide)	668	.On insulating carrier other than a printed circuit board
648	...Combined with channel stop region in semiconductor	669	.With stress relief
649	..Insulating layer of silicon nitride or silicon oxynitride	670	.With separate tie bar element or plural tie bars
650	..Insulating layer of glass	671	..Of insulating material
651	..Details of insulating layer electrical charge (e.g., negative insulator layer charge)	672	.Small lead frame (e.g., "spider" frame) for connecting a large lead frame to a semiconductor chip
652	.Channel stop layer	673	.With bumps on ends of lead fingers to connect to semiconductor
653	WITH SPECIFIED SHAPE OF PN JUNCTION	674	.With means for controlling lead tension
654	.Interdigitated pn junction or more heavily doped side of junction is concave	675	.With heat sink means
655	WITH SPECIFIED IMPURITY CONCENTRATION GRADIENT	676	.With structure for mounting semiconductor chip to lead frame (e.g., configuration of die bonding flag, absence of a die bonding flag, recess for LED)
656	.With high resistivity (e.g., "intrinsic") layer between P and N layers (e.g., PIN diode)	677	.Of specified material other than copper (e.g., Kovar (T.M.))
657	.Stepped profile	678	HOUSING OR PACKAGE
658	PLATE TYPE RECTIFIER ARRAY	679	.Smart (e.g., credit) card package
659	WITH SHIELDING (E.G., ELECTRICAL OR MAGNETIC SHIELDING, OR FROM ELECTROMAGNETIC RADIATION OR CHARGED PARTICLES)	680	.With window means
		681	..For erasing EPROM
		682	.With desiccant, getter, or gas filling
		683	.With means to prevent explosion of package
		684	.With semiconductor element forming part (e.g., base, of housing)
		685	.Multiple housings
		686	..Stacked arrangement

687	..Housing or package filled with solid or liquid electrically insulating material	717	..Isolation of cooling means (e.g., heat sink) by an electrically insulating element (e.g., spacer)
688	..With large area flexible electrodes in press contact with opposite sides of active semiconductor chip and surrounded by an insulating element, e.g., ring	718	..Heat dissipating element held in place by clamping or spring means
689	..Rigid electrode portion	719	...Pressed against semiconductor element
690	..With contact or lead	720	..Heat dissipating element has high thermal conductivity insert (e.g., copper slug in aluminum heat sink)
691	..Having power distribution means (e.g., bus structure)	721	..With gas coolant
692	..With particular lead geometry	722	...With fins
693	...External connection to housing	723	.For plural devices
694	Axial leads	724	..With discrete components
695	Fanned/radial leads	725	..With electrical isolation means
696	Bent (e.g., J-shaped) lead	726	...Devices held in place by clamping
697	Pin grid type	727	.Device held in place by clamping
698	..With specific electrical feedthrough structure	728	.For high frequency (e.g., microwave) device
699	...Housing entirely of metal except for feedthrough structure	729	.Portion of housing of specific materials
700	..Multiple contact layers separated from each other by insulator means and forming part of a package or housing (e.g., plural ceramic layer package)	730	.Outside periphery of package having specified shape or configuration
701	..Insulating material	731	.With housing mount
702	..Of insulating material other than ceramic	732	..Flanged mount
703	..Composite ceramic, or single ceramic with metal	733	..Stud mount
704	..Cap or lid	734	COMBINED WITH ELECTRICAL CONTACT OR LEAD
705	..Of high thermal conductivity ceramic (e.g., BeO)	735	.Beam leads (i.e., leads that extend beyond the ends or sides of a chip component)
706	..With heat sink	736	..Layered
707	...Directly attached to semiconductor device	737	.Bump leads
708	..Entirely of metal except for feedthrough	738	..Ball shaped
709	..With specified insulator to isolate device from housing	739	.With textured surface
710	..With specified means (e.g., lip) to seal base to cap	740	.With means to prevent contact from penetrating shallow PN junction (e.g., prevention of aluminum "spiking")
711	..With raised portion of base for mounting semiconductor chip	741	.Of specified material other than unalloyed aluminum
712	..With provision for cooling the housing or its contents	742	..With a semiconductor conductivity substitution type dopant (e.g., germanium in the case of a gallium arsenide semiconductor) in a contact metal)
713	..For integrated circuit	743	...For compound semiconductor material
714	..Liquid coolant		
715	...Boiling (evaporative) liquid		
716	...Cryogenic liquid coolant		

744	..For compound semiconductor material	766	...At least one layer containing chromium or nickel
745	...Contact for III-V material	767	..Resistive to electromigration or diffusion of the contact or lead material
746	..Composite material (e.g., fibers or strands embedded in solid matrix)	768	..Refractory or platinum group metal or alloy or silicide thereof
747	..With thermal expansion matching of contact or lead material to semiconductor active device	769	...Platinum group metal or silicide thereof
748	...Plural layers of specified contact or lead material	770	...Molybdenum, tungsten, or titanium or their silicides
749	..At least portion of which is transparent to ultraviolet, visible or infrared light	771	..Alloy containing aluminum
750	..Layered	772	..Solder composition
751	...At least one layer forms a diffusion barrier	773	.Of specified configuration
752	...Planarized to top of insulating layer	774	..Via (interconnection hole) shape
753	...With adhesion promoting means (e.g., layer of material) to promote adhesion of contact to an insulating layer	775	..Varying width or thickness of conductor
754	...At least one layer of silicide or polycrystalline silicon	776	..Cross-over arrangement, component or structure
755	Polysilicon laminated with silicide	777	.Chip mounted on chip
756	Multiple polysilicon layers	778	.Flip chip
757	Silicide of refractory or platinum group metal	779	.Solder wettable contact, lead, or bond
758	..Multiple metal levels on semiconductor, separated by insulating layer (e.g., multiple level metallization for integrated circuit)	780	.Ball or nail head type contact, lead, or bond
759	Including organic insulating material between metal levels	781	..Layered contact, lead or bond
760	Separating insulating layer is laminate or composite of plural insulating materials (e.g., silicon oxide on silicon nitride, silicon oxynitride)	782	.Die bond
761	...At least one layer containing vanadium, hafnium, niobium, zirconium, or tantalum	783	..With adhesive means
762	...At least one layer containing silver or copper	784	.Wire contact, lead, or bond
763	...At least one layer of molybdenum, titanium, or tungsten	785	.By pressure alone
764	Alloy containing molybdenum, titanium, or tungsten	786	.Configuration or pattern of bonds
765	...At least one layer of an alloy containing aluminum	787	ENCAPSULATED
		788	.With specified encapsulant
		789	..With specified filler material
		790	..Plural encapsulating layers
		791	..Including polysiloxane (e.g., silicone resin)
		792	..Including polyimide
		793	..Including epoxide
		794	..Including glass
		795	.With specified filler material
		796	.With heat sink embedded in encapsulant
		797	ALIGNMENT MARKS
		798	MISCELLANEOUS
			<u>E-SUBCLASSES</u>

The following subclasses beginning with the letter E are E-subclasses. Each E-subclass corresponds in scope to a classification in a foreign classification system, for example, the European Classification system (ECLA). The foreign classification equivalent to an E-subclass is identified in the subclass definition. In addition to US documents classified in E-subclasses by US examiners, documents are regularly classified in E-subclasses according to the classification practices of any foreign Offices identified in parentheses at the end of the title. For example, "(EPO)" at the end of a title indicates both European and US patent documents, as classified by the EPO, are regularly added to the subclass. E-subclasses may contain subject matter outside the scope of this class. Consult their definitions, or the documents themselves to clarify or interpret titles.

E47.001 **BULK NEGATIVE RESISTANCE EFFECT DEVICES, E.G., GUNN-EFFECT DEVICES, PROCESSES, OR APPARATUS PECULIAR TO MANUFACTURE OR TREATMENT OF SUCH DEVICES, OR OF PARTS THEREOF (EPO)**

E47.002 .Gunn-effect devices or transferred electron devices (EPO)

E47.003 ..Controlled by electromagnetic radiation (EPO)

E47.004 ..Gunn diodes (EPO)

E47.005 .Processes or apparatus peculiar to manufacture or treatment of these devices or of parts thereof (EPO)

E39.001 **DEVICES USING SUPERCONDUCTIVITY, PROCESSES, OR APPARATUS PECULIAR TO MANUFACTURE OR TREATMENT OF SUCH DEVICES, OR OF PARTS THEREOF (EPO)**

E39.002 .Containers or mountings (EPO)

E39.003 ..For Josephson devices (EPO)

E39.004 .Characterized by current path (EPO)

E39.005 .Characterized by shape of element (EPO)

E39.006 .Characterized by material (EPO)

E39.007 ..Organic materials (EPO)

E39.008 ...Fullerene superconductors, e.g., soccerball-shaped allotrope of carbon, e.g., C60, C94 (EPO)

E39.009 ..Ceramic materials (EPO)

E39.01 ...Comprising copper oxide (EPO)

E39.011 Multilayered structures, e.g., super lattices (EPO)

E39.012 .Devices comprising junction of dissimilar materials, e.g., Josephson-effect devices (EPO)

E39.013 ..Single electron tunnelling devices (EPO)

E39.014 ..Josephson-effect devices (EPO)

E39.015 ...Comprising high Tc ceramic materials (EPO)

E39.016 ..Three or more electrode devices, e.g., transistor-like structures (EPO)

E39.017 .Permanent superconductor devices (EPO)

E39.018 ..Comprising high Tc ceramic materials (EPO)

E39.019 ..Three or more electrode devices (EPO)

E39.02 ...Field-effect devices (EPO)

E51.001 **ORGANIC SOLID STATE DEVICES, PROCESSES OR APPARATUS PECULIAR TO MANUFACTURE OR TREATMENT OF SUCH DEVICES OR OF PARTS THEREOF**

E51.002 .Structural detail of device (EPO)

E51.003 ..Organic solid-state device adapted for rectifying, amplifying, oscillating, or switching, or capacitors or resistors with potential or surface barrier (EPO)

E51.004 ...Controllable by only signal applied to control electrode (e.g., base of bipolar transistor, gate of field-effect transistor) (EPO)

E51.005 Field-effect device (e.g., TFT, FET) (EPO)

E51.006 Insulated gate field-effect transistor (EPO)

E51.007 Comprising organic gate dielectric (EPO)

- E51.008 ...Controllable only by variation of electric current supplied or only electric potential applied to electrode carrying current to be rectified, amplified, oscillated, or switched (e.g., two terminal device) (EPO)
- E51.009 Comprising Schottky junction (EPO)
- E51.01 Comprising organic/organic junction (e.g., heterojunction) (EPO)
- E51.011 Comprising organic/inorganic heterojunction (EPO)
- E51.012 ..Radiation-sensitive organic solid-state device (EPO)
- E51.013 ...Metal-organic semiconductor-metal device (EPO)
- E51.014 ...Comprising bulk heterojunction (EPO)
- E51.015 ...Comprising organic/inorganic heterojunction (EPO)
- E51.016 Majority carrier device using sensitization of wide band gap semiconductor (e.g., TiO_2) (EPO)
- E51.017 ...Comprising organic semiconductor-organic semiconductor heterojunction (EPO)
- E51.018 ..Light-emitting organic solid-state device with potential or surface barrier (EPO)
- E51.019 ...Electrode (EPO)
- E51.02 Encapsulation (EPO)
- E51.021 Arrangements for extracting light from device (e.g., Bragg reflector pair) (EPO)
- E51.022 ...Multicolor organic light-emitting device (OLED) (EPO)
- E51.023 ..Molecular electronic device (EPO)
- E51.024 .Selection of material for organic solid-state device (EPO)
- E51.025 ..For organic solid-state device adapted for rectifying, amplifying, oscillating, or switching, or capacitors or resistors with potential or surface barrier (EPO)
- E51.026 ..For radiation-sensitive or light-emitting organic solid-state device with potential or surface barrier (EPO)
- E51.027 ..Organic polymer or oligomer (EPO)
- E51.028 ...Comprising aromatic, heteroaromatic, or arraylic chains (e.g., polyaniline, polyphenylene, polyphenylene vinylene) (EPO)
- E51.029 Heteroaromatic compound comprising sulfur or selenium (e.g., polythiophene) (EPO)
- E51.03 Polyethylene dioxythiophene and derivative (EPO)
- E51.031 Polyphenylenevinylene and derivatives (EPO)
- E51.032 Polyfluorene and derivative (EPO)
- E51.033 ...Comprising aliphatic or olefinic chains (e.g., polyN-vinylcarbazol, PVC, PTFE) (EPO)
- E51.034 Polyacetylene or derivatives (EPO)
- E51.035 PolyN-vinylcarbazol and derivative (EPO)
- E51.036 ...Copolymers (EPO)
- E51.037 ...Ladder-type polymer (EPO)
- E51.038 ..Carbon-containing materials (EPO)
- E51.039 ...Fullerenes (EPO)
- E51.04 ...Carbon nanotubes (EPO)
- E51.041 ..Coordination compound (e.g., porphyrin, phthalocyanine, metal(II) polypyridine complexes) (EPO)
- E51.042 ...Phthalocyanine (EPO)
- E51.043 ...Metal complexes comprising Group IIIB metal (Al, Ga, In, or Ti) (e.g., Tris (8-hydroxyquinoline) aluminium (Alq_3)) (EPO)
- E51.044 ...Transition metal complexes (e.g., Ru(II) polypyridine complexes) (EPO)
- E51.045 ..Biomolecule or macromolecule (e.g., proteins, ATP, chlorophyll, beta-carotene, lipids, enzymes) (EPO)
- E51.046 ..Silicon-containing organic semiconductor (EPO)
- E51.047 ..Macromolecular system with low molecular weight (e.g., cyanine dyes, coumarine dyes, tetrathiafulvalene) (EPO)
- E51.048 ...Charge transfer complexes (EPO)

- E51.049 ...Polycondensed aromatic or heteroaromatic compound (e.g., pyrene, perylene, pentacene) (EPO)
- E51.05 Aromatic compound containing heteroatom (e.g., perylenetetracarboxylic dianhydride, perylene tetracarboxylic diimide) (EPO)
- E51.051 ...Amine compound having at least two aryl on amine-nitrogen atom (e.g., triphenylamine) (EPO)
- E51.052 ..Langmuir Blodgett film (EPO)
- E43.001 **SEMICONDUCTOR OR SOLID-STATE DEVICES USING GALVANO-MAGNETIC OR SIMILAR MAGNETIC EFFECTS, PROCESSES OR APPARATUS PECULIAR TO MANUFACTURE OR TREATMENT OF SUCH DEVICES, OR OF PARTS THEREOF (EPO)**
- E43.002 ..Hall-effect devices (EPO)
- E43.003 ..Semiconductor Hall-effect devices (EPO)
- E43.004 ..Magnetic-field-controlled resistors (EPO)
- E43.005 ..Selection of materials (EPO)
- E43.006 ..Processes or apparatus peculiar to manufacture or treatment of these devices or of parts thereof (EPO)
- E43.007 ..For Hall-effect devices (EPO)
- E33.001 **LIGHT EMITTING SEMICONDUCTOR DEVICES HAVING A POTENTIAL OR A SURFACE BARRIER, PROCESSES OR APPARATUS PECULIAR TO THE MANUFACTURE OR TREATMENT OF SUCH DEVICES, OR OF PARTS THEREOF**
- E33.002 ..Device characterized by semiconductor body (EPO)
- E33.003 ..Particular crystalline orientation or structure (EPO)
- E33.004 ...Comprising amorphous semiconductor (EPO)
- E33.005 ..Shape or structure (e.g., shape of epitaxial layer) (EPO)
- E33.006 ...Shape of semiconductor body (EPO)
- E33.007 ...Shape of potential barrier (EPO)
- E33.008 ...Multiple quantum well structure (EPO)
- E33.009 Including, apart from doping materials or other only impurities, Group IV element (e.g., Si-SiGe superlattice) (EPO)
- E33.01 Doped superlattice (e.g., nipi superlattice) (EPO)
- E33.011 ...For current confinement (EPO)
- E33.012 ...Multiple active regions between two electrodes (e.g., stacks) (EPO)
- E33.013 ..Material of active region (EPO)
- E33.014 ...In different regions (EPO)
- E33.015 ...Comprising only Group IV element (EPO)
- E33.016 With heterojunction (EPO)
- E33.017 Characterized by doping material (EPO)
- E33.018 Including porous Si (EPO)
- E33.019 ...Comprising only Group II-VI compound (EPO)
- E33.02 Ternary or quaternary compound (e.g., CdHgTe) (EPO)
- E33.021 With heterojunction (EPO)
- E33.022 Characterized by doping material (EPO)
- E33.023 ...Comprising only Group III-V compound (EPO)
- E33.024 Binary compound (e.g., GaAs) (EPO)
- E33.025 Including nitride (e.g., GaN) (EPO)
- E33.026 Ternary or quaternary compound (e.g., AlGaAs) (EPO)
- E33.027 With heterojunction (EPO)
- E33.028 Including nitride (e.g., AlGaN) (EPO)
- E33.029 Characterized by doping material (EPO)
- E33.03 Nitride compound (EPO)
- E33.031 Including ternary or quaternary compound (e.g., AlGaAs) (EPO)
- E33.032 With heterojunction (e.g., AlGaAs/GaAs) (EPO)
- E33.033 Comprising nitride compound (e.g., AlGaN) (EPO)
- E33.034 With heterojunction (e.g., AlGaN/GaN) (EPO)
- E33.035 ...Comprising only Group IV compound (e.g., SiC) (EPO)
- E33.036 Characterized by doping material (EPO)

