

**Cross Reference Art Collection Class 977
NANOTECHNOLOGY (April 19, 2005)**

- 7200E** **NANOSTRUCTURE:**
Subject matter under the class definition directed to the structural features, properties, or characteristics of at least one nanosized element, component, or device.
- 7240D** **Integrated with dissimilar structures on a common substrate:**
Subject matter under subclass 7200E wherein a nanostructure is integrated onto a common substrate with one or more different structures, devices, or systems that, in turn, may or may not constitute or include a nanostructure.
- (1) Note. Classification under this subclass sequence is appropriate when dissimilar structures, including at least one nanostructure, are integrated on a common substrate, regardless of whether any one of the dissimilar structures, itself, has uniqueness independent of the integration.
- 7355C** **Having biological material component:**
Subject matter under subclass 7240D wherein the dissimilar structures constitute a component that is derived from or relating to a living organism.
- 7356H** **Cellular:**
Subject matter under subclass 7355C wherein the biological material component is a cell or a subpart of a cell.
- 7357R** **Nucleic acids (e.g., DNA or RNA, etc.):**
Subject matter under subclass 7355C wherein the biological material component is a nucleic acid.
- (1) Note. Nucleic acid, such as DNA or RNA, is any of various acids composed of a sugar or derivative of a sugar, phosphoric acid, and a base.
- 7358W** **Protein or peptide:**
Subject matter under subclass 7355C wherein the biological material component is a protein or a peptide.
- (1) Note. Protein is any of numerous naturally occurring complex combinations of amino acids that contain the elements carbon, hydrogen, nitrogen, oxygen, and other elements.
- (2) Note. Peptide is derivative of two or more amino acids by combination of the amino group of one acid with the carboxyl group of another acid and is usually obtained by partial hydrolysis of proteins.
- 7359T** **Carbohydrate:**
Subject matter under subclass 7355C wherein the biological material component is a carbohydrate.
- (1) Note. Carbohydrate is any of various neutral compounds of carbon, hydrogen, and oxygen such as sugars, starches, and celluloses, most of which are formed by green plants.

- 7203Y** **Having different types of nanoscale structures or devices on a common substrate:**
Subject matter under subclass 7240D wherein two or more different kinds of nanosized structures or devices are integrated on the common substrate.
- (1) Note. A specific example of subject matter included in this subclass is substrate supporting one or more semiconductor nanodots and one or more metal nanodots, but would NOT be proper for a substrate supporting only an array of identical nanodots.
- 7205H** **With distinct switching device:**
Subject matter under subclass 7240D includes a separate switching device.
- (1) Note: The switching devices may or may not constitute or include nanostructures, e.g., a quantum-dot memory array and peripheral, carbon-nanotube-based circuitry interconnected by a separate array of conventional selected transistors, etc.
- 7360C** **Including molecular switching device**
Subject matter under subclass 7205H wherein the nanosized switching device constitutes a molecular structure that exhibits switching properties or capability, e.g., to shift from one to another state, function, etc.
- 7361H** **Biological switching:**
Subject matter under subclass 7360C wherein the switching device constitutes a molecular structure of a living organism, e.g., a receptor/ligand switching pair, etc.
- 7362R** **Nucleic acid switching:**
Subject matter under subclass 7361H wherein the switching device constitutes molecular structure of a nucleic acid.
- 7222Y** **Formed from plural layers of nanosized material (e.g. stacked structures, etc.):**
Subject matter under subclass 7240D wherein identical or different nanostructures are provided in two or more layers on a common substrate such as plural layers, each containing vertical nanowires (or “nanovias”) for interconnecting three or more interconnected layers; or (2) quantum-dot memory device formed on one layer and nanovias formed on one or more other layers.
- 7363W** **Including lipid layer:**
Subject matter under subclass 7222Y including one or more nanosized layers that are lipid.
- 7364T** **Containing protein:**
Subject matter under subclass 7363W wherein the lipid layer contain one or more protein molecules, e.g. protein spanning a lipid layer structure, etc.
- 7366N** **On an organic substrate:**
Subject matter under subclass 7240D wherein the common substrate consists of a material relating to or containing carbon compounds, i.e. made of organic material.
- 7365E** **Biological cell surface:**
Subject matter under subclass 7366N wherein the organic substrate is the surface of a living cell organism.
- 7367D** **Lipid substrate:**
Subject matter under subclass 7366N wherein the organic substrate is a lipid layer, e.g., lipid monolayer or bilayer, etc.
- 7468Y** **Carbohydrate substrate:**

Subject matter under subclass 7366N wherein the substrate is a carbohydrate layer, e.g., cellulosic paper, etc.