- E33.037 ...Comprising compound other than Group II-VI, III-V, and IV compound (EPO)
- E33.038 Comprising only Group IV-VI compound (EPO)
- E33.039 Comprising only Group II-IV-VI compound (EPO)
- E33.04 Comprising only Group I-III-VI compound (EPO)
- E33.041 Characterized by doping material (EPO)
- E33.042 Comprising only Group IV-VI or II-IV-VI compound (EPO)
- E33.043 ..Physical imperfections (e.g., particular concentration or distribution of impurity) (EPO)
- E33.044 .Device characterized by their operation (EPO)
- E33.045 ..Having p-n or hi-lo junction (EPO)
- E33.046 ...P-I-N device (EPO)
- E33.047 ...Having at least two p-n junctions (EPO)
- E33.048 ..Having heterojunction or graded gap (EPO)
- E33.049 ...Comprising only Group III-V compound (EPO)
- E33.05 Comprising only Group II-IV compound (EPO)
- E33.051 ..Having Schottky barrier (EPO)
- E33.052 ..Having MIS barrier layer (EPO)
- E33.053 ..Characterized by field-effect operation (EPO)
- E33.054 ..Device being superluminescent diode (EPO)
- E33.055 .Detail of nonsemiconductor component other than light-emitting semiconductor device (EPO)
- E33.056 ..Packaging (EPO)
- E33.057 ...Adapted for surface mounting (EPO)
- E33.058 ...Housing (EPO)
- E33.059 ...Encapsulation (EPO)
- E33.06 ..Coatings (EPO)
- E33.061 ...Comprising luminescent material (e.g., fluorescent) (EPO)
- E33.062 ..Electrodes (EPO)
- E33.063 ...Characterized by material (EPO)
- E33.064 Comprising transparent conductive layers (e.g., transparent conductive oxides (TCO), indium tin oxide (ITO)) (EPO)
- E33.065 ...Characterized by shape (EPO)
- E33.066 ..Electrical contact or lead (e.g., lead frame) (EPO)
- E33.067 ..Means for light extraction or guiding (EPO)
- E33.068 ...Integrated with device (e.g., back surface reflector, lens) (EPO)
- E33.069 Comprising resonant cavity structure (e.g., Bragg reflector pair) (EPO)
- E33.07 Comprising window layer (EPO)
- E33.071 ...Not integrated with device (EPO)
- E33.072 Reflective means (EPO)
- E33.073 Refractive means (e.g., lens) (EPO)
- E33.074 ...Scattering means (e.g., surface roughening) (EPO)
- E33.075 ..With means for cooling or heating (EPO)
- E33.076 ..With means for light detecting (e.g., photodetector) (EPO)
- E33.077 ..Monolithic integration with photosensitive device (EPO)
- E31.001 **SEMICONDUCTOR DEVICES RESPONSIVE OR SENSITIVE TO ELECTROMAGNETIC RADIATION (E.G., INFRARED RADIATION, ADAPTED FOR CONVERSION OF RADIATION INTO ELECTRICAL ENERGY OR FOR CONTROL OF ELECTRICAL ENERGY BY SUCH RADIATION PROCESSES, OR APPARATUS PECULIAR TO MANUFACTURE OR TREATMENT OF SUCH DEVICES, OR OF PARTS THEREOF) (EPO)**
- E31.002 .Characterized by semiconductor body (EPO)
- E31.003 ..Characterized by semiconductor body material (EPO)
- E31.004 ...Inorganic materials (EPO)
- E31.005 In different semiconductor regions (e.g., Cu₂X/CdX heterojunction and X being Group VI element) (EPO)
- E31.006 Comprising only Cu₂X/CdX heterojunction and X being Group VI element (EPO)

- E31.007 Comprising only heterojunction including Group I-III-VI compound (e.g., CdS/CuInSe₂ heterojunction) (EPO)
- E31.008 Selenium or tellurium (EPO)
- E31.009 For device having potential or surface barrier (EPO)
- E31.01 Characterized by doping material (EPO)
- E31.011 Including, apart from doping material or other impurity, only Group IV element (EPO)
- E31.012 For device having potential or surface barrier (EPO)
- E31.013 Comprising porous silicon as part of active layer (EPO)
- E31.014 Characterized by doping material (EPO)
- E31.015 Including, apart from doping material or other impurity, only Group II-VI compound (e.g., CdS, ZnS, HgCdTe) (EPO)
- E31.016 For device having potential or surface barrier (EPO)
- E31.017 Characterized by doping material (EPO)
- E31.018 Including ternary compound (e.g., HgCdTe) (EPO)
- E31.019 Including, apart from doping material or other impurity, only Group III-V compound (EPO)
- E31.02 For device having potential or surface barrier (EPO)
- E31.021 Characterized by doping material GaAlAs, InGaAs, InGaAsP (EPO)
- E31.022 Including ternary or quaternary compound (EPO)
- E31.023 Including, apart from doping material or other impurity, only Group IV compound (e.g., SiC) (EPO)
- E31.024 For device having potential or surface barrier (EPO)
- E31.025 Characterized by doping material (EPO)
- E31.026 Including, apart from doping material or other impurity, only compound other than Group II-VI, III-V, and IV compound (EPO)
- E31.027 Comprising only Group I-III-VI chalcopyrite compound (e.g., CuInSe₂, CuGaSe₂, CuInGaSe₂) (EPO)
- E31.028 Characterized by doping material (EPO)
- E31.029 Comprising only Group IV-VI or II-IV-VI chalcogenide compound (e.g., PbSnTe) (EPO)
- E31.03 Characterized by doping material (EPO)
- E31.031 Characterized by doping material (EPO)
- E31.032 ..Characterized by semiconductor body shape, relative size, or disposition of semiconductor regions (EPO)
- E31.033 ...Multiple quantum well structure (EPO)
- E31.034 Characterized by amorphous semiconductor layer (EPO)
- E31.035 Including, apart from doping material or other impurity, only Group IV element or compound (e.g., Si-SiGe superlattice) (EPO)
- E31.036 ...Doping superlattice (e.g., nipi superlattice) (EPO)
- E31.037 ...For device having potential or surface barrier (EPO)
- E31.038 Shape of body (EPO)
- E31.039 Shape of potential or surface barrier (EPO)
- E31.04 ..Characterized by semiconductor body crystalline structure or plane (EPO)
- E31.041 ...Including thin film deposited on metallic or insulating substrate (EPO)
- E31.042 Including only Group IV element (EPO)
- E31.043 ...Including polycrystalline semiconductor (EPO)
- E31.044 Including only Group IV element (EPO)
- E31.045 Including microcrystalline silicon (c-Si) (EPO)
- E31.046 Including microcrystalline Group IV compound (e.g., c-SiGe, c-SiC) (EPO)
- E31.047 ...Including amorphous semiconductor (EPO)
- E31.048 Including only Group IV element (EPO)

- E31.049 Including Group IV compound (e.g., SiGe, SiC) (EPO)
- E31.05 Having light-induced characteristic variation (e.g., Staebler-Wronski effect) (EPO)
- E31.051 ...Including other nonmonocrystalline material (e.g., semiconductor particles embedded in insulating material) (EPO)
- E31.052 ..Adapted to control current flow through device (e.g., photoresistor) (EPO)
- E31.053 ..For device having potential or surface barrier (e.g., phototransistor) (EPO)
- E31.054 ...Device sensitive to infrared, visible, or ultraviolet radiation (EPO)
- E31.055 Characterized by only one potential or surface barrier (EPO)
- E31.056 Potential barrier being of point contact type (EPO)
- E31.057 PN homojunction potential barrier (EPO)
- E31.058 Device comprising active layer formed only by Group II-VI compound (e.g., HgCdTe IR photodiode) (EPO)
- E31.059 Device comprising active layer formed only by Group III-V compound (EPO)
- E31.06 Device comprising active layer formed only by Group IV compound (EPO)
- E31.061 PIN potential barrier (EPO)
- E31.062 Device comprising Group IV amorphous material (EPO)
- E31.063 Potential barrier working in avalanche mode (e.g., avalanche photodiode) (EPO)
- E31.064 Heterostructure (e.g., surface absorption or multiplication (SAM) layer) (EPO)
- E31.065 Schottky potential barrier (EPO)
- E31.066 Metal-semiconductor-metal (MSM) Schottky barrier (EPO)
- E31.067 PN heterojunction potential barrier (EPO)
- E31.068 Characterized by two potential or surface barriers (EPO)
- E31.069 Bipolar phototransistor (EPO)
- E31.07 Characterized by at least three potential barriers (EPO)
- E31.071 Photothyristor (EPO)
- E31.072 Static induction type (i.e., SIT device) (EPO)
- E31.073 Field-effect type (e.g., junction field-effect phototransistor) (EPO)
- E31.074 With Schottky gate (EPO)
- E31.075 Charge-coupled device (CCD) (EPO)
- E31.076 Photo MESFET (EPO)
- E31.077 With PN homojunction gate (EPO)
- E31.078 Charge-coupled device (CCD) (EPO)
- E31.079 Field-effect phototransistor (EPO)
- E31.08 With PN heterojunction gate (EPO)
- E31.081 Charge-coupled device (CCD) (EPO)
- E31.082 Field-effect phototransistor (EPO)
- E31.083 Conductor-insulator-semiconductor type (EPO)
- E31.084 Diode or charge-coupled device (CCD) (EPO)
- E31.085 Metal-insulator-semiconductor field-effect transistor (EPO)
- E31.086 ...Device sensitive to very short wavelength (e.g., X-ray, gamma-ray, or corpuscular radiation) (EPO)
- E31.087 Bulk-effect radiation detector (e.g., Ge-Li compensated PIN gamma-ray detector) (EPO)
- E31.088 Li-compensated PIN gamma-ray detector (EPO)
- E31.089 With surface barrier or shallow PN junction (e.g., surface barrier alpha-particle detector) (EPO)
- E31.09 With shallow PN junction (EPO)
- E31.091 Field-effect type (e.g., MIS-type detector) (EPO)

- E31.092 ..Device being sensitive to very short wavelength (e.g., X-ray, gamma-ray) (EPO)
- E31.093 ..Device sensitive to infrared, visible, or ultraviolet radiation (EPO)
- E31.094 ...Comprising amorphous semiconductor (EPO)
- E31.095 .Structurally associated with electric light source (e.g., electroluminescent light source) (EPO)
- E31.096 ..Hybrid device containing photosensitive and electroluminescent components within one single body (EPO)
- E31.097 ..Light source controlled by radiation-sensitive semiconductor device (e.g., image converter, image amplifier, image storage device) (EPO)
- E31.098 ...Device without potential or surface barrier (EPO)
- E31.099 Light source being semiconductor device with potential or surface barrier (e.g., light-emitting diode) (EPO)
- E31.1 ...Device with potential or surface barrier (EPO)
- E31.101 ...Semiconductor light source and radiation-sensitive semiconductor device both having potential or surface barrier (EPO)
- E31.102 Formed in or on common substrate (EPO)
- E31.103 ..Radiation-sensitive semiconductor device controlled by light source (EPO)
- E31.104 ...Radiation-sensitive semiconductor device without potential or surface barrier (e.g., photoresistor) (EPO)
- E31.105 Light source being semiconductor device having potential or surface barrier (e.g., light-emitting diode) (EPO)
- E31.106 Optical potentiometer (EPO)
- E31.107 ...Radiation-sensitive semiconductor device with potential or surface barrier (EPO)
- E31.108 ...Semiconductor light source and radiation-sensitive semiconductor device both having potential or surface barrier (EPO)
- E31.109 Formed in or on common substrate (EPO)
- E31.11 .Detail of nonsemiconductor component of radiation-sensitive semiconductor device (EPO)
- E31.111 ..Input/output circuit of device (EPO)
- E31.112 ...For device having potential or surface barrier (EPO)
- E31.113 ..Circuit arrangement of general character for device (EPO)
- E31.114 ...For device having potential or surface barrier (EPO)
- E31.115 Position-sensitive and lateral-effect photodetector (e.g., quadrant photodiode) (EPO)
- E31.116 Device working in avalanche mode (EPO)
- E31.117 ..Encapsulation (EPO)
- E31.118 ...For device having potential or surface barrier (EPO)
- E31.119 ..Coatings (EPO)
- E31.12 ...For device having potential or surface barrier (EPO)
- E31.121 For filtering or shielding light (e.g., multicolor filter for photodetector) (EPO)
- E31.122 For shielding light (e.g., light-blocking layer, cold shield for infrared detector) (EPO)
- E31.123 For interference filter (e.g., multilayer dielectric filter) (EPO)
- E31.124 ..Electrode (EPO)
- E31.125 ...For device having potential or surface barrier (EPO)
- E31.126 ...Transparent conductive layer (e.g., transparent conductive oxide (TCO), indium tin oxide (ITO) layer) (EPO)
- E31.127 ..Optical element associated with device (EPO)
- E31.128 ...Device having potential or surface barrier (EPO)
- E31.129 ...Comprising luminescent member (e.g., fluorescent sheet) (EPO)

- E31.13 ..Texturized surface (EPO)
- E31.131 ..Arrangement for temperature regulation (e.g., cooling, heating, or ventilating) (EPO)
- E27.001 **DEVICE CONSISTING OF A PLURALITY OF SEMICONDUCTOR OR OTHER SOLID STATE COMPONENTS FORMED IN OR ON A COMMON SUBSTRATE, E.G., INTEGRATED CIRCUIT DEVICE (EPO)**
- E27.002 ..Including bulk negative resistance effect component (EPO)
- E27.003 ..Including Gunn-effect device (EPO)
- E27.004 ..Including solid state component for rectifying, amplifying, or switching without a potential barrier or surface barrier (EPO)
- E27.005 ..Including component using galvano-magnetic effects, e.g. Hall effect (EPO)
- E27.006 ..Including piezo-electric, electro-resistive, or magneto-resistive component (EPO)
- E27.007 ..Including superconducting component (EPO)
- E27.008 ..Including thermo-electric or thermo-magnetic component with or without a junction of dissimilar material or thermo-magnetic component (EPO)
- E27.009 ..Including semiconductor component with at least one potential barrier or surface barrier adapted for rectifying, oscillating, amplifying, or switching, or Including integrated passive circuit elements (EPO)
- E27.01 ..With semiconductor substrate only (EPO)
- E27.011 ...Including a plurality of components in a non-repetitive configuration (EPO)
- E27.012 Made of compound semiconductor material, e.g. III-V material (EPO)
- E27.013 Integrated circuit having a two-dimensional layout of components without a common active region (EPO)
- E27.014 Including a field-effect type component (EPO)
- E27.015 In combination with bipolar transistor (EPO)
- E27.016 In combination with diode, resistor, or capacitor (EPO)
- E27.017 In combination with bipolar transistor and diode, resistor, or capacitor (EPO)
- E27.018 With component other than field-effect type (EPO)
- E27.019 Bipolar transistor in combination with diode, capacitor, or resistor (EPO)
- E27.02 Vertical bipolar transistor in combination with diode, capacitor, or resistor (EPO)
- E27.021 Vertical bipolar transistor in combination with resistor or capacitor only (EPO)
- E27.022 Vertical bipolar transistor in combination with diode only (EPO)
- E27.023 Lateral bipolar transistor in combination with diode, capacitor, or resistor (EPO)
- E27.024 Including combination of diode, capacitor, or resistor (EPO)
- E27.025 Including combination of capacitor or resistor only (EPO)
- E27.026 Integrated circuit having a three-dimensional layout (EPO)
- E27.027 Including components formed on opposite sides of a semiconductor substrate (EPO)
- E27.028 Including component having an active region in common (EPO)
- E27.029 Including component of the field-effect type (EPO)
- E27.03 In combination with bipolar transistor and diode, capacitor, or resistor (EPO)
- E27.031 In combination with vertical bipolar transistor and diode, capacitor, or resistor (EPO)
- E27.032 In combination with lateral bipolar transistor and diode, capacitor, or resistor (EPO)
- E27.033 In combination with diode, capacitor, or resistor (EPO)

- E27.034 In combination with capacitor only (EPO)
- E27.035 In combination with resistor only (EPO)
- E27.036 With component other than field-effect type (EPO)
- E27.037 Bipolar transistor in combination with diode, capacitor, or resistor (EPO)
- E27.038 Vertical bipolar transistor in combination with diode, capacitor, or resistor (EPO)
- E27.039 Vertical bipolar transistor in combination with diode only (EPO)
- E27.04 With Schottky diode only (EPO)
- E27.041 Vertical bipolar transistor in combination with resistor only (EPO)
- E27.042 Vertical bipolar transistor in combination with capacitor only (EPO)
- E27.043 Lateral bipolar transistor in combination with diode, capacitor, or resistor (EPO)
- E27.044 Including combination of diode, capacitor, or resistor (EPO)
- E27.045 Combination of capacitor and resistor (EPO)
- E27.046 ...Including only semiconductor components of a single kind, e.g., all bipolar transistors, all diodes, or all CMOS (EPO)
- E27.047 Resistor only (EPO)
- E27.048 Capacitor only (EPO)
- E27.049 Varactor diode (EPO)
- E27.05 Metal-insulated-semiconductor (MIS) diode (EPO)
- E27.051 Diode only (EPO)
- E27.052 Thyristor only (EPO)
- E27.053 Bipolar component only (EPO)
- E27.054 Combination of lateral and vertical transistors only (EPO)
- E27.055 Vertical bipolar transistor only (EPO)
- E27.056 Vertical direct transistor of the same conductivity type having different characteristics, (e.g. Darlington transistor) (EPO)
- E27.057 Vertical complementary transistor (EPO)
- E27.058 Combination of direct and inverse vertical transistors (e.g., collector acts as emitter) (EPO)
- E27.059 ...Including field-effect component only (EPO)
- E27.06 Field-effect transistor with insulated gate (EPO)
- E27.061 Combination of depletion and enhancement field-effect transistors (EPO)
- E27.062 Complementary MIS (EPO)
- E27.063 Means for preventing a parasitic bipolar action between the different transistor regions, e.g. latch-up prevention (EPO)
- E27.064 Combination of complementary transistors having a different structure, e.g. stacked CMOS, high-voltage and low-voltage CMOS (EPO)
- E27.065 Including an N-well only in the substrate (EPO)
- E27.066 Including a P-well only in the substrate (EPO)
- E27.067 Including both N- and P-wells in the substrate, e.g. twin-tub (EPO)
- E27.068 Schottky barrier gate field-effect transistor (EPO)
- E27.069 PN junction gate field-effect transistor
- E27.07 ...Including a plurality of individual components in a repetitive configuration (EPO)
- E27.071 ...Including resistor or capacitor only (EPO)
- E27.072 ...Including bipolar component (EPO)
- E27.073 Including diode only (EPO)
- E27.074 Including bipolar transistor (EPO)
- E27.075 Bipolar dynamic random access memory structure (EPO)
- E27.076 Array of single bipolar transistors only, e.g. read only memory structure (EPO)
- E27.077 Static bipolar memory cell structure (EPO)

- E27.078 Bipolar electrically programmable memory structure (EPO)
- E27.079 Thyristor (EPO)
- E27.08 Unijunction transistor, i.e., three terminal device with only one p-n junction having a negative resistance region in the I-V characteristic (EPO)
- E27.081 Including field-effect component (EPO)
- E27.082 Including bucket brigade type charge coupled device (C.C.D) (EPO)
- E27.083 Including charge coupled device (C.C.D) or charge injection device (C.I.D) (EPO)
- E27.084 Dynamic random access memory, DRAM, structure (EPO)
- E27.085 One-transistor memory cell structure, i.e., each memory cell containing only one transistor (EPO)
- E27.086 Storage electrode stacked over the transistor
- E27.087 With bit line higher than capacitor (EPO)
- E27.088 With capacitor higher than bit line level (EPO)
- E27.089 Storage electrode having multiple wings (EPO)
- E27.09 Capacitor extending under the transistor (EPO)
- E27.091 Transistor in trench (EPO)
- E27.092 Capacitor in trench (EPO)
- E27.093 Capacitor extending under or around the transistor (EPO)
- E27.094 Having storage electrode extension stacked over the transistor (EPO)
- E27.095 Capacitor and transistor in common trench (EPO)
- E27.096 Vertical transistor (EPO)
- E27.097 Peripheral structure (EPO)
- E27.098 Static random access memory, SRAM, structure (EPO)
- E27.099 Load element being a MOSFET transistor (EPO)
- E27.1 Load element being a thin film transistor (EPO)
- E27.101 Load element being a resistor (EPO)
- E27.102 Read-only memory, ROM, structure (EPO)
- E27.103 Electrically programmable ROM (EPO)
- E27.104 Ferroelectric non-volatile memory structure (EPO)
- E27.105 Masterslice integrated circuit (EPO)
- E27.106 Using bipolar structure (EPO)
- E27.107 Using field-effect structure (EPO)
- E27.108 CMOS gate array (EPO)
- E27.109 Using combined field-effect/ bipolar structure (EPO)
- E27.11 Input and output buffer/ driver (EPO)
- E27.111 ..Substrate comprising other than a semiconductor material, e.g. insulating substrate or layered substrate Including a non-semiconductor layer (EPO)
- E27.112 ...Including insulator on semiconductor, e.g. SOI (silicon on insulator) (EPO)
- E27.113 ...Combined with thin-film or thick-film passive component (EPO)
- E27.114 .Including only passive thin-film or thick-film elements on a common insulating substrate (EPO)
- E27.115 ..Thick-film circuits (EPO)
- E27.116 ..Thin-film circuits (EPO)
- E27.117 .Including organic material in active region
- E27.118 ..Including semiconductor components sensitive to infrared radiation, light, or electromagnetic radiation of a shorter wavelength (EPO)
- E27.119 ..Including semiconductor components with at least one potential barrier, surface barrier, or recombination zone adapted for light emission (EPO)
- E27.12 .Including semiconductor component with at least one potential barrier or surface barrier adapted for light emission structurally associated with controlling devices having a variable impedance and not being light sensitive (EPO)
- E27.121 ..In a repetitive configuration (EPO)

- E27.122 .Including active semiconductor component sensitive to infrared radiation, light, or electromagnetic radiation of a shorter wavelength (EPO)
- E27.123 ..Energy conversion device (EPO)
- E27.124 ...In a repetitive configuration, e.g. planar multi-junction solar cells (EPO)
- E27.125 Including only thin film solar cells deposited on a substrate (EPO)
- E27.126 Including multiple vertical junction or V-groove junction solar cells formed in a semiconductor substrate (EPO)
- E27.127 ..Device controlled by radiation (EPO)
- E27.128 ...With at least one potential barrier or surface barrier (EPO)
- E27.129 In a repetitive configuration (EPO)
- E27.13 ...Imager Including structural or functional details of the device (EPO)
- E27.131 Geometry or disposition of pixel-elements, address-lines, or gate-electrodes (EPO)
- E27.132 Pixel-elements with integrated switching, control, storage, or amplification elements (EPO)
- E27.133 Photodiode array or MOS imager (EPO)
- E27.134 Color imager (EPO)
- E27.135 Multicolor imager having a stacked pixel-element structure, e.g. npn, npnpn or MQW elements (EPO)
- E27.136 Infrared imager (EPO)
- E27.137 Of the hybrid type (e.g., chip-on-chip, bonded substrates) (EPO)
- E27.138 Multispectral infrared imager having a stacked pixel-element structure, e.g., npn, npnpn or MQW structures (EPO)
- E27.139 Anti-blooming (EPO)
- E27.14 X-ray, gamma-ray, or high energy radiation imager (measuring X-, gamma- or corpuscular radiation) (EPO)
- E27.141 Imager using a photoconductor layer (e.g., single photoconductor layer for all pixels) (EPO)
- E27.142 Color imager (EPO)
- E27.143 Infrared imager (EPO)
- E27.144 Of the hybrid type (e.g., chip-on-chip, bonded substrates) (EPO)
- E27.145 Anti-blooming (EPO)
- E27.146 X-ray, gamma-ray, or high energy radiation imagers (EPO)
- E27.147 Contact-type imager (e.g., contacts document surface) (EPO)
- E27.148 Junction field effect transistor (JFET) imager or static induction transistor (SIT) imager (EPO)
- E27.149 Bipolar transistor imager (EPO)
- E27.15 Charge coupled imager (EPO)
- E27.151 Structural or functional details (EPO)
- E27.152 Geometry or disposition of pixel-elements, address lines or gate-electrodes (EPO)
- E27.153 Linear CCD imager (EPO)
- E27.154 Area CCD imager (EPO)
- E27.155 Frame-interline transfer (EPO)
- E27.156 Interline transfer (EPO)
- E27.157 Frame transfer (EPO)
- E27.158 Charge injection device (CID) imager (EPO)
- E27.159 CCD or CID color imager (EPO)
- E27.16 Infrared CCD or CID imager (EPO)
- E27.161 Of the hybrid type (e.g., chip-on-chip, bonded substrates) (EPO)
- E27.162 Anti-blooming (EPO)
- E27.163 Including a photoconductive layer deposited on the CCD structure (EPO)
- E29.001 **SEMICONDUCTORS DEVICES ADAPTED FOR RECTIFYING, AMPLIFYING, OSCILLATING, OR SWITCHING, CAPACITORS, OR RESISTORS WITH AT LEAST ONE POTENTIAL-JUMP BARRIER OR SURFACE BARRIER (EPO)**

- E29.002 .Electrical characteristics due to properties of entire semiconductor body rather than just surface region (EPO)
- E29.003 ..Characterized by their crystalline structure (e.g., polycrystalline, cubic) particular orientation of crystalline planes (EPO)
- E29.004 ...With specified crystalline planes or axis (EPO)
- E29.005 ..Characterized by specified shape or size of PN junction or by specified impurity concentration gradient within the device (EPO)
- E29.006 ...Characterized by particular design considerations to control electrical field effect within device (EPO)
- E29.007 For controlling surface leakage or electric field concentration (EPO)
- E29.008 For controlling breakdown voltage of reverse biased devices (EPO)
- E29.009 With field relief electrode (field plate) (EPO)
- E29.01 With at least two field relief electrodes used in combination and not electrically interconnected (EPO)
- E29.011 With one or more field relief electrode comprising resistance material (e.g., semi insulating material, lightly doped poly-silicon) (EPO)
- E29.012 By doping profile or shape or arrangement of the PN junction, or with supplementary regions (e.g., guard ring, LDD, drift region) (EPO)
- E29.013 With supplementary region doped oppositely to or in rectifying contact with semiconductor containing or contacting region(e.g., guard rings with PN or Schottky junction) (EPO)
- E29.014 With breakdown supporting region for localizing breakdown or limiting its voltage (EPO)
- E29.015 With insulating layer characterized by dielectric or electrostatic property (e.g., including fixed charge or semi-insulating surface layer) (EPO)
- E29.016 For preventing surface leakage due to surface inversion layer (e.g., channel stop) (EPO)
- E29.017 With field relief electrodes acting on insulator potential or insulator charges (EPO)
- E29.018 ...Comprising internal isolation within devices or components (EPO)
- E29.019 Isolation by PN junctions (EPO)
- E29.02 Isolation by dielectric regions (EPO)
- E29.021 For source or drain region of field-effect device (EPO)
- E29.022 ..Characterized by shape of semiconductor body (EPO)
- E29.023 ...Adapted for altering junction breakdown voltage by shape of semiconductor body (EPO)
- E29.024 ..Characterized by shape, relative sizes or dispositions of semiconductor regions or junctions between regions (EPO)
- E29.025 ...Characterized by particular shape of junction between semiconductor regions (EPO)
- E29.026 Surface layout of device (EPO)
- E29.027 Surface layout of MOS gated device (e.g., DMOSFET or IGBT) (EPO)
- E29.028 With a nonplanar gate structure (EPO)
- E29.029 ...With semiconductor regions connected to electrode carrying current to be rectified, amplified or switched and such electrode being part of semiconductor device which comprises three or more electrodes (EPO)
- E29.03 Emitter regions of bipolar transistors (EPO)
- E29.031 Of lateral transistors (EPO)
- E29.032 Noninterconnected multiemitter structures (EPO)

- E29.033 Of heterojunction bipolar transistors (EPO)
- E29.034 Collector regions of bipolar transistors (EPO)
- E29.035 Pedestal collectors (EPO)
- E29.036 Anode or cathode regions of thyristors or gated bipolar-mode devices (EPO)
- E29.037 Anode regions of thyristors or gated bipolar-mode devices (EPO)
- E29.038 Cathode regions of thyristors (EPO)
- E29.039 Source or drain regions of field-effect devices (EPO)
- E29.04 Of field-effect transistors with insulated gate (EPO)
- E29.041 Of field-effect transistors with Schottky gate (EPO)
- E29.042 Tunneling barrier (EPO)
- E29.043...With semiconductor regions connected to electrode not carrying current to be rectified, amplified or switched and such electrode being part of semiconductor device which comprises three or more electrodes (EPO)
- E29.044 Base region of bipolar transistors (EPO)
- E29.045 Of lateral transistors (EPO)
- E29.046 Base regions of thyristors (EPO)
- E29.047 Anode base regions of thyristors (EPO)
- E29.048 Cathode base regions of thyristors (EPO)
- E29.049 Channel region of field-effect devices (EPO)
- E29.05 Of field-effect transistors (EPO)
- E29.051 With insulated gate (EPO)
- E29.052 Nonplanar channel (EPO)
- E29.053 With nonuniform doping structure in channel region surface (EPO)
- E29.054 Doping structure being parallel to channel length (EPO)
- E29.055 With vertical doping variation (EPO)
- E29.056 With variation of composition of channel (EPO)
- E29.057 With PN junction gate
- E29.058 Of charge coupled devices (EPO)
- E29.059 Gate region of field-effect devices with PN junction gate (EPO)
- E29.06 Substrate region of field-effect devices (EPO)
- E29.061 Of field-effect transistors (EPO)
- E29.062 With insulated gate (EPO)
- E29.063 With inactive supplementary region (e.g., for preventing punch-through, improving capacity effect or leakage current) (EPO)
- E29.064 Characterized by contact structure of substrate region (EPO)
- E29.065 Of charge coupled devices (EPO)
- E29.066 Body region structure of IGFET's with channel containing layer (DMOSFET or IGBT) (EPO)
- E29.067 With nonplanar gate structure (EPO)
- E29.068 ..Characterized by materials of semiconductor body (EPO)
- E29.069 ...Single quantum well structures (EPO)
- E29.07 Quantum wire structures (EPO)
- E29.071 Quantum box or quantum dot structures (EPO)
- E29.072 ...Structures with periodic or quasi-periodic potential variation, (e.g., multiple quantum wells, superlattices) (EPO)
- E29.073 Doping structures (e.g., doping superlattices, nipi-superlattices) (EPO)
- E29.074 Structures without potential periodicity in direction perpendicular to major surface of substrate (e.g., lateral superlattice) (EPO)
- E29.075 Compositional structures (EPO)
- E29.076 With layered structures with quantum effects in vertical direction (EPO)
- E29.077 Comprising at least one long-range structurally disordered material (e.g., one-dimensional vertical amorphous superlattices) (EPO)

- E29.078 Comprising only semiconductor materials (EPO)
- E29.079 ...Two or more elements from two or more groups of Periodic Table of elements (e.g., alloys) (EPO)
- E29.08 Amorphous materials (EPO)
- E29.081 In different semiconductor regions (e.g., heterojunctions) (EPO)
- E29.082 ...Only element from fourth group of Periodic System in uncombined form (EPO)
- E29.083 Amorphous materials (EPO)
- E29.084 Including two or more of elements from fourth group of Periodic System (EPO)
- E29.085 In different semiconductor regions (e.g., heterojunctions) (EPO)
- E29.086.....Further characterized by doping material (EPO)
- E29.087 ...Selenium or tellurium only (EPO)
- E29.088 Amorphous materials (EPO)
- E29.089 ...Only Group III-V compounds (EPO)
- E29.09 Including two or more compounds (e.g., alloys) (EPO)
- E29.091 In different semiconductor regions (e.g., heterojunctions) (EPO)
- E29.092 Amorphous materials (EPO)
- E29.093 Further characterized by doping material (EPO)
- E29.094 ...Only Group II-VI compounds (EPO)
- E29.095 Amorphous materials (EPO)
- E29.096 Including two or more compounds (e.g., alloys) (EPO)
- E29.097 In different semiconductor regions (e.g., heterojunctions) (EPO)
- E29.098 Further characterized by doping material (EPO)
- E29.099 CdX compounds being one element of sixth group of Periodic System (EPO)
- E29.1 ...Semiconductor materials other than Group IV, selenium, tellurium, or Group III-V compounds (EPO)
- E29.101 Amorphous materials (EPO)
- E29.102 Group I-VI or I-VII compounds (e.g., Cu₂O, CuI) (EPO)
- E29.103 Pb compounds (e.g., PbO) (EPO)
- E29.104 Si compounds (e.g., SiC) (EPO)
- E29.105 ..Characterized by combinations of two or more features of crystalline structure, shape, materials, physical imperfections, and concentration/distribution of impurities in bulk material (EPO)
- E29.106 ..Characterized by physical imperfections; having polished or roughened surface (EPO)
- E29.107 ...Imperfections within semiconductor body (EPO)
- E29.108 ...Imperfections on surface of semiconductor body (EPO)
- E29.109 ..Characterized by concentration or distribution of impurities in bulk material (EPO)
- E29.11 ...Planar doping (e.g., atomic-plane doping, delta-doping) (EPO)
- E29.111 .Electrodes (EPO)
- E29.112 ..Characterized by their shape, relative sizes or dispositions (EPO)
- E29.113 ...Carrying current to be rectified, amplified or switched (EPO)
- E29.114 Emitter or collector electrodes for bipolar transistors (EPO)
- E29.115 Cathode or anode electrodes for thyristors (EPO)
- E29.116 Source or drain electrodes for field-effect devices (EPO)
- E29.117 For thin film transistors with insulated gate (EPO)
- E29.118 For vertical current flow (EPO)
- E29.119 For lateral devices where connection to source or drain region is done through at least one part of semiconductor substrate thickness (e.g., with connecting sink or with via-hole) (EPO)

- E29.12 Layout configuration for lateral device source or drain region (e.g., cellular, interdigitated or ring structure or being curved or angular) (EPO)
- E29.121 Source or drain electrode in groove (EPO)
- E29.122 Characterized by relative position of source or drain electrode and gate electrode (EPO)
- E29.123 ...Not carrying current to be rectified, amplified, or switched (EPO)
- E29.124 Base electrodes for bipolar transistors (EPO)
- E29.125 Gate electrodes for thyristors (EPO)
- E29.126 Gate stack for field-effect devices (EPO)
- E29.127 For field-effect transistors (EPO)
- E29.128 With insulated gate (EPO)
- E29.129 Gate electrodes for transistors with floating gate (EPO)
- E29.13 Gate electrodes for nonplanar MOSFET (EPO)
- E29.131 Having drain and source regions at different vertical level having channel composed only of vertical sidewall connecting drain and source layers (EPO)
- E29.132 Characterized by insulating layer (EPO)
- E29.133 Nonuniform insulating layer thickness (EPO)
- E29.134 Characterized by configuration of gate electrode layer (EPO)
- E29.135 Characterized by length or sectional shape (EPO)
- E29.136 Characterized by surface lay-out (EPO)
- E29.137 Characterized by configuration of gate stack of thin film FETs (EPO)
- E29.138 For charge coupled devices (EPO)
- E29.139 ..Of specified material (EPO)
- E29.14 ...For gate of heterojunction field-effect devices (EPO)
- E29.141 ...Resistive materials for field-effect devices (EPO)
- E29.142 ...Superconductor materials (EPO)
- E29.143 ...Ohmic electrodes (EPO)
- E29.144 On Group III-V material (EPO)
- E29.145 On thin-film Group III-V material (EPO)
- E29.146 On silicon (EPO)
- E29.147 For thin-film silicon (EPO)
- E29.148 ...Schottky barrier electrodes (EPO)
- E29.149 On Group III-V material (EPO)
- E29.15 ...Electrodes for IGFET (EPO)
- E29.151 For TFT (EPO)
- E29.152 With lateral structure (e.g., poly-silicon gate with lateral doping variation or with lateral composition variation or characterized by sidewalls being composed of conductive, resistivity) (EPO)
- E29.154 Silicon gate conductor material (EPO)
- E29.155 Multiple silicon layers
- E29.156 Including silicide layer contacting silicon layer (EPO)
- E29.157 Including barrier layer between silicon and non-Si electrode
- E29.158 ...Elemental metal gate conductor material (e.g., W, Mo) (EPO)
- E29.159 Diverse conductors (EPO)
- E29.16 ...Gate conductor material being compound or alloy material (e.g., organic material, TiN, MoSi₂) (EPO)
- E29.161 Silicide (EPO)
- E29.162 Insulating materials for IGFET (EPO)
- E29.164 With at least one ferroelectric layer (EPO)
- E29.165 Multiple layers (EPO)
- E29.166 ..Types of semiconductor device (EPO)
- E29.167 ..Controllable by plural effects that include variations in magnetic field, mechanical force, or electric current/potential applied to device or one or more electrodes of device (EPO)
- E29.168 ..Quantum effect device (EPO)