7369C

Nucleic acid substrate:

Subject matter under subclass 7366N wherein the substrate constitutes a nucleic acid, e.g., substrate made of chromosomal network material, etc.

7242C

On an electrically conducting, semi-conducting, or semi-insulating substrate:

Subject matter under subclass 7240D wherein the common substrate has an ability to transmit or conduct electrical current; i.e., an electrically conducting, semi-conducting, or semi-insulating substrate.

(1) Note. "Semi-insulating structures" were included in this subsection (as opposed to being included in the insulating substrate subsection) so that distinctions would not have to be drawn between a semiconductor substrate that is doped with shallow impurities, i.e., n- or p- doped, undoped, or doped with deep-level impurities, e.g., Fe or Au, etc.

7243H

On a silicon substrate:

Subject matter under subclass 7242C wherein the common substrate is composed of silicon.

(1) Note: This subclass includes Si substrate that may be doped with shallow-level dopants, e.g., p-doped with Al or Ga impurities or n-doped with P or As impurities, etc.; doped with deep-level dopants, e.g., Au or Pt, etc.; or undoped.

7244R

On a metal substrate:

Subject matter under subclass 7242C wherein the common substrate is composed of a metal or metal alloy.

7245W

On an electrically insulating substrate:

Subject matter under subclass 7240D wherein the common substrate conducts or transmits electrical current.

7206R

Devices having flexible or movable element:

Subject matter under subclass 7200E wherein the device includes at least one nanosized flexible member, e.g., a cantilever or diaphragm, etc.; or the device includes a first member that moves, slides, or rotates relative to a second member, in which the first member, second member, or means to interconnect the first and second members are composed of a nanosized structure.

7235D

NanoMotor/nanoactuator:

Subject matter under subclass 7206R wherein the nanosized flexible or movable element of a device receives a form of energy to produce motion or to convert a form of energy into mechanical energy.

7236Y

Using chemical reaction/biological energy (e.g. ATP, etc.)

Subject matter under subclass 7235D wherein the received energy is produced by a chemical reaction or derived from a living organism.

7207W

Formed from biological material:

Subject matter under subclass 7206R wherein the nanosized flexible or movable element or structure is composed of or includes a material relating to life or a living organism.

- 7227T Nucleic acid (e.g., DNA, etc.):**
Subject matter under subclass 7207W wherein the biological material is a nucleic acid, e.g. DNA, etc.
- (1) Note. Nucleic acid, such as DNA or RNA, is any of various acids composed of a sugar or derivative of a sugar, phosphoric acid, and a base.
- 7208T From protein or unit thereof (e.g., enzyme or carboxyl group, etc.):**
Subject matter under subclass 7207W wherein the biological material is specifically derived from a protein or a unit thereof.
- (1) Note. Protein is any of numerous naturally occurring complex combinations of amino acids that contain the elements carbon, hydrogen, nitrogen, oxygen, and other elements.
- 7209E For electrical purposes:**
Subject matter under subclass 7207W wherein the nanosized flexible or movable biological material is specifically employed for electrical or electronic purpose, e.g., used in an electrical device, etc.
- 7210H Formed from a single atom, molecule, or cluster:**
Subject matter under subclass 7206R wherein the nanosized flexible or movable element or structure constitutes a single atom, molecule, or a group of same elements, e.g., a single atom, molecule, or a group of same elements that is capable of moving around within a hollow cavity of a molecular chamber.
- 7211R Nanocantilever:**
Subject matter under subclass 7206R including a nanosized structural member with a first end fixed to a support and a second end free to move relative to the support.
- 7246T Nanodiaphragm:**
Subject matter under subclass 7206R including a nanosized plate, disk, or sheet that bends or vibrates in response to pressure or sound waves.
- (1) Note. This subclass does not cover the alternative definition of diaphragm commonly used in the field of optics wherein the term refers to a ring or plate with a hole in the center which is placed on the axis of an optical instrument, such as a camera, and which controls the amount of light entering the instrument.
- SEE OR SEARCH THIS CLASS, SUBCLASS:
7223C, for structures including nanosized physical via-holes or pores.
- 7135N Fullerenes (i.e., graphene-based structures, e.g., nanohorns, nanococoons, nanoscrolls, etc.) or Fullerene-like structures (e.g., WS₂ or MoS₂ chalcogenide nanotubes, planar C₃N₄, etc.):**
Subject matter under subclass 7200E wherein the nanostructure is formed of caged, curved, or planar graphene or wherein the nanostructure is formed or caged, curved or planar graphene, or hexagol-ring structure which constitutes either a non-carbon-based composition (e.g., WS₂ or MoS₂) or substantially a non-carbon-based, e.g., planar C₃N₄, etc.
- (1) Note. Graphene is the name given to a single layer of (most commonly) carbon atoms densely packed into a hexagol-ring structure; it is widely used to describe properties of many materials including graphite, soot, fullerenes having a caged molecular structure, e.g., Buckyballs, nanotubes, and nanococoons; fullerenes having a curved or partially caged molecular structure, e.g., nanohorns and nanoscrolls, etc.;