- E29.169 ...Controllable by only signal applied to control electrode (e.g., base of bipolar transistor, gate of field-effect transistor) (EPO)
- E29.17 ...Memory effect devices (EPO)
- E29.171 ...Bipolar device (EPO)
- E29.172 Double-base diode (EPO)
- E29.173 Transistor-type device (i.e., able to continuously respond to applied control signal)
- E29.174 Bipolar junction transistor
- E29.175 Structurally associated with other devices (EPO)
- E29.176 Device being resistive element (e.g., ballasting resistor) (EPO)
- E29.177 Point contact transistors (EPO)
- E29.178 Schottky transistors (EPO)
- E29.179 Tunnel transistors (EPO)
- E29.18 Avalanche transistors (EPO)
- E29.181 Transistors with hook collector (i.e., collector having two layers of opposite conductivity type (e.g., SCR)) (EPO)
- E29.182 Bipolar thin-film transistors (EPO)
- E29.183 Vertical transistor (EPO)
- E29.184 Having emitter-base and base-collector junctions in same plane (EPO)
- E29.185 Having emitter-base junction and base-collector junction on different surfaces (e.g., mesa planar transistor) (EPO)
- E29.186 Inverse vertical transistor (EPO)
- E29.187 Lateral transistor (EPO)
- E29.188 Hetero-junction transistor (EPO)
- E29.189 Vertical transistors (EPO)
- E29.19 Having two-dimensional base (e.g., modulation-doped base, inversion layer base, delta-doped base) (EPO)
- E29.191 Having emitter comprising one or more nonmonocrystalline elements of Group IV (e.g., amorphous silicon) alloys comprising Group IV elements (EPO)
- E29.192 Resonant tunneling transistors (EPO)
- E29.193 Comprising lattice mismatched active layers (e.g., SiGe strained layer transistors) (EPO)
- E29.194 Controlled by field effect (e.g., bipolar static induction transistor (BSIT)) (EPO)
- E29.195 Gated diode structure (EPO)
- E29.196 With PN junction gate (e.g., field-controlled thyristor (FCTh), static induction thyristor (SITh)) (EPO)
- E29.197 Insulated gate bipolar mode transistor (e.g., IGBT; IGT; COMFET) (EPO)
- E29.198 Transistor with vertical current flow (EPO)
- E29.199 With both emitter and collector contacts in same substrate side (EPO)
- E29.2 With nonplanar surface (e.g., with nonplanar gate or with trench or recess or pillar in surface of emitter, base, or collector region for improving current density or short-circuiting emitter and base regions) (EPO)
- E29.201 And gate structure lying on slanted or vertical surface or formed in groove (e.g., trench gate IGBT) (EPO)
- E29.202 Thin-film device (EPO)
- E29.211 Thyristor-type device (e.g., having four-zone regenerative action) (EPO)
- E29.212 Gate-turn-off device (EPO)
- E29.213 With turn off by field effect (EPO)
- E29.214 Produced by insulated gate structure (EPO)
- E29.215 Bidirectional device (e.g., triac) (EPO)
- E29.216 With turn on by field effect (EPO)
- E29.217 Combined structurally with at least one other device (EPO)
- E29.218 Combined with capacitor or resistor (EPO)
- E29.219 Combined with diode (EPO)

- E29.22 Antiparallel diode (EPO)
E29.221 Combined with field-effect transistor (EPO)
E29.222 Having built-in localized breakdown/breakover region (EPO)
E29.223 Having amplifying gate structure (e.g., Darlington configuration) (EPO)
E29.224 Asymmetrical thyristor (EPO)
E29.225 Lateral thyristor (EPO)
E29.226 ...Unipolar device (EPO)
E29.227 Charge transfer device (EPO)
E29.228 Charge-coupled device (EPO)
E29.229 With field effect produced by insulated gate (EPO)
E29.23 Input structure (EPO)
E29.231 Output structure (EPO)
E29.232 Structure for improving output signal (EPO)
E29.233 Buried channel CCD (EPO)
E29.234 Two-phase CCD (EPO)
E29.235 Three-phase CCD (EPO)
E29.236 Four-phase CCD (EPO)
E29.237 Surface channel CCD (EPO)
E29.238 Two-phase CCD (EPO)
E29.239 Three-phase CCD (EPO)
E29.24 Four-phase CCD (EPO)
E29.241 Hot electron transistor (HET) or metal base transistor (MBT) (EPO)
E29.242 Field-effect transistor (EPO)
E29.243 Using static field induced region (e.g., SIT, PBT) (EPO)
E29.244 Velocity modulations transistor (i.e., VMT) (EPO)
E29.245 With one-dimensional charge carrier gas channel (e.g., quantum wire FET) (EPO)
E29.246 With two-dimensional charge carrier gas channel (e.g., HEMT; with two-dimensional charge-carrier layer formed at heterojunction interface) (EPO)
E29.247 With inverted single heterostructure (i.e., with active layer formed on top of wide bandgap layer (e.g., IHMT)) (EPO)
E29.248 With confinement of carriers by at least two heterojunctions (e.g., DHHEMT, quantum well HEMT, DHMODFET) (EPO)
E29.249 Using Group III-V semiconductor material (EPO)
E29.25 With more than one donor layer (EPO)
E29.251 With delta or planar doped donor layer (EPO)
E29.252 With direct single heterostructure (i.e., with wide bandgap layer formed on top of active layer (e.g., direct single heterostructure MIS-like HEMT)) (EPO)
E29.253 With wide bandgap charge-carrier supplying layer (e.g., direct single heterostructure MODFET) (EPO)
E29.254 With delta-doped channel (EPO)
E29.255 With field effect produced by insulated gate (EPO)
E29.256 With channel containing layer contacting drain drift region (e.g., DMOS transistor) (EPO)
E29.257 Having vertical bulk current component or current vertically following trench gate (e.g., vertical power DMOS transistor) (EPO)
E29.258 With both source and drain contacts in same substrate side (EPO)
E29.259 With nonplanar surface (EPO)
E29.26 Channel structure lying under slanted or vertical surface or being formed along surface of groove (e.g., trench gate DMOSFET) (EPO)
E29.261 With at least part of active region on insulating substrate (e.g., lateral DMOS in oxide isolated well) (EPO)
E29.262 Vertical transistor (EPO)
E29.263 Comprising gate-to-body connection (i.e., bulk dynamic threshold voltage MOSFET) (EPO)
E29.264 With multiple gate structure (EPO)
E29.265 Structure comprising MOS gate and at least one non-MOS gate (e.g., JFET or MESFET gate) (EPO)
E29.266 With lightly doped drain or source extension (EPO)

- E29.267 With nonplanar structure (e.g., gate or source or drain being nonplanar) (EPO)
- E29.268 Source region and drain region having nonsymmetrical structure about gate electrode (EPO)
- E29.269 With overlap between lightly doped extension and gate electrode (EPO)
- E29.27 With buried channel (EPO)
- E29.271 With Schottky drain or source contact (EPO)
- E29.272 Gate comprising ferroelectric layer (EPO)
- E29.273 Thin-film transistor (EPO)
- E29.274 Vertical transistor (EPO)
- E29.275 With multiple gates (EPO)
- E29.276 With supplementary region or layer in thin film or in insulated bulk substrate supporting it for controlling or increasing voltage resistance of device (EPO)
- E29.277 Characterized by drain or source properties (EPO)
- E29.278 With LDD structure or extension or offset region or characterized by doping profile (EPO)
- E29.279 Asymmetrical source and drain regions (EPO)
- E29.28 For preventing leakage current (EPO)
- E29.281 For preventing kink or snapback effect (e.g., discharging minority carriers of channel region for preventing bipolar effect) (EPO)
- E29.282 With light shield (EPO)
- E29.283 With supplementary region or layer for improving flatness of device (EPO)
- E29.284 With drain or source connected to bulk conducting substrate (EPO)
- E29.285 Silicon transistor (EPO)
- E29.286 Monocrystalline only (EPO)
- E29.287 SOS transistor (EPO)
- E29.288 Nonmonocrystalline (EPO)
- E29.289 Amorphous silicon transistor (EPO)
- E29.29 With top gate (EPO)
- E29.291 With inverted transistor structure (EPO)
- E29.292 Polycrystalline or microcrystalline silicon transistor (EPO)
- E29.293 With top gate (EPO)
- E29.294 With inverted transistor structure (EPO)
- E29.295 Characterized by insulating substrate or support (EPO)
- E29.296 Comprising Group III-V or II-VI compound, or of Se, Te, or oxide semiconductor (EPO)
- E29.297 Comprising Group IV non-Si semiconductor materials or alloys (e.g., Ge, SiN alloy, SiC alloy) (EPO)
- E29.298 With multilayer structure or superlattice structure (EPO)
- E29.299 Characterized by property or structure of channel or contact thereto (EPO)
- E29.3 With floating gate (EPO)
- E29.301 Programmable by two single electrons (EPO)
- E29.302 Hi-lo programming levels only (EPO)
- E29.303 Charging by injection of carriers through conductive insulator (e.g., Poole-Frankel conduction) (EPO)
- E29.304 Charging by tunneling of carriers (e.g., Fowler-Nordheim tunneling) (EPO)
- E29.305 Charging by hot carrier injection (EPO)
- E29.306 Hot carrier injection from channel (EPO)
- E29.307 Hot carrier produced by avalanche breakdown of PN junction (e.g., FAMOS) (EPO)
- E29.308 Programmable with more than two possible different levels (EPO)
- E29.309 With charge trapping gate insulator (e.g., MNOS-memory transistors) (EPO)
- E29.31 With field effect produced by PN or other rectifying junction gate (i.e., potential barrier) (EPO)
- E29.311 With Schottky drain or source contact (EPO)

- E29.312 With PN junction gate
(e.g., PN homojunction gate)
(EPO)
- E29.313 Vertical transistors (EPO)
- E29.314 Thin-film JFET (EPO)
- E29.315 With heterojunction gate
(e.g., transistors with
semiconductor layer acting as
gate insulating layer) (EPO)
- E29.316 Programmable transistor
(e.g., with charge-trapping
quantum well) (EPO)
- E29.317 With Schottky gate (EPO)
- E29.318 Vertical transistors (EPO)
- E29.319 With multiple gate (EPO)
- E29.32 Thin-film MESFET (EPO)
- E29.321 With recessed gate (EPO)
- E29.322 Single electron transistors:
Coulomb blockade device (EPO)
- E29.323 ..Controllable by variation of
magnetic field applied to
device (EPO)
- E29.324 ..Controllable by variation of
applied mechanical force
(e.g., of pressure) (EPO)
- E29.325 ..Controllable only by variation
of electric current supplied
or only electric potential
applied to electrode carrying
current to be rectified,
amplified, oscillated, or
switched (EPO)
- E29.326 ...Resistor with PN junction
(EPO)
- E29.327 ...Diode (EPO)
- E29.328 Planar PN junction diode
(EPO)
- E29.329 Mesa PN junction diode (EPO)
- E29.33 Hi-lo semiconductor device
(e.g., memory device) (EPO)
- E29.331 Charge trapping diode (EPO)
- E29.332 Punchthrough diode (i.e.,
with bulk potential barrier
(e.g., camel diode, planar
doped barrier diode, graded
bandgap diode)) (EPO)
- E29.333 Point contact diode (EPO)
- E29.334 Transit-time diode (e.g.,
IMPATT, TRAPATT diode) (EPO)
- E29.335 Avalanche diode (e.g., Zener
diode) (EPO)
- E29.336 PIN diode (EPO)
- E29.337 Thyristor diode (i.e., having
only two terminals and no
control electrode (e.g.,
Shockley diode, break-over
diode)) (EPO)
- E29.338 Schottky diode (EPO)
- E29.339 Tunneling diode (EPO)
- E29.34 Resonant tunneling diode
(i.e., RTD, RTBD) (EPO)
- E29.341 Esaki diode (EPO)
- E29.342 ...Capacitor with potential
barrier or surface barrier
(EPO)
- E29.343 Conductor-insulator-conductor
capacitor on semiconductor
substrate (EPO)
- E29.344 Variable capacitance diode
(e.g., varactors) (EPO)
- E29.345 Metal-insulator-semiconductor
(e.g., MOS capacitor) (EPO)
- E29.346 Trench capacitor (EPO)
- E29.347 ..Controllable by thermal signal
(e.g., IR) (EPO)
- E45.001 **SOLID-STATE DEVICES ADAPTED FOR
RECTIFYING, AMPLIFYING,
OSCILLATING, OR SWITCHING
WITHOUT POTENTIAL-JUMP BARRIER
OR SURFACE BARRIER, E.G.,
DIELECTRIC TRIODES; OVSHINSKY-
EFFECT DEVICES, PROCESSES, OR
APPARATUS PECULIAR TO
MANUFACTURE OR TREATMENT
THEREOF, OR OF PARTS THEREOF
(EPO)**
- E45.002 .Bistable switching devices,
e.g., Ovshinsky-effect devices
(EPO)
- E45.003 ..Switching materials being
oxides or nitrides (EPO)
- E45.004 ..N: Light-controlled Ovshinsky
devices (EPO)
- E45.005 .Charge density wave transport
devices (EPO)
- E45.006 .Solid-state travelling-wave
devices (EPO)
- E25.001 **ASSEMBLIES CONSISTING OF
PLURALITY OF INDIVIDUAL
SEMICONDUCTOR OR OTHER SOLID-
STATE DEVICES (EPO)**
- E25.002 .All devices being of same type,
e.g., assemblies of rectifier
diodes (EPO)
- E25.003 ..Devices not having separate
containers (EPO)

- E25.004 ...Devices responsive or sensitive to electromagnetic radiation, e.g., infrared radiation, adapted for conversion of radiation into electrical energy or for control of electrical energy by such radiation (EPO)
- E25.005 Devices being arranged next to each other (EPO)
- E25.006 Stacked arrangements of devices (EPO)
- E25.007 Devices being solar cells (EPO)
- E25.008 ...Organic solid-state devices (EPO)
- E25.009 Devices responsive or sensitive to electromagnetic radiation, e.g., infrared radiation, adapted for conversion of radiation into electrical energy or for control of electrical energy by such radiation, e.g., photovoltaic modules based on organic solar cells (EPO)
- E25.01 ...Device consisting of plurality of semiconductor or other solid state devices or components formed in or on common substrate, e.g., integrated circuit device (EPO)
- E25.011 Devices being arranged next and on each other, i.e., mixed assemblies (EPO)
- E25.012 Devices being arranged next to each other (EPO)
- E25.013 Stacked arrangements of devices (EPO)
- E25.014 ...Semiconductor devices adapted for rectifying, amplifying, oscillating, or switching, capacitors, or resistors with at least one potential-jump barrier or surface barrier (EPO)
- E25.015 Devices being arranged next and on each other, i.e., mixed assemblies (EPO)
- E25.016 Devices being arranged next to each other (EPO)
- E25.017 Apertured devices mounted on one or more rods passed through apertures (EPO)
- E25.018 Stacked arrangements of nonapertured devices (EPO)
- E25.019 ...Incoherent light-emitting semiconductor devices having potential or surface barrier (EPO)
- E25.02 Devices being arranged next to each other (EPO)
- E25.021 Stacked arrangements of devices (EPO)
- E25.022 ..Devices having separate containers (EPO)
- E25.023 ...Device consisting of plurality of semiconductor or other solid-state devices or components formed in or on common substrate, e.g., integrated circuit device (EPO)
- E25.024 ...Semiconductors devices adapted for rectifying, amplifying, oscillating, or switching, capacitors, or resistors with at least one potential-jump barrier or surface barrier (EPO)
- E25.025 Mixed assemblies (EPO)
- E25.026 Devices being arranged next to each other (EPO)
- E25.027 Stacked arrangements of devices (EPO)
- E25.028 ...Incoherent light-emitting semiconductor devices having potential or surface barrier (EPO)
- E25.029 .Devices being of two or more types, e.g., forming hybrid circuits (EPO)
- E25.03 ..Devices being mounted on two or more different substrates (EPO)
- E25.031 ..Containers (EPO)
- E25.032 ..Comprising optoelectronic devices, e.g., LED, photodiodes (EPO)
- E23.001 **PACKAGING, INTERCONNECTS, AND MARKINGS FOR SEMICONDUCTOR OR OTHER SOLID-STATE DEVICES (EPO)**
- E23.002 .Details not otherwise provided for, e.g., protection against moisture (EPO)
- E23.003 .Mountings, e.g., nondetachable insulating substrates (EPO)
- E23.004 ..Characterized by shape (EPO)

- E23.005 ...Characterized by material or its electrical properties (EPO)
- E23.006 ...Metallic substrates having insulating layers (EPO)
- E23.007 ...Organic substrates, e.g., plastic (EPO)
- E23.008 ...Semiconductor insulating substrates (EPO)
- E23.009 ...Ceramic or glass substrates (EPO)
- E23.01 ...Arrangements for conducting electric current to or from solid-state body in operation, e.g., leads, terminal arrangements (EPO)
- E23.011 ...Internal lead connections, e.g., via connections, feedthrough structures (EPO)
- E23.012 ...Consisting of lead-in layers inseparably applied to semiconductor body (EPO)
- E23.013 ...Bridge structure with air gap (EPO)
- E23.014 ...Beam leads (EPO)
- E23.015 ...Pads with extended contours, e.g., grid structure, branch structure, finger structure (EPO)
- E23.016 ...For devices consisting of semiconductor layers on insulating or semi-insulating substrates, e.g., silicon on sapphire devices, i.e., SOS (EPO)
- E23.017 ...Materials (EPO)
- E23.018 Conductive organic material or pastes, e.g., conductive adhesives, inks (EPO)
- E23.019 ...Consisting of layered constructions comprising conductive layers and insulating layers, e.g., planar contacts (EPO)
- E23.02 Bonding areas, e.g., pads (EPO)
- E23.021 Bump or ball contacts (EPO)
- E23.022 Overhang structure (EPO)
- E23.023 ...Consisting of soldered or bonded constructions (EPO)
- E23.024 ...Wire-like arrangements or pins or rods (EPO)
- E23.025 Characterized by materials of wires or their coatings (EPO)
- E23.026 ...Bases or plates or solder therefor (EPO)
- E23.027 Having heterogeneous or anisotropic structure (EPO)
- E23.028 Characterized by material (EPO)
- E23.029 Semiconductor (EPO)
- E23.03 Carbon (EPO)
- E23.031 ...Lead frames or other flat leads (EPO)
- E23.032 Additional leads (EPO)
- E23.033 Additional leads being bump or wire (EPO)
- E23.034 Additional leads being tape carrier or flat leads (EPO)
- E23.035 Additional leads being multilayer (EPO)
- E23.036 Additional leads being wiring board (EPO)
- E23.037 Characterized by die pad (EPO)
- E23.038 Insulative substrate being used as die pad, e.g., ceramic, plastic (EPO)
- E23.039 Chip-on-leads or leads-on-chip techniques, i.e., inner lead fingers being used as die pad (EPO)
- E23.04 Having bonding material between chip and die pad (EPO)
- E23.041 Multilayer (EPO)
- E23.042 Plurality of lead frames mounted in one device (EPO)
- E23.043 Geometry of lead frame (EPO)
- E23.044 For devices adapted for rectifying, amplifying, oscillating, or switching, capacitors, or resistors with at least one potential-jump barrier or surface barrier (EPO)
- E23.045 Deformation absorbing parts in lead frame plane, e.g., meanderline shape (EPO)
- E23.046 Cross-section geometry (EPO)
- E23.047 Characterized by bent parts (EPO)
- E23.048 Bent parts being outer leads (EPO)
- E23.049 Insulating layers on lead frame, e.g., bridging members (EPO)
- E23.05 Side rails of lead frame, e.g., with perforations, sprocket holes (EPO)

- E23.051 Specifically adapted to facilitate heat dissipation (EPO)
- E23.052 Assembly of semiconductor devices on lead frame (EPO)
- E23.053 Characterized by materials of lead frames or layers thereon (EPO)
- E23.054 Metallic layers on lead frames (EPO)
- E23.055 Consisting of thin flexible metallic tape with or without film carrier (EPO)
- E23.056 Insulating layers on lead frames (EPO)
- E23.057 Capacitor integral with or on lead frame (EPO)
- E23.058 Battery in combination with lead frame (EPO)
- E23.059 Oscillators in combination with lead frame (EPO)
- E23.06 Leads, i.e., metallizations or lead frames on insulating substrates, e.g., chip carriers (EPO)
- E23.061 Leads being also applied on sidewalls or bottom of substrate, e.g., leadless packages for surface mounting (EPO)
- E23.062 Multilayer substrates (EPO)
- E23.063 Chip support structure consisting of plurality of insulating substrates (EPO)
- E23.064 For flat cards, e.g., credit cards (EPO)
- E23.065 Flexible insulating substrates (EPO)
- E23.066 Lead frames fixed on or encapsulated in insulating substrates (EPO)
- E23.067 Via connections through substrates, e.g., pins going through substrate, coaxial cables (EPO)
- E23.068 Additional leads joined to metallizations on insulating substrate, e.g., pins, bumps, wires, flat leads (EPO)
- E23.069 Spherical bumps on substrate for external connection, e.g., ball grid arrays (BGA) (EPO)
- E23.07 Geometry or layout (EPO)
- E23.071 For devices adapted for rectifying, amplifying, oscillating, or switching, capacitors, or resistors with at least one potential-jump barrier or surface barrier (EPO)
- E23.072 Characterized by materials (EPO)
- E23.073 Conductive materials containing semiconductor material (EPO)
- E23.074 Carbon, e.g., fullerenes (EPO)
- E23.075 Conductive materials containing organic materials or pastes, e.g., for thick films (EPO)
- E23.076 Conductive materials containing superconducting material (EPO)
- E23.077 Materials of insulating layers or coatings (EPO)
- E23.078 ..Flexible arrangements, e.g., pressure contacts without soldering (EPO)
- E23.079 ..For integrated circuit devices, e.g., power bus, number of leads (EPO)
- E23.08 ..Arrangements for cooling, heating, ventilating or temperature compensation; temperature-sensing arrangements (EPO)
- E23.081 ..Arrangements for heating (EPO)
- E23.082 ..Cooling arrangements using Peltier effect (EPO)
- E23.083 ..Mountings or securing means for detachable cooling or heating arrangements; fixed by friction, plugs or springs (EPO)
- E23.084 ...With bolts or screws (EPO)
- E23.085 For stacked arrangements of plurality of semiconductor devices (EPO)
- E23.086 ...Snap-on arrangements, e.g., clips (EPO)
- E23.087 ..Fillings or auxiliary members in containers or encapsulations selected or arranged to facilitate heating or cooling (EPO)
- E23.088 ...Cooling by change of state, e.g., use of heat pipes (EPO)

- E23.089 By melting or evaporation of solids (EPO)
- E23.09 ...Auxiliary members in containers characterized by their shape, e.g., pistons (EPO)
- E23.091 Bellows (EPO)
- E23.092 Auxiliary members in encapsulations (EPO)
- E23.093 In combination with jet impingement (EPO)
- E23.094 Pistons, e.g., spring-loaded members (EPO)
- E23.095 ..Complete device being wholly immersed in fluid other than air (EPO)
- E23.096 ...Fluid being liquefied gas, e.g., in cryogenic vessel (EPO)
- E23.097 ..Involving transfer of heat by flowing fluids (EPO)
- E23.098 ...By flowing liquids (EPO)
- E23.099 ...By flowing gases, e.g., air (EPO)
- E23.1 Jet impingement (EPO)
- E23.101 ..Selection of materials, or shaping, to facilitate cooling or heating, e.g., heat sinks (EPO)
- E23.102 ...Cooling facilitated by shape of device (EPO)
- E23.103 Foil-like cooling fins or heat sinks (EPO)
- E23.104 Characterized by shape of housing (EPO)
- E23.105 Wire-like or pin-like cooling fins or heat sinks (EPO)
- E23.106 ...Laminates or multilayers, e.g., direct bond copper ceramic substrates (EPO)
- E23.107 Organic materials with or without thermo-conductive filler (EPO)
- E23.108 Semiconductor materials (EPO)
- E23.109 Metallic materials (EPO)
- E23.11 ...Cooling facilitated by selection of materials for device (or materials for thermal expansion adaptation, e.g., carbon) (EPO)
- E23.111 Diamond (EPO)
- E23.112 Having heterogeneous or anisotropic structure, e.g., powder or fibers in matrix, wire mesh, porous structures (EPO)
- E23.113 Ceramic materials or glass (EPO)
- E23.114 ..Protection against radiation, e.g., light, electromagnetic waves (EPO)
- E23.115 ..Against alpha rays (EPO)
- E23.116 ..Encapsulations, e.g., encapsulating layers, coatings, e.g., for protection (EPO)
- E23.117 ..Characterized by material, e.g., carbon (EPO)
- E23.118 ...Oxides or nitrides or carbides, e.g., ceramics, glass (EPO)
- E23.119 ...Organic, e.g., plastic, epoxy (EPO)
- E23.12 Organo-silicon compounds, e.g., silicone (EPO)
- E23.121 Containing filler (EPO)
- E23.122 ...Semiconductor material, e.g., amorphous silicon (EPO)
- E23.123 ..Characterized by arrangement or shape (EPO)
- E23.124 ...Device being completely enclosed (EPO)
- E23.125 Substrate forming part of encapsulation (EPO)
- E23.126 Double encapsulation or coating and encapsulation (EPO)
- E23.127 Sealing arrangements between parts, e.g., adhesion promoters (EPO)
- E23.128 Encapsulation having cavity (EPO)
- E23.129 ...Partial encapsulation or coating (EPO)
- E23.13 Coating being foil (EPO)
- E23.131 Coating or filling in grooves made in semiconductor body (EPO)
- E23.132 Coating being directly applied to semiconductor body, e.g., passivation layer (EPO)
- E23.133 Coating also covering sidewalls of semiconductor body (EPO)
- E23.134 Multilayer coating (EPO)

- E23.135 ..Fillings or auxiliary members in containers or encapsulations, e.g., centering rings (EPO)
- E23.136 ..Fillings characterized by material, its physical or chemical properties, or its arrangement within complete device (EPO)
- E23.137 ...Including materials for absorbing or reacting with moisture or other undesired substances, e.g., getters (EPO)
- E23.138 ...Gaseous at normal operating temperature of device (EPO)
- E23.139 ...Liquid at normal operating temperature of device (EPO)
- E23.14 ..Solid or gel at normal operating temperature of device (EPO)
- E23.141 ..Arrangements for conducting electric current within device in operation from one component to another, interconnections, e.g., wires, lead frames (EPO)
- E23.142 ..Including external interconnections consisting of multilayer structure of conductive and insulating layers inseparably formed on semiconductor body (EPO)
- E23.143 ...Crossover interconnections (EPO)
- E23.144 ...Capacitive arrangements or effects of, or between wiring layers (EPO)
- E23.145 ...Via connections in multilevel interconnection structure (EPO)
- E23.146 ...With adaptable interconnections (EPO)
- E23.147 Comprising antifuses, i.e., connections having their state changed from nonconductive to conductive (EPO)
- E23.148 Change of state resulting from use of external beam, e.g., laser beam or ion beam (EPO)
- E23.149 Comprising fuses, i.e., connections having their state changed from conductive to nonconductive (EPO)
- E23.15 Change of state resulting from use of external beam, e.g., laser beam or ion beam (EPO)
- E23.151 ...Geometry or layout of interconnection structure (EPO)
- E23.152 ...Cross-sectional geometry (EPO)
- E23.153 Arrangements of power or ground buses (EPO)
- E23.154 ...Characterized by materials (EPO)
- E23.155 Conductive materials (EPO)
- E23.156 Containing superconducting materials (EPO)
- E23.157 Based on metals, e.g., alloys, metal silicides (EPO)
- E23.158 Principal metal being aluminum (EPO)
- E23.159 Aluminum alloys (EPO)
- E23.16 Additional layers associated with aluminum layers, e.g., adhesion, barrier, cladding layers (EPO)
- E23.161 Principal metal being copper (EPO)
- E23.162 Principal metal being noble metal, e.g., gold (EPO)
- E23.163 Principal metal being refractory metal (EPO)
- E23.164 Containing semiconductor material, e.g., polysilicon (EPO)
- E23.165 Containing carbon, e.g., fullerenes (EPO)
- E23.166 Containing conductive organic materials or pastes, e.g., conductive adhesives, inks (EPO)
- E23.167 ...Insulating materials (EPO)
- E23.168 ..Including internal interconnections, e.g., cross-under constructions (EPO)
- E23.169 ..Interconnection structure between plurality of semiconductor chips being formed on or in insulating substrates (EPO)
- E23.17 ...Crossover interconnections, e.g., bridge stepovers (EPO)
- E23.171 ...Adaptable interconnections, e.g., for engineering changes (EPO)

- E23.172 ...Assembly of plurality of insulating substrates (EPO)
- E23.173 ...Multilayer substrates (EPO)
- E23.174 ...Conductive vias through substrate with or without pins, e.g., buried coaxial conductors (EPO)
- E23.175 ...Geometry or layout of interconnection structure (EPO)
- E23.176 ...For flat cards, e.g., credit cards (EPO)
- E23.177 ...Flexible insulating substrates (EPO)
- E23.178 ...Chips being integrally enclosed by interconnect and support structures (EPO)
- E23.179 .Marks applied to semiconductor devices or parts, e.g., registration marks, test patterns, alignment structures, wafer maps (EPO)
- E23.18 .Containers; seals (EPO)
- E23.181 ..Characterized by shape of container or parts, e.g., caps, walls (EPO)
- E23.182 ...Container being hollow construction having no base used as mounting for semiconductor body (EPO)
- E23.183 ...Container being hollow construction and having conductive base as mounting as well as lead for the semiconductor body (EPO)
- E23.184 Other leads having insulating passage through base (EPO)
- E23.185 Other leads being parallel to base (EPO)
- E23.186 Other leads being perpendicular to base (EPO)
- E23.187 Another lead being formed by cover plate parallel to base plate, e.g., sandwich type (EPO)
- E23.188 ...Container being hollow construction and having insulating or insulated base as mounting for semiconductor body (EPO)
- E23.189 Leads being parallel to base (EPO)
- E23.19 Leads having passage through base (EPO)
- E23.191 ..Characterized by material of container or its electrical properties (EPO)
- E23.192 ...Material being electrical insulator, e.g., glass (EPO)
- E23.193 ..Characterized by material or arrangement of seals between parts, e.g., between cap and base of container or between leads and walls of container (EPO)
- E23.194 .Protection against mechanical damage (EPO)
- E49.001 **SOLID-STATE DEVICES WITH AT LEAST ONE POTENTIAL-JUMP BARRIER OR SURFACE BARRIER USING ACTIVE LAYER OF LOWER ELECTRICAL CONDUCTIVITY THAN MATERIAL ADJACENT THERETO AND THROUGH WHICH CARRIER TUNNELING OCCURS, PROCESSES OR APPARATUS PECULIAR TO MANUFACTURE OR TREATMENT OF SUCH DEVICES, OR OF PARTS THEREOF (EPO)**
- E49.002 .Devices using Mott metal-insulator transition, e.g., field-effect transistors (EPO)
- E49.003 .Quantum devices, e.g., quantum interference devices, metal single electron transistor (EPO)
- E49.004 .Thin-film or thick-film devices (EPO)
- E21.001 **PROCESSES OR APPARATUS ADAPTED FOR MANUFACTURE OR TREATMENT OF SEMICONDUCTOR OR SOLID-STATE DEVICES OR OF PARTS THEREOF (EPO)**
- E21.002 .Manufacture or treatment of semiconductor device (EPO)
- E21.003 ..Manufacture of two-terminal component for integrated circuit (EPO)
- E21.004 ...Of resistor (EPO)
- E21.005 Active material comprising carbon, e.g., diamond or diamond-like carbon (EPO)
- E21.006 Active material comprising refractory, transition, or noble metal or metal compound, e.g., alloy, silicide, oxide, nitride (EPO)
- E21.007 Active material comprising organic conducting material, e.g., conducting polymer (EPO)
- E21.008 ...Of capacitor (EPO)

- E21.009 Dielectric having perovskite structure (EPO)
- E21.01 Dielectric comprising two or more layers, e.g., buffer layers, seed layers, gradient layers (EPO)
- E21.011 Formation of electrode (EPO)
- E21.012 With increased surface area, e.g., by roughening, texturing (EPO)
- E21.013 With rough surface, e.g., using hemispherical grains (EPO)
- E21.014 Having cylindrical, crown, or fin-type shape (EPO)
- E21.015 Having horizontal extensions (EPO)
- E21.016 Made by depositing layers, e.g., alternately conductive and insulating layers (EPO)
- E21.017 Made by patterning layers, e.g., etching conductive layers (EPO)
- E21.018 Having vertical extensions (EPO)
- E21.019 Made by depositing layers, e.g., alternately conductive and insulating layers (EPO)
- E21.02 Made by patterning layers, e.g., etching conductive layers (EPO)
- E21.021 Having multilayers, e.g., comprising barrier layer and metal layer (EPO)
- E21.022 ...Of inductor (EPO)
- E21.023 ..Making mask on semiconductor body for further photolithographic processing (EPO)
- E21.024 ...Comprising organic layer (EPO)
- E21.025 For lift-off process (EPO)
- E21.026 Characterized by treatment of photoresist layer (EPO)
- E21.027 Photolithographic process (EPO)
- E21.028 Using laser (EPO)
- E21.029 Using anti-reflective coating (EPO)
- E21.03 Electro-lithographic process (EPO)
- E21.031 X-ray lithographic process (EPO)
- E21.032 Ion lithographic process (EPO)
- E21.033 ...Comprising inorganic layer (EPO)
- E21.034 For lift-off process (EPO)
- E21.035 Characterized by their composition, e.g., multilayer masks, materials (EPO)
- E21.036 Characterized by their size, orientation, disposition, behavior, shape, in horizontal or vertical plane (EPO)
- E21.037 Characterized by their behavior during process, e.g., soluble mask, re-deposited mask (EPO)
- E21.038 Characterized by process involved to create mask, e.g., lift-off mask, sidewalls, or to modify mask, such as pre-treatment, post-treatment (EPO)
- E21.039 Process specially adapted to improve the resolution of the mask (EPO)
- E21.04 ..Device having at least one potential-jump barrier or surface barrier, e.g., PN junction, depletion layer, carrier concentration layer (EPO)
- E21.041 ...Device having semiconductor body comprising carbon, e.g., diamond, diamond-like carbon (EPO)
- E21.042 Making n- or p-doped regions (EPO)
- E21.043 Using ion implantation (EPO)
- E21.044 Changing their shape, e.g., forming recess (EPO)
- E21.045 Making electrode (EPO)
- E21.046 Ohmic electrode (EPO)
- E21.047 Schottky electrode (EPO)
- E21.048 Conductor-insulator-semiconductor electrode, e.g., MIS contacts (EPO)
- E21.049 Multistep processes for manufacture of device whose active layer, e.g., base, channel, comprises semiconducting carbon, e.g., diamond, diamond-like carbon (EPO)

- E21.05 Device controllable only by electric current supplied or the electric potential applied to electrode which does not carry current to be rectified, amplified, or switched, e.g., three-terminal devices such as source, drain, and gate terminals; emitter, base, collector terminals (EPO)
- E21.051 Field-effect transistor (EPO)
- E21.052 Device controllable only by variation of electric current supplied or the electric potential applied to electrodes carrying current to be rectified, amplified, oscillated, or switched, e.g., two-terminal device (EPO)
- E21.053 Diode (EPO)
- E21.054 ...Device having semiconductor body comprising silicon carbide (SiC) (EPO)
- E21.055 Passivating silicon carbide surface (EPO)
- E21.056 Making n- or p- doped regions or layers, e.g., using diffusion (EPO)
- E21.057 Using ion implantation (EPO)
- E21.058 Using masks (EPO)
- E21.059 Angled implantation (EPO)
- E21.06 Changing shape of semiconductor body, e.g., forming recesses (EPO)
- E21.061 Making electrode (EPO)
- E21.062 Ohmic electrode (EPO)
- E21.063 Conductor-insulator-semiconductor electrode, e.g., MIS contact (EPO)
- E21.064 Schottky electrode (EPO)
- E21.065 Multistep processes for manufacture of device whose active layer, e.g., base, channel, comprises silicon carbide (EPO)
- E21.066 Device controllable only by electric current supplied or the electric potential applied to electrode which does not carry current to be rectified, amplified, or switched, e.g., three-terminal device (EPO)
- E21.067 Device controllable only by variation of electric current supplied or electric potential applied to one or more of the electrodes carrying current to be rectified, amplified, oscillated, or switched, e.g., two-terminal device (EPO)
- E21.068 ...Device having semiconductor body comprising selenium (Se) or tellurium (Te) (EPO)
- E21.069 Preparation of substrate or foundation plate for Se or Te semiconductor (EPO)
- E21.07 Preliminary treatment of Se or Te, its application to substrate, or the subsequent treatment of combination (EPO)
- E21.071 Application of Se or Te to substrate or foundation plate (EPO)
- E21.072 Conversion of Se or Te to conductive state (EPO)
- E21.073 Treatment of surface of Se or Te layer after having been made conductive (EPO)
- E21.074 Provision of discrete insulating layer, i.e., specified barrier layer material (EPO)
- E21.075 Application of electrode to exposed surface of Se or Te after Se or Te has been applied to foundation plate (EPO)
- E21.076 Treatment of complete device, e.g., by electroforming to form barrier (EPO)
- E21.077 Heat treating (EPO)
- E21.078 ...Device having semiconductor body comprising cuprous oxide (Cu₂O) or cuprous iodide (CuI) (EPO)
- E21.079 Preparation of substrate, preliminary treatment oxidation of substrate, reduction treatment (EPO)
- E21.08 Preliminary treatment of foundation plate (EPO)
- E21.081 Reduction of copper oxide, treatment of oxide layer (EPO)
- E21.082 Oxidation and subsequent heat treatment of substrate (EPO)
- E21.083 Application of specified conductive layer (EPO)

- E21.084 Treatment of complete device, e.g., electroforming, heat treating (EPO)
- E21.085 ...Device having semiconductor body comprising Group IV elements or Group III-V compounds with or without impurities, e.g., doping materials (EPO)
- E21.086 Intermixing or interdiffusion or disordering of Group III-V heterostructures, e.g., IILD (EPO)
- E21.087 Joining of semiconductor body for junction formation (EPO)
- E21.088 By direct bonding (EPO)
- E21.089 Multistep processes for manufacture of device using quantum interference effect, e.g., electrostatic Aharonov-Bohm effect (EPO)
- E21.09 Deposition of semiconductor material on substrate, e.g., epitaxial growth, solid phase epitaxy (EPO)
- E21.091 Using physical deposition, e.g., vacuum deposition, sputtering (EPO)
- E21.092 Epitaxial deposition of Group IV element, e.g., Si, Ge (EPO)
- E21.093 Deposition on semiconductor substrate being different from deposited semiconductor material; i.e., formation of heterojunctions (EPO)
- E21.094 Deposition on insulating or metallic substrate (EPO)
- E21.095 Epitaxial deposition of diamond (EPO)
- E21.096 Deposition of diamond (EPO)
- E21.097 Epitaxial deposition of Group III-V compound (EPO)
- E21.098 Deposition on semiconductor substrate not being an Group III-V compound (EPO)
- E21.099 Deposition on insulating or metallic substrate (EPO)
- E21.1 Doping during epitaxial deposition (EPO)
- E21.101 Using reduction or decomposition of gaseous compound yielding solid condensate, i.e., chemical deposition (EPO)
- E21.102 Epitaxial deposition of Group IV elements, e.g., Si, Ge, C (EPO)
- E21.103 Deposition on a semiconductor substrate which is different from the semiconductor material being deposited, i.e., formation of heterojunctions (EPO)
- E21.104 Deposition on an insulating or a metallic substrate (EPO)
- E21.105 Epitaxial deposition of diamond (EPO)
- E21.106 Doping during the epitaxial deposition (EPO)
- E21.107 Deposition of diamond (EPO)
- E21.108 Epitaxial deposition of Group III-V compound (EPO)
- E21.109 Using molecular beam technique (EPO)
- E21.11 Doping the epitaxial deposit (EPO)
- E21.111 Doping with transition metals to form semi-insulating layers (EPO)
- E21.112 Deposition on a semiconductor substrate not being Group III-V compound (EPO)
- E21.113 Deposition on an insulating or a metallic substrate (EPO)
- E21.114 Using liquid deposition (EPO)
- E21.115 Epitaxial deposition of Group IV elements, e.g., Si, Ge, C (EPO)
- E21.116 Deposition on a semiconductor substrate which is different from the semiconductor material being deposited, i.e., formation of heterojunction (EPO)
- E21.117 Epitaxial deposition of Group III-V compound (EPO)
- E21.118 Deposition on a semiconductor substrate not being an Group III-V compound (EPO)

- E21.119 Characterized by the substrate (EPO)
- E21.12 Characterized by the post-treatment used to control the interface between substrate and epitaxial layer, e.g., ion implantation followed by annealing (EPO)
- E21.121 Substrate is crystalline insulating material, e.g., sapphire (EPO)
- E21.122 Bonding of semiconductor wafer to insulating substrate or to semiconductor substrate using an intermediate insulating layer (EPO)
- E21.123 Substrate is crystalline semiconductor material, e.g., lattice adaptation, heteroepitaxy (EPO)
- E21.124 Heteroepitaxy (EPO)
- E21.125 Defect and dislocation suppression due to lattice mismatch, e.g., lattice adaptation (EPO)
- E21.126 Group III-V compound on dissimilar Group III-V compound (EPO)
- E21.127 Group III-V compound on Si or Ge (EPO)
- E21.128 Carbon on a noncarbon semiconductor substrate (EPO)
- E21.129 Group IVA, e.g., Si, C, Ge on Group IVB, e.g., Ti, Zr (EPO)
- E21.13 The substrate is crystalline conducting material, e.g., metallic silicide (EPO)
- E21.131 Selective epilaxial growth, e.g., simultaneous deposition of mono- and non-mono semiconductor material (EPO)
- E21.132 Preparation of substrate for selective epitaxy (EPO)
- E21.133 Epitaxial re-growth of non-monocrystalline semiconductor material, e.g., lateral epitaxy by seeded solidification, solid-state crystallization, solid-state graphoepitaxy, explosive crystallization, grain growth in polycrystalline material (EPO)
- E21.134 Using a coherent energy beam, e.g., laser or electron beam (EPO)
- E21.135 Diffusion of impurity material, e.g., doping material, electrode material, into or out of a semiconductor body, or between semiconductor regions; interactions between two or more impurities; redistribution of impurities (EPO)
- E21.136 From the substrate during epitaxy, e.g., autodoping; preventing or using autodoping (EPO)
- E21.137 To control carrier lifetime, i.e., deep level dopant (EPO)
- E21.138 In Group III-V compound (EPO)
- E21.139 Lithium-drift (EPO)
- E21.14 Diffusion source (EPO)
- E21.141 Using diffusion into or out of a solid from or into a gaseous phase (EPO)
- E21.142 Diffusion into or out of Group III-V compound (EPO)
- E21.143 From or into plasma phase (EPO)
- E21.144 Using diffusion into or out of a solid from or into a solid phase, e.g., a doped oxide layer (EPO)
- E21.145 Diffusion into or out of Group IV semiconductor (EPO)
- E21.146 Using predeposition of impurities into the semiconductor surface, e.g., from gaseous phase (EPO)
- E21.147 By ion implantation (EPO)
- E21.148 From or through or into an applied layer, e.g., photoresist, nitride (EPO)
- E21.149 Applied layer is oxide, e.g., P_2O_5 , PSG, H_3BO_3 , doped oxide (EPO)
- E21.15 Through the applied layer (EPO)
- E21.151 Applied layer being silicon or silicide or SIPOS, e.g., polysilicon, porous silicon (EPO)
- E21.152 Diffusion into or out of Group III-V compound (EPO)

- E21.153 Using diffusion into or out of a solid from or into a liquid phase, e.g., alloy diffusion process (EPO)
- E21.154 Alloying of impurity material, e.g., doping material, electrode material, with a semiconductor body (EPO)
- E21.155 Alloying of doping material with Group III-V compound (EPO)
- E21.156 Alloying of electrode material (EPO)
- E21.157 With Group III-V compound (EPO)
- E21.158 Manufacture of electrode on semiconductor body using process other than by epitaxial growth, diffusion of impurities, alloying of impurity materials, or radiation bombardment (EPO)
- E21.159 Deposition of conductive or insulating material for electrode conducting electric current (EPO)
- E21.16 From a gas or vapor, e.g., condensation (EPO)
- E21.161 Of conductive layer (EPO)
- E21.162 On semiconductor body comprising Group IV element (EPO)
- E21.163 Deposition of Schottky electrode (EPO)
- E21.164 O layer comprising silicide (EPO)
- E21.165 Conductive layer comprising silicide (EPO)
- E21.166 Conductive layer comprising semiconducting material (EPO)
- E21.167 Making of side-wall contact (EPO)
- E21.168 Conductive layer comprising transition metal, e.g., Ti, W, Mo (EPO)
- E21.169 By physical means, e.g., sputtering, evaporation (EPO)
- E21.17 By chemical means, e.g., CVD, LPCVD, PECVD, laser CVD (EPO)
- E21.171 Selective deposition (EPO)
- E21.172 On semiconductor body comprising Group III-V compound (EPO)
- E21.173 Deposition of Schottky electrode (EPO)
- E21.174 From a liquid, e.g., electrolytic deposition (EPO)
- E21.175 Using an external electrical current, i.e., electro-deposition (EPO)
- E21.176 Manufacture or post-treatment of electrode having a capacitive structure, i.e., gate structure for field-effect device (EPO)
- E21.177 MOS-gate structure (EPO)
- E21.178 Joint-gate structure (EPO)
- E21.179 Floating or plural gate structure (EPO)
- E21.18 Gate structure with charge-trapping insulator (EPO)
- E21.181 On semiconductor body not comprising Group IV element, e.g., Group III-V compound (EPO)
- E21.182 On semiconductor body comprising Group IV element excluding non-elemental Si, e.g., Ge, C, diamond, silicon compound or compound, such as SiC or SiGe (EPO)
- E21.183 For charge-coupled device (EPO)
- E21.184 PN-homojunction gate structure (EPO)
- E21.185 For charge-coupled device (EPO)
- E21.186 Schottky gate structure (EPO)
- E21.187 For charge-coupled device (EPO)
- E21.188 Heterojunction gate structure (EPO)
- E21.189 For charge-coupled device (EPO)
- E21.19 Making electrode structure comprising conductor-insulator-semiconductor, e.g., MIS gate (EPO)
- E21.191 Insulator formed on silicon semiconductor body (EPO)
- E21.192 Characterized by insulator (EPO)

- E21.193 On single crystalline silicon (EPO)
- E21.194 Characterized by treatment after formation of definitive gate conductor (EPO)
- E21.195 Characterized by conductor (EPO)
- E21.196 Final conductor next to insulator having lateral composition or doping variation, or being formed laterally by more than one deposition step (EPO)
- E21.197 Final conductor layer next to insulator being silicon e.g., polysilicon, with or without impurities (EPO)
- E21.198 Conductor comprising at least another nonsilicon conductive layer (EPO)
- E21.199 Conductor comprising silicide layer formed by silicidation reaction of silicon with metal layer (EPO)
- E21.2 Conductor comprising metal or metallic silicide formed by deposition e.g., sputter deposition, i.e., without silicidation reaction (EPO)
- E21.201 Conductor layer next to insulator is Si or Ge or C and their non-Si alloys (EPO)
- E21.202 Conductor layer next to the insulator is single metal, e.g., Ta, W, Mo, Al (EPO)
- E21.203 Conductor layer next to insulator is metallic silicide (Me Si) (EPO)
- E21.204 Conductor layer next to insulator is non-MeSi composite or compound, e.g., TiN (EPO)
- E21.205 Characterized by sectional shape, e.g., T-shape, inverted T, spacer (EPO)
- E21.206 Lithography, isolation, or planarization-related aspects of making conductor-insulator-semiconductor structure, e.g., sub-lithography lengths; to solve problems arising at crossing with side of device isolation (EPO)
- E21.207 Insulator formed on nonelemental silicon semiconductor body, e.g., Ge, SiGe, SiGeC (EPO)
- E21.208 Comprising layer having ferroelectric properties (EPO)
- E21.209 Making electrode structure comprising conductor-insulator-conductor-insulator-semiconductor, e.g., gate stack for non-volatile memory (EPO)
- E21.21 Comprising charge trapping insulator (EPO)
- E21.211 Treatment of semiconductor body using process other than deposition of semiconductor material on a substrate, diffusion or alloying of impurity material, or radiation treatment (EPO)
- E21.212 Hydrogenation or deuterization, e.g., using atomic hydrogen or deuterium from a plasma (EPO)
- E21.213 Of Group III-V compound (EPO)
- E21.214 To change their surface-physical characteristics or shape, e.g., etching, polishing, cutting (EPO)
- E21.215 Chemical or electrical treatment, e.g., electrolytic etching (EPO)
- E21.216 Electrolytic etching (EPO)
- E21.217 Of Group III-V compound (EPO)
- E21.218 Plasma etching; reactive-ion etching (EPO)
- E21.219 Chemical etching (EPO)
- E21.22 Etching of Group III-V compound (EPO)
- E21.221 Anisotropic liquid etching (EPO)
- E21.222 Vapor phase etching (EPO)

- E21.223 Anisotropic liquid etching (EPO)
- E21.224 Chemical cleaning (EPO)
- E21.225 Cleaning diamond or graphite (EPO)
- E21.226 Dry cleaning (EPO)
- E21.227 With gaseous hydrogen fluoride (HF) (EPO)
- E21.228 Wet cleaning only (EPO)
- E21.229 Combining dry and wet cleaning steps (EPO)
- E21.23 With simultaneous mechanical treatment, e.g., chemical-mechanical polishing (EPO)
- E21.231 Using mask (EPO)
- E21.232 Characterized by their composition, e.g., multilayer masks, materials (EPO)
- E21.233 Characterized by their size, orientation, disposition, behavior, shape, in horizontal or vertical plane (EPO)
- E21.234 Characterized by their behavior during process, e.g., soluble mask, redeposited mask (EPO)
- E21.235 Characterized by process involved to create mask, e.g., lift-off mask, sidewall, or to modify the mask, e.g., pre-treatment, post-treatment (EPO)
- E21.236 Process specially adapted to improve resolution of mask (EPO)
- E21.237 Mechanical treatment, e.g., grinding, polishing, cutting (EPO)
- E21.238 Making grooves, e.g., cutting (EPO)
- E21.239 Using abrasion, e.g., sand-blasting (EPO)
- E21.24 To form insulating layer thereon, e.g., for masking or by using photolithographic technique (EPO)
- E21.241 Post-treatment (EPO)
- E21.242 Of organic layer (EPO)
- E21.243 Planarization of insulating layer (EPO)
- E21.244 Involving dielectric removal step (EPO)
- E21.245 Removal by chemical etching, e.g., dry etching (EPO)
- E21.246 Removal by selective chemical etching, e.g., selective dry etching through mask (EPO)
- E21.247 Doping insulating layer (EPO)
- E21.248 By ion implantation (EPO)
- E21.249 Etching insulating layer by chemical or physical means (EPO)
- E21.25 Etching inorganic layer (EPO)
- E21.251 By chemical means (EPO)
- E21.252 By dry-etching (EPO)
- E21.253 Of layers not containing Si, e.g., PZT, Al₂O₃ (EPO)
- E21.254 Etching organic layer (EPO)
- E21.255 By chemical means (EPO)
- E21.256 By dry-etching (EPO)
- E21.257 Using mask (EPO)
- E21.258 Using masks (EPO)
- E21.259 Organic layers, e.g., photoresist (EPO)
- E21.26 Layer comprising organo-silicon compound (EPO)
- E21.261 Layer comprising polysiloxane compound (EPO)
- E21.262 Layer comprising hydrogen silsesquioxane (EPO)
- E21.263 Layer comprising silazane compounds (EPO)
- E21.264 Layers comprising fluoro hydrocarbon compounds, e.g., polytetrafluoroethylene (EPO)
- E21.265 By Langmuir-Blodgett technique (EPO)
- E21.266 Inorganic layer (EPO)
- E21.267 Composed of alternated layers or of mixtures of nitrides and oxides or of oxynitrides, e.g., formation of oxynitride by oxidation of nitride layer (EPO)
- E21.268 Of silicon (EPO)
- E21.269 Formed by deposition from a gas or vapor (EPO)
- E21.27 Carbon layer, e.g., diamond-like layer (EPO)

E21.271	Composed of oxide or glassy oxide or oxide based glass (EPO)	E21.294	Deposition/post-treatment of noninsulating, e.g., conductive - or resistive - layers on insulating layers (EPO)
E21.272	With perovskite structure (EPO)	E21.295	Deposition of layer comprising metal, e.g., metal, alloys, metal compounds (EPO)
E21.273	Deposition of porous oxide or porous glassy oxide or oxide based porous glass (EPO)	E21.296	Of metal-silicide layer (EPO)
E21.274	Deposition from gas or vapor (EPO)	E21.297	Deposition of semiconductive layer, e.g., poly - or amorphous silicon layer (EPO)
E21.275	Deposition of boron or phosphorus doped silicon oxide, e.g., BSG, PSG, BPSG (EPO)	E21.298	Deposition of superconductive layer (EPO)
E21.276	Deposition of halogen doped silicon oxide, e.g., fluorine doped silicon oxide (EPO)	E21.299	Deposition of conductive or semi-conductive organic layer (EPO)
E21.277	Deposition of carbon doped silicon oxide, e.g., SiOC (EPO)	E21.3	Post treatment (EPO)
E21.278	Deposition of silicon oxide (EPO)	E21.301	Oxidation of silicon-containing layer (EPO)
E21.279	On silicon body (EPO)	E21.302	Nitriding of silicon-containing layer (EPO)
E21.28	Deposition of aluminum oxide (EPO)	E21.303	Planarization (EPO)
E21.281	On a silicon body (EPO)	E21.304	By chemical mechanical polishing (CMP) (EPO)
E21.282	Formed by oxidation (EPO)	E21.305	Physical or chemical etching of layer, e.g., to produce a patterned layer from pre-deposited extensive layer (EPO)
E21.283	Of semiconductor material, e.g., by oxidation of semiconductor body itself (EPO)	E21.306	By physical means only (EPO)
E21.284	By thermal oxidation (EPO)	E21.307	Of silicon-containing layer (EPO)
E21.285	Of silicon (EPO)	E21.308	By chemical means only (EPO)
E21.286	Of Group III-V compound (EPO)	E21.309	By liquid etching only (EPO)
E21.287	By anodic oxidation (EPO)	E21.31	By vapor etching only (EPO)
E21.288	Of silicon (EPO)	E21.311	Using plasma (EPO)
E21.289	Of Group III-V compound (EPO)	E21.312	Of silicon-containing layer (EPO)
E21.29	Of metallic layer, e.g., Al deposited on body, e.g., formation of multi-layer insulating structures (EPO)	E21.313	Pre- or post-treatment, e.g., anti-corrosion process (EPO)
E21.291	By anodic oxidation (EPO)	E21.314	Using mask (EPO)
E21.292	Inorganic layer composed of nitride (EPO)	E21.315	Doping layer (EPO)
E21.293	Of silicon nitride (EPO)	E21.316	Doping polycrystalline or amorphous silicon layer (EPO)

- E21.317 To modify their internal properties, e.g., to produce internal imperfections (EPO)
- E21.318 Of silicon body, e.g., for gettering (EPO)
- E21.319 Using cavities formed by inert gas ion implantation, e.g., hydrogen, noble gas (EPO)
- E21.32 Of silicon on insulator (SOI) (EPO)
- E21.321 Thermally inducing defects using oxygen present in silicon body for intrinsic gettering (EPO)
- E21.322 Of Group III-V compound, e.g., to make them semi-insulating (EPO)
- E21.323 Of diamond body (EPO)
- E21.324 Thermal treatment for modifying the properties of semiconductor body, e.g., annealing, sintering (EPO)
- E21.325 For the formation of PN junction without ad dition of impurities (EPO)
- E21.326 Of Group III-V compound (EPO)
- E21.327 Application of electric current or field, e.g., for electroforming (EPO)
- E21.328 Radiation treatment (EPO)
- E21.329 Using natural radiation, e.g., alpha , beta or gamma radiation (EPO)
- E21.33 To produce chemical element by transmutation (EPO)
- E21.331 With high-energy radiation (EPO)
- E21.332 For etching, e.g., sputter etching (EPO)
- E21.333 For heating, e.g., electron beam heating (EPO)
- E21.334 Producing ions for implantation (EPO)
- E21.335 In Group IV semiconductor (EPO)
- E21.336 Of electrically active species (EPO)
- E21.337 Through-implantation (EPO)
- E21.338 Recoil-implantation (EPO)
- E21.339 Of electrically inactive species in silicon to make buried insulating layer (EPO)
- E21.34 In Group III-V compound (EPO)
- E21.341 Of electrically active species (EPO)
- E21.342 Through-implantation (EPO)
- E21.343 Characterized by the implantation of both electrically active and inactive species in the same semiconductor region to be doped (EPO)
- E21.344 In diamond (EPO)
- E21.345 Characterized by the angle between the ion beam and the crystal planes or the main crystal surface (EPO)
- E21.346 Using mask (EPO)
- E21.347 Using electromagnetic radiation, e.g., laser radiation (EPO)
- E21.348 Using X-ray laser (EPO)
- E21.349 Using incoherent radiation (EPO)
- E21.35 Multi-step process for manufacture of device of bipolar type, e.g., diodes, transistors, thyristors, resistors, capacitors) (EPO)
- E21.351 Device comprising one or two electrodes, e.g., diode, resistor or capacitor with PN or Schottky junctions (EPO)
- E21.352 Diode (EPO)
- E21.353 Tunnel diode (EPO)
- E21.354 Transit time diode, e.g., IMPATT, TRAPATT diode (EPO)
- E21.355 Break-down diode, e.g., Zener diode, avalanche diode (EPO)
- E21.356 Zener diode (EPO)
- E21.357 Avalanche diode (EPO)
- E21.358 Rectifier diode (EPO)
- E21.359 Schottky diode (EPO)
- E21.36 Planar diode (EPO)
- E21.361 Multi-layer diode, e.g., PNPN or NPNP diode (EPO)
- E21.362 Gat ed-diode structure, e.g., SITh, FCTh, FCD (EPO)
- E21.363 Resistor with PN junction (EPO)
- E21.364 Capacitor with PN - or Schottky junction, e.g., varactor (EPO)

- E21.365 Active layer is Group III-V compound (EPO)
- E21.366 Diode (EPO)
- E21.367 With an heterojunction, e.g., resonant tunneling diodes (RTD) (EPO)
- E21.368 Schottky diode (EPO)
- E21.369 Device comprising three or more electrodes (EPO)
- E21.37 Transistor (EPO)
- E21.371 Heterojunction transistor (EPO)
- E21.372 Bipolar thin film transistor (EPO)
- E21.373 Lateral transistor (EPO)
- E21.374 Schottky transistor (EPO)
- E21.375 Silicon vertical transistor (EPO)
- E21.376 Planar transistor (EPO)
- E21.377 Mesa-planar transistor (EPO)
- E21.378 Inverse transistor (EPO)
- E21.379 With single crystalline emitter, collector or base including extrinsic, link or graft base formed on the silicon substrate, e.g., by epitaxy, recrystallization, after insulating device isolation (EPO)
- E21.38 Where main current goes through whole of silicon substrate, e.g., power bipolar transistor (EPO)
- E21.381 With a multi- emitter, e.g., interdigitated, multicellular, distributed (EPO)
- E21.382 Field-effect controlled bipolar-type transistor, e.g., insulated gate bipolar transistor (IGBT) (EPO)
- E21.383 Vertical insulated gate bipolar transistor (EPO)
- E21.384 With recessed gate (EPO)
- E21.385 With recess formed by etching in source/emitter contact region (EPO)
- E21.386 Active layer, e.g., base, is Group III-V compound (EPO)
- E21.387 Heterojunction transistor (EPO)
- E21.388 Thyristor (EPO)
- E21.389 Lateral or planar thyristor (EPO)
- E21.39 Structurally associated with other devices (EPO)
- E21.391 Other device being a controlling device of the field-effect-type (EPO)
- E21.392 Bi-directional thyristor (EPO)
- E21.393 Active layer is Group III-V compound (EPO)
- E21.394 Multi-step process for the manufacture of unipolar device (EPO)
- E21.395 Transistor-like structure, e.g., hot electron transistor (HET); metal base transistor (MBT); resonant tunneling HET (RHET); resonant tunneling transistor (RTT); bulk barrier transistor (BBT); planar doped barrier transistor (PDBT); charge injection transistor (CHINT); ballistic transistor (EPO)
- E21.396 Metal-insulator-semiconductor capacitor, e.g., trench capacitor (EPO)
- E21.397 Comprising PN junction, e.g., hybrid capacitor (EPO)
- E21.398 Active layer is Group III-V compound (EPO)
- E21.399 Transistor-like structure, e.g., hot electron transistor (HET), metal base transistor (MBT), resonant tunneling hot electron transistor (RHET), resonant tunneling transistor (RTT), bulk barrier transistor (BBT), planar doped barrier transistor (PDBT), charge injection transistor (CHINT) (EPO)
- E21.4 Field-effect transistor (EPO)
- E21.401 Using static field induced region, e.g., SIT, PBT (EPO)
- E21.402 Permeable base transistor (PBT) (EPO)
- E21.403 With heterojunction interface channel or gate, e.g., HFET, HIGFET, SISFET, HJFET, HEMT (EPO)

- E21.404 With one or zero or quasi-one or quasi-zero dimensional charge carrier gas channel, e.g., quantum wire FET; single electron transistor (SET); striped channel transistor; coulomb blockade device (EPO)
- E21.405 Active layer is Group III-V compound, e.g., III-V velocity modulation transistor (VMT), NERFET (EPO)
- E21.406 Using static field induced region, e.g., SIT, PBT (EPO)
- E21.407 With an heterojunction interface channel or gate, e.g., HFET, HIGFET, SI SFET, HJFET, HEMT (EPO)
- E21.408 With one or zero or quasi-one or quasi-zero dimensional channel, e.g., in plane gate transistor (IPG), single electron transistor (SET), striped channel transistor, coulomb blockade device (EPO)
- E21.409 With an insulated gate (EPO)
- E21.41 Vertical transistor (EPO)
- E21.411 Thin film unipolar transistor (EPO)
- E21.412 Amorphous silicon or polysilicon transistor (EPO)
- E21.413 Lateral single gate single channel transistor with noninverted structure, i.e., channel layer is formed before gate (EPO)
- E21.414 Lateral single gate single channel transistor with inverted structure, i.e., channel layer is formed after gate (EPO)
- E21.415 Monocrystalline silicon transistor on insulating substrate, e.g., quartz substrate (EPO)
- E21.416 On sapphire substrate, e.g., silicon on sapphire (SOS) transistor (EPO)
- E21.417 With channel containing layer, e.g., p-base, formed in or on drain region, e.g., DMOS transistor (EPO)
- E21.418 Vertical power DMOS transistor (EPO)
- E21.419 With recessed gate (EPO)
- E21.42 With recess formed by etching in source/base contact region (EPO)
- E21.421 With multiple gate, one gate having MOS structure and others having same or a different structure, i.e., non MOS, e.g., JFET gate (EPO)
- E21.422 With floating gate (EPO)
- E21.423 With charge trapping gate insulator, e.g., MNOS transistor (EPO)
- E21.424 Lateral single gate silicon transistor (EPO)
- E21.425 With source or drain region formed by Schottky barrier or conductor-insulator-semiconductor structure (EPO)
- E21.426 With single crystalline channel formed on the silicon substrate after insulating device isolation (EPO)
- E21.427 With asymmetry in channel direction, e.g., high-voltage lateral transistor with channel containing layer, e.g., p-base (EPO)
- E21.428 With a recessed gate, e.g., lateral U-MOS (EPO)
- E21.429 Using etching to form recess at gate location (EPO)
- E21.43 Recessing gate by adding semiconductor material at source (S) or drain (D) location, e.g., transistor with elevated single crystal S and D (EPO)
- E21.431 With source and drain recessed by etching or recessed and refilled (EPO)
- E21.432 With source and drain contacts formation strictly before final gate formation, e.g., contact first technology (EPO)
- E21.433 Where the source and drain or source and drain extensions are self-aligned to sides of gate (EPO)
- E21.434 With initial gate mask or masking layer complementary to prospective gate location, e.g., with dummy source and drain contacts (EPO)

- E21.435 Lateral single gate single channel silicon transistor with both lightly doped source and drain extensions and source and drain self-aligned to sides of gate, e.g., LDD MOSFET, DDD MOSFET (EPO)
- E21.436 Gate comprising layer with ferroelectric properties (EPO)
- E21.437 With lightly doped drain selectively formed at side of gate (EPO)
- E21.438 Using self-aligned silicidation, i.e., salicide (EPO)
- E21.439 Providing different silicide thicknesses on gate and on source or drain (EPO)
- E21.44 Using self-aligned selective metal deposition simultaneously on gate and on source or drain (EPO)
- E21.441 Active layer is Group III-V compound (EPO)
- E21.442 With gate at side of channel (EPO)
- E21.443 Using self-aligned punch through stopper or threshold implant under gate region (EPO)
- E21.444 Using dummy gate wherein at least part of final gate is self-aligned to dummy gate (EPO)
- E21.445 With PN junction or heterojunction gate (EPO)
- E21.446 With PN homojunction gate (EPO)
- E21.447 Vertical transistor, e.g., tecnetrons (EPO)
- E21.448 With heterojunction gate (EPO)
- E21.449 Active layer is Group III-V compound (EPO)
- E21.45 With Schottky gate, e.g., MESFET (EPO)
- E21.451 Active layer being Group III-V compound (EPO)
- E21.452 Lateral single-gate transistors (EPO)
- E21.453 Process wherein final gate is made after formation of source and drain regions in active layer, e.g., dummy-gate process (EPO)
- E21.454 Process wherein final gate is made before formation, e.g., activation anneal, of source and drain regions in active layer (EPO)
- E21.455 Lateral transistor with two or more independent gates (EPO)
- E21.456 Charge transfer device (EPO)
- E21.457 With insulated gate (EPO)
- E21.458 With Schottky gate (EPO)
- E21.459 ...Device having semiconductor body other than carbon, Si, Ge, SiC, Se, Te, Cu₂O, CuI, and Group III-V compounds with or without impurities, e.g., doping materials (EPO)
- E21.46 Multistep process (EPO)
- E21.461 Deposition of semiconductor material on substrate, e.g., epitaxial growth (EPO)
- E21.462 Using physical deposition, e.g., vacuum deposition, sputtering (EPO)
- E21.463 Using reduction or decomposition of gaseous compound yielding solid condensate, i.e., chemical deposition (EPO)
- E21.464 Using liquid deposition (EPO)
- E21.465 From molten solution of compound or alloy, e.g., liquid phase epitaxy (EPO)
- E21.466 Diffusion of impurity material, e.g., dopant, electrode material, into or out of semiconductor body, or between semiconductor regions (EPO)
- E21.467 Using diffusion into or out of solid from or into gaseous phase (EPO)
- E21.468 Using diffusion into or out of solid from or into solid phase, e.g., doped oxide layer (EPO)
- E21.469 Using diffusion into or out of solid from or into liquid phase, e.g., alloy diffusion process (EPO)
- E21.47 Alloying of impurity material, e.g., dopant, electrode material, with semiconductor body (EPO)
- E21.471 Radiation treatment (EPO)

- E21.472 With high-energy radiation (EPO)
- E21.473 Producing ion implantation (EPO)
- E21.474 Using mask (EPO)
- E21.475 Using electromagnetic radiation, e.g., laser radiation (EPO)
- E21.476 Manufacture of electrodes on semiconductor bodies using processes or apparatus other than epitaxial growth, e.g., coating, diffusion, or alloying, or radiation treatment (EPO)
- E21.477 Deposition of conductive or insulating materials for electrode (EPO)
- E21.478 From gas or vapor, e.g., condensation (EPO)
- E21.479 From liquid, e.g., electrolytic deposition (EPO)
- E21.48 Involving application of pressure, e.g., thermo compression bonding (EPO)
- E21.481 Including application of mechanical vibration, e.g., ultrasonic vibration (EPO)
- E21.482 Treatment of semiconductor body using process other than electromagnetic radiation (EPO)
- E21.483 To change their surface-physical characteristics or shape, e.g., etching, polishing, cutting (EPO)
- E21.484 Mechanical treatment, e.g., grinding, ultrasonic treatment (EPO)
- E21.485 Chemical or electrical treatment, e.g., electrolytic etching (EPO)
- E21.486 Using mask (EPO)
- E21.487 To form insulating layer thereon, e.g., for masking or by using photolithographic techniques; post treatment of these layers (EPO)
- E21.488 Using mask (EPO)
- E21.489 Post treatment of insulating layer (EPO)
- E21.49 Etching layer (EPO)
- E21.491 Doping layer (EPO)
- E21.492 Organic layer, e.g., photoresist (EPO)
- E21.493 Inorganic layer (EPO)
- E21.494 Composed of oxide or glassy oxide or oxide-based glass (EPO)
- E21.495 Deposition of noninsulating, e.g., conductive -, resistive -, layer on insulating layer (EPO)
- E21.496 Post treatment of layer (EPO)
- E21.497 Thermal treatment for modifying property of semiconductor body, e.g., annealing, sintering (EPO)
- E21.498 Application of electric current or fields, e.g., for electroforming (EPO)
- E21.499 ...Assembling semiconductor devices, e.g., packaging , including mounting, encapsulating, or treatment of packaged semiconductor (EPO)
- E21.5 Mounting semiconductor bodies in container (EPO)
- E21.501 Providing fillings in container, e.g., gas fillings (EPO)
- E21.502 Encapsulation, e.g., encapsulation layer, coating (EPO)
- E21.503 Encapsulation of active face of flip chip device, e.g., under filling or under encapsulation of flip-chip, encapsulation perform on chip or mounting substrate (EPO)
- E21.504 Moulds (EPO)
- E21.505 Insulative mounting semiconductor device on support (EPO)
- E21.506 Attaching or detaching leads or other conductive members, to be used for carrying current to or from device in operation (EPO)
- E21.507 Formation of contacts to semiconductor by use of metal layers separated by insulating layers, e.g., self-aligned contacts to source/drain or emitter/base (EPO)
- E21.508 Forming solder bumps (EPO)
- E21.509 Involving soldering or alloying process, e.g., soldering wires (EPO)

- E21.51 Mounting on metallic conductive member (EPO)
- E21.511 Mounting on insulating member provided with metallic leads, e.g., flip-chip mounting, conductive die mounting (EPO)
- E21.512 Right-up bonding (EPO)
- E21.513 Mounting on semiconductor conductive member (EPO)
- E21.514 Involving use of conductive adhesive (EPO)
- E21.515 Involving use of mechanical auxiliary part without use of alloying or soldering process, e.g., pressure contacts (EPO)
- E21.516 Involving automation techniques using film carriers (EPO)
- E21.517 Involving use of electron or laser beam (EPO)
- E21.518 Involving application of mechanical vibration, e.g., ultrasonic vibration (EPO)
- E21.519 Involving application of pressure, e.g., thermo-compression bonding (EPO)
- E21.52 ..Devices having no potential-jump barrier or surface barrier (EPO)
- E21.521 ..Testing or measuring during manufacture or treatment or reliability measurement, i.e., testing of parts followed by no processing which modifies parts as such (EPO)
- E21.522 ..Structural arrangement (EPO)
- E21.523 ...Additional lead-in metallization on device, e.g., additional pads or lands, lines in scribe line, sacrificed conductors, sacrificed frames (EPO)
- E21.524 ...Circuit for characterizing or monitoring manufacturing process, e.g., whole test die, wafer filled with test structures, onboard devices incorporated on each die, process/product control monitors or PCM, devices in scribe-line/kerf, drop-in devices (EPO)
- E21.525 ..Procedures, i.e., sequence of activities consisting of plurality of measurement and correction, marking or sorting steps (EPO)
- E21.526 ...Connection or disconnection of subentities or redundant parts of device in response to measurement, e.g., wafer scale, memory devices (EPO)
- E21.527 ...Optical enhancement of defects or not directly visible states, e.g., selective electrolytic deposition, bubbles in liquids, light emission, color change (EPO)
- E21.528 ...Acting in response to ongoing measurement without interruption of processing, e.g., endpoint detection, in-situ thickness measurement (EPO)
- E21.529 ..Measuring as part of manufacturing process (EPO)
- E21.53 ...For structural parameters, e.g., thickness, line width, refractive index, temperature, warp, bond strength, defects, optical inspection, electrical measurement of structural dimensions, metallurgic measurement of diffusions (EPO)
- E21.531 ...For electrical parameters, e.g., resistance, deep-levels, CV, diffusions by electrical means (EPO)
- E21.532 ..Manufacture or treatment of devices consisting of plurality of solid-state components formed in or on common substrate or of parts thereof; manufacture of integrated circuit devices or of parts thereof (EPO)
- E21.533 ..Of thick- or thin-film circuits or parts thereof (EPO)
- E21.534 ...Of thick-film circuits or parts thereof (EPO)
- E21.535 ...Of thin-film circuits or parts thereof (EPO)
- E21.536 ..Manufacture of specific parts of devices (EPO)

- E21.537 ...Making of localized buried regions, e.g., buried collector layer, internal connection, substrate contacts (EPO)
- E21.538 Making of internal connections, substrate contacts (EPO)
- E21.539 For Group III-V compound semiconductor integrated circuits (EPO)
- E21.54 ...Making of isolation regions between components (EPO)
- E21.541 Between components manufactured in active substrate comprising SiC compound semiconductor (EPO)
- E21.542 Between components manufactured in active substrate comprising Group III-V compound semiconductor (EPO)
- E21.543 Between components manufactured in active substrate comprising Group II-VI compound semiconductor (EPO)
- E21.544 PN junction isolation (EPO)
- E21.545 Dielectric regions, e.g., EPIC dielectric isolation, LOCOS; trench refilling techniques, SOI technology, use of channel stoppers (EPO)
- E21.546 Using trench refilling with dielectric materials (EPO)
- E21.547 Dielectric material being obtained by full chemical transformation of nondielectric materials, such as polycrystalline silicon, metals (EPO)
- E21.548 Concurrent filling of plurality of trenches having different trench shape or dimension, e.g., rectangular and V-shaped trenches, wide and narrow trenches, shallow and deep trenches (EPO)
- E21.549 Of trenches having shape other than rectangular or V shape, e.g., rounded corners, oblique or rounded trench walls (EPO)
- E21.55 Trench shape altered by local oxidation of silicon process step, e.g., trench corner rounding by LOCOS (EPO)
- E21.551 Introducing impurities in trench side or bottom walls, e.g., for forming channel stoppers or alter isolation behavior (EPO)
- E21.552 Using local oxidation of silicon, e.g., LOCOS, SWAMI, SILO (EPO)
- E21.553 In region recessed from surface, e.g., in recess, groove, tub or trench region (EPO)
- E21.554 Using auxiliary pillars in recessed region, e.g., to form LOCOS over extended areas (EPO)
- E21.555 Recessed region having shape other than rectangular, e.g., rounded or oblique shape (EPO)
- E21.556 Introducing electrical inactive or active impurities in local oxidation region, e.g., to alter LOCOS oxide growth characteristics or for additional isolation purpose (EPO)
- E21.557 Introducing electrical active impurities in local oxidation region solely for forming channel stoppers (EPO)
- E21.558 Introducing both types of electrical active impurities in local oxidation region solely for forming channel stoppers, e.g., for isolation of complementary doped regions (EPO)
- E21.559 With plurality of successive local oxidation steps (EPO)
- E21.56 Dielectric isolation using EPIC technique, i.e., epitaxial passivated integrated circuit (EPO)
- E21.561 Using semiconductor or insulator technology, i.e., SOI technology (EPO)
- E21.562 Using selective deposition of single crystal silicon, e.g., Selective Epitaxial Growth (SEG) (EPO)

- E21.563 Using silicon implanted buried insulating layers, e.g., oxide layers, i.e., SIMOX technique (EPO)
- E21.564 SOI together with lateral isolation, e.g., using local oxidation of silicon, or dielectric or polycrystalline material refilled trench or air gap isolation regions, e.g., completely isolated semiconductor islands (EPO)
- E21.565 Using full isolation by porous oxide silicon, i.e., FIPOS technique (EPO)
- E21.566 Using lateral overgrowth technique, i.e., ELO techniques (EPO)
- E21.567 Using bonding technique (EPO)
- E21.568 With separation/delamination along ion implanted layer, e.g., "Smart-cut", "Unibond" (EPO)
- E21.569 Using silicon etch back technique, e.g., BESOI, ELTRAN (EPO)
- E21.57 With separation/delamination along porous layer (EPO)
- E21.571 Using selective deposition of single crystal silicon, i.e., SEG technique (EPO)
- E21.572 Polycrystalline semiconductor regions (EPO)
- E21.573 Air gaps (EPO)
- E21.574 Isolation by field effect (EPO)
- E21.575 ...Interconnections, comprising conductors and dielectrics, for carrying current between separate components within device (EPO)
- E21.576 Characterized by formation and post treatment of dielectrics, e.g., planarizing (EPO)
- E21.577 By forming via holes (EPO)
- E21.578 Tapered via holes (EPO)
- E21.579 For "dual damascene" type structures (EPO)
- E21.58 Planarizing dielectric (EPO)
- E21.581 Dielectric comprising air gaps (EPO)
- E21.582 Characterized by formation and post treatment of conductors, e.g., patterning (EPO)
- E21.583 Planarization; smoothing (EPO)
- E21.584 Barrier, adhesion or liner layer (EPO)
- E21.585 Filling of holes, grooves, vias or trenches with conductive material (EPO)
- E21.586 By selective deposition of conductive material in vias, e.g., selective chemical vapor deposition on semiconductor material, plating (EPO)
- E21.587 By deposition over sacrificial masking layer, e.g., lift-off (EPO)
- E21.588 Reflowing or applying pressure to fill contact hole, e.g., to remove voids (EPO)
- E21.589 By forming conductive members before deposition of protective insulating material, e.g., pillars, studs (EPO)
- E21.59 Local interconnects; local pads (EPO)
- E21.591 Modifying pattern or conductivity of conductive members, e.g., formation of alloys, reduction of contact resistances (EPO)
- E21.592 By altering solid-state characteristics of conductive members, e.g., fuses, in situ oxidation, laser melting (EPO)
- E21.593 By forming silicide of refractory metal (EPO)
- E21.594 By using super-conducting material (EPO)
- E21.595 Modifying pattern (EPO)
- E21.596 Using laser, e.g., laser cutting, laser direct writing, laser repair (EPO)
- E21.597 Formed through semiconductor substrate (EPO)
- E21.598 ..Manufacture or treatment of devices consisting of plurality of solid-state components or integrated circuits formed in, or on, common substrate (EPO)

- E21.599 With subsequent division of substrate into plural individual devices (EPO)
- E21.6 Involving separation of active layers from substrate (EPO)
- E21.601 Leaving reusable substrate, e.g., epitaxial lift-off process (EPO)
- E21.602 To produce devices each consisting of plurality of components, e.g., integrated circuits (EPO)
- E21.603 Substrate is semiconductor, using combination of semiconductor substrates, e.g., diamond, SiC, Si, Group III-V compound, and/or Group II-VI compound semiconductor substrates (EPO)
- E21.604 Substrate is semiconductor, using diamond technology (EPO)
- E21.605 Substrate is semiconductor, using SiC technology (EPO)
- E21.606 Substrate being semiconductor, using silicon technology (EPO)
- E21.607 Substrate being semiconductor, using silicon technology (EPO)
- E21.608 Bipolar technology (EPO)
- E21.609 Comprising combination of vertical and lateral transistors (EPO)
- E21.61 Comprising merged transistor logic or integrated injection logic (EPO)
- E21.611 Complementary devices, e.g., complementary transistors (EPO)
- E21.612 Complementary vertical transistors (EPO)
- E21.613 Memory structures (EPO)
- E21.614 Three-dimensional integrated circuits stacked in different levels (EPO)
- E21.615 Field-effect technology (EPO)
- E21.616 MIS technology (EPO)
- E21.617 Combination of charge coupled devices, i.e., CCD or BBD (EPO)
- E21.618 With particular manufacturing method of channel, e.g., channel implants, halo or pocket implants, or channel materials (EPO)
- E21.619 With particular manufacturing method of source or drain, e.g., specific S or D implants or silicided S or D structures or raised S or D structures (EPO)
- E21.62 Manufacturing common source or drain regions between plurality of conductor-insulator-semiconductor structures (EPO)
- E21.621 With particular manufacturing method of gate conductor, e.g., particular materials, shapes (EPO)
- E21.622 Silicided or salicided gate conductors (EPO)
- E21.623 Gate conductors with different gate conductor materials or different gate conductor implants, e.g., dual gate structures (EPO)
- E21.624 Gate conductors with different shapes, lengths or dimensions (EPO)
- E21.625 With particular manufacturing method of gate insulating layer, e.g., different gate insulating layer thicknesses, particular gate insulator materials or particular gate insulator implants (EPO)
- E21.626 With particular manufacturing method of gate sidewall spacers, e.g., double spacers, particular spacer material or shape (EPO)
- E21.627 Interconnection or wiring or contact manufacturing related aspects (EPO)
- E21.628 Isolation region manufacturing related aspects, e.g., to avoid interaction of isolation region with adjacent structure (EPO)

- E21.629 With particular manufacturing method of vertical transistor structures, i.e., with channel vertical to substrate surface (EPO)
- E21.63 With particular manufacturing method of wells or tubs, e.g., twin tubs, high energy well implants, buried implanted layers for lateral isolation (BILLI) (EPO)
- E21.631 Combination of enhancement and depletion transistors (EPO)
- E21.632 Complementary field-effect transistors, e.g., CMOS (EPO)
- E21.633 With particular manufacturing method of channel, e.g., channel implants, halo or pocket implants, or channel materials (EPO)
- E21.634 With particular manufacturing method of source or drain, e.g., specific S or D implants or silicided S or D structures or raised S or D structures (EPO)
- E21.635 With particular manufacturing method of gate conductor, e.g., particular materials, shapes (EPO)
- E21.636 Silicided or salicided gate conductors (EPO)
- E21.637 Gate conductors with different gate conductor materials or different gate conductor implants, e.g., dual gate structures (EPO)
- E21.638 Gate conductors with different shapes, lengths or dimensions (EPO)
- E21.639 With particular manufacturing method of gate insulating layer, e.g., different gate insulating layer thicknesses, particular gate insulator materials or particular gate insulator implants (EPO)
- E21.64 With particular manufacturing method of gate sidewall spacers, e.g., double spacers, particular spacer material or shape (EPO)
- E21.641 Interconnection or wiring or contact manufacturing related aspects (EPO)
- E21.642 Isolation region manufacturing related aspects, e.g., to avoid interaction of isolation region with adjacent structure (EPO)
- E21.643 With particular manufacturing method of vertical transistor structures, i.e., with channel vertical to substrate surface (EPO)
- E21.644 With particular manufacturing method of wells or tubs, e.g., twin tubs, high energy well implants, buried implanted layers for lateral isolation (BILLI) (EPO)
- E21.645 Memory structures (EPO)
- E21.646 Dynamic random access memory structures (DRAM) (EPO)
- E21.647 Characterized by type of capacitor (EPO)
- E21.648 Capacitor stacked over transfer transistor (EPO)
- E21.649 Making connection between transistor and capacitor, e.g., plug (EPO)
- E21.65 Capacitor extending under transfer transistor area (EPO)
- E21.651 Capacitor in U- or V-shaped trench in substrate (EPO)
- E21.652 In combination with vertical transistor (EPO)
- E21.653 Making connection between transistor and capacitor, e.g., buried strap (EPO)
- E21.654 Characterized by type of transistor; manufacturing of transistor (EPO)
- E21.655 Transistor in U- or V-shaped trench in substrate (EPO)
- E21.656 Characterized by data lines (EPO)

E21.657 Making bit line (EPO)	E21.68 Electrically
E21.658 Making bit line contact (EPO)	programmable (EPROM), i.e.,
E21.659 Making word line (EPO)	floating gate memory
E21.66 Simultaneous	structures (EPO)
fabrication of periphery and	E21.681 With conductive layer
memory cells (EPO)	as control gate (EPO)
E21.661 Static random access	E21.682 With source and drain
memory structures (SRAM) (EPO)	on same level and without cell
E21.662 Read-only memory	select transistor (EPO)
structures (ROM), i.e.,	E21.683 Simultaneous
nonvolatile memory structures	fabrication of periphery and
(EPO)	memory cells (EPO)
E21.663 Ferroelectric	E21.684 Including one type
nonvolatile memory structures	of peripheral FET (EPO)
(EPO)	E21.685 Control gate layer
E21.664 With ferroelectric	used for peripheral FET (EPO)
capacitor (EPO)	E21.686 Intergate
E21.665 Magnetic nonvolatile	dielectric layer used for
memory structures, e.g., MRAM	peripheral FET (EPO)
(EPO)	E21.687 Floating gate
E21.666 PROM (EPO)	layer used for peripheral FET
E21.667 ROM only (EPO)	(EPO)
E21.668 With source and drain	E21.688 Floating gate
on same level, e.g., lateral	dielectric layer used for
channel (EPO)	peripheral FET (EPO)
E21.669 Source or drain	E21.689 Including different
contact programmed (EPO)	types of peripheral FETs (EPO)
E21.67 Gate contact	E21.69 With source and drain
programmed (EPO)	on same level and with cell
E21.671 Doping programmed,	select transistor (EPO)
e.g., mask ROM (EPO)	E21.691 Simultaneous
E21.672 Entire channel	fabrication of periphery and
doping programmed (EPO)	memory cells (EPO)
E21.673 Source or drain	E21.692 With source and drain
doping programmed (EPO)	on different levels, e.g.,
E21.674 Gate programmed,	sloping channel (EPO)
e.g., different gate material	E21.693 For vertical channel
or no gate (EPO)	(EPO)
E21.675 Gate dielectric	E21.694 With doped region as
programmed, e.g., different	control gate (EPO)
thickness (EPO)	E21.695 Combination of bipolar and
E21.676 With source and drain	field-effect technologies
on different levels, e.g.,	(EPO)
vertical channel (EPO)	E21.696 Bipolar and MOS
E21.677 With FETs on different	technologies (EPO)
levels, e.g., 3D ROM (EPO)	E21.697 Substrate is Group III-V
E21.678 Simultaneous	semiconductor (EPO)
fabrication of periphery and	E21.698 Substrate is Group II-VI
memory cells (EPO)	semiconductor (EPO)
E21.679 Charge trapping	E21.699 Substrate is semiconductor
insulator nonvolatile memory	other than diamond, SiC, Si,
structures (EPO)	Group III-V compound, or Group
	II-VI compound (EPO)

E21.7	Substrate is nonsemiconductor body, e.g., insulating body (EPO)	913	WITH MEANS TO ABSORB OR LOCALIZE UNWANTED IMPURITIES OR DEFECTS FROM SEMICONDUCTORS (E.G., HEAVY METAL GETTERING)
E21.701	Substrate is sapphire, e.g., silicon on sapphire structure (SOS) (EPO)	914	POLYSILICON CONTAINING OXYGEN, NITROGEN, OR CARBON (E.G., SIPOS)
E21.702	To produce devices, each consisting of single circuit element (EPO)	915	WITH TITANIUM NITRIDE PORTION OR REGION
E21.703	Substrate is semiconductor body (EPO)	916	NARROW BAND GAP SEMICONDUCTOR MATERIAL (<<1eV)
E21.704	Substrate is nonsemiconductor body, e.g., insulating body (EPO)	917	PLURAL DOPANTS OF SAME CONDUCTIVITY TYPE IN SAME REGION
E21.705	..Assembly of devices consisting of solid-state components formed in or on a common substrate; assembly of integrated circuit devices (EPO)	918	LIGHT EMITTING REGENERATIVE SWITCHING DEVICE (E.G., LIGHT EMITTING SCR) ARRAYS, CIRCUITRY, ETC.
<u>CROSS-REFERENCE ART COLLECTIONS</u>		919	ELEMENTS OF SIMILAR CONSTRUCTION CONNECTED IN SERIES OR PARALLEL TO AVERAGE OUT MANUFACTURING VARIATIONS IN CHARACTERISTICS
900	MOSFET TYPE GATE SIDEWALL INSULATING SPACER	920	CONDUCTOR LAYERS ON DIFFERENT LEVELS CONNECTED IN PARALLEL (E.G., TO REDUCE RESISTANCE)
901	MOSFET SUBSTRATE BIAS	921	RADIATION HARDENED SEMICONDUCTOR DEVICE
902	FET WITH METAL SOURCE REGION	922	WITH MEANS TO PREVENT INSPECTION OF OR TAMPERING WITH AN INTEGRATED CIRCUIT (E.G., "SMART CARD", ANTI-TAMPER)
903	FET CONFIGURATION ADAPTED FOR USE AS STATIC MEMORY CELL	923	WITH MEANS TO OPTIMIZE ELECTRICAL CONDUCTOR CURRENT CARRYING CAPACITY (E.G., PARTICULAR CONDUCTOR ASPECT RATIO)
904	.WITH PASSIVE COMPONENTS, (e.g., POLYSILICON RESISTORS)	924	WITH PASSIVE DEVICE (E.G., CAPACITOR), OR BATTERY, AS INTEGRAL PART OF HOUSING OR HOUSING ELEMENT (E.G., CAP)
905	PLURAL DRAM CELLS SHARE COMMON CONTACT OR COMMON TRENCH	925	BRIDGE RECTIFIER MODULE
906	DRAM WITH CAPACITOR ELECTRODES USED FOR ACCESSING (E.G., BIT LINE IS CAPACITOR PLATE)	926	ELONGATED LEAD EXTENDING AXIALLY THROUGH ANOTHER ELONGATED LEAD
907	FOLDED BIT LINE DRAM CONFIGURATION	927	DIFFERENT DOPING LEVELS IN DIFFERENT PARTS OF PN JUNCTION TO PRODUCE SHAPED DEPLETION LAYER
908	DRAM CONFIGURATION WITH TRANSISTORS AND CAPACITORS OF PAIRS OF CELLS ALONG A STRAIGHT LINE BETWEEN ADJACENT BIT LINES	928	WITH SHORTED PN OR SCHOTTKY JUNCTION OTHER THAN EMITTER JUNCTION
909	MACROCELL ARRAYS (E.G., GATE ARRAYS WITH VARIABLE SIZE OR CONFIGURATION OF CELLS)		
910	DIODE ARRAYS (E.G., DIODE READ-ONLY MEMORY ARRAY)		
911	LIGHT SENSITIVE ARRAY ADAPTED TO BE SCANNED BY ELECTRON BEAM (E.G., VIDICON DEVICE)		
912	CHARGE TRANSFER DEVICE USING BOTH ELECTRON AND HOLE SIGNAL CARRIERS		

- 929 PN JUNCTION ISOLATED INTEGRATED
 CIRCUIT WITH ISOLATION WALLS
 HAVING MINIMUM DOPANT
 CONCENTRATION AT INTERMEDIATE
 DEPTH IN EPITAXIAL LAYER
 (E.G., DIFFUSED FROM BOTH
 SURFACES OF EPITAXIAL LAYER)
- 930 THERMOELECTRIC (E.G., PELTIER
 EFFECT) COOLING

FOREIGN ART COLLECTIONS

FOR 000 CLASS-RELATED FOREIGN DOCUMENTS