and fullerenes having a planar molecular structure (although planar graphene itself has been historically presumed to be unstable and typically not existing in the free state).

- (2) Note. Fullerene, also called buckminsterfullerene or buckyball, is a large molecule comprised specifically or primarily of carbon atoms and having shape of an empty cage, i.e., carbon cage.
- (3) Note. This subclass contains Fullerene-like structures that are not strictly carbon-based cage structures, whereas subclass 7248N and its indents contain carbon-based fullerenes.
- (4) Note. A buckyball having a C₆₀-like molecular structure wherein roughly a quarter or a half of the atoms are non-carbon atoms, e.g., C₄₀X₂₀, etc., would be properly classified as a Fullerene-like structure.

SEE OR SEARCH THIS CLASS, SUBCLASS:
7217Y, for carbon-based fullerenes.

SEE OR SEARCH CLASS:
428, Stock Material or Miscellaneous Articles, particularly subclass 408 for self-sustaining carbon mass, e.g., bulk structure or layer comprising fullerene or fullerene-like structures, etc.

7248N

Carbon buckyball (C₆₀, C₇₀, etc., and derivatives and modifications thereof):

Subject matter under 7135N wherein the fullerene specifically has a spherical or quasi-spherical carbon-cage molecular structure.

(1) Note. Carbon-based Fullerenes having a C₆₀-like molecular structure wherein several non-carbon atoms substituted for several C atoms, e.g., C₅₇X₃, etc., are included in this subclass.

SEE OR SEARCH THIS CLASS, SUBCLASS:
7253N, for carbon cages with compositional substitution.
7135N, for fullerene or fullerene-like structures.

7249D

Having atoms interior to the carbon cage:

Subject matter under subclass 7248N wherein the buckyball includes additional atoms or molecules, e.g., tri-metallic atom clusters, etc. interior to the carbon-cage structure, e.g., farctate buckyballs, etc.

7250W

Having a modified surface:

Subject matter under subclass 7248N wherein the surface of the buckyball is functionalized with a dissimilar atom or molecule.

7251T

Modified with biological, organic, or hydrocarbon material:

Subject matter under subclass 7250W wherein the surface of the buckyball is functionalized by a material relating to a living organism, or a carbon-based or a hydrocarbon based material.

7371N

Modified with an enzyme:

Subject matter under subclass 7251T wherein the surface of the buckyball is functionalized by an enzyme.

(1) Note. An enzyme is any of numerous proteins or conjugated proteins produced by living organisms functioning as chemical catalysts in living organisms.

- 7252E Modified with atoms or molecules bonded to the surface:**
Subject matter under subclass 7250W wherein the surface of the buckyball is modified by bonding or attaching a dissimilar atom or molecule to the surface.
- 7253N Modified with dissimilar atom or molecule substituted for carbon atoms of the buckyball (e.g., impurity doping or compositional substitution, etc.):**
Subject matter under subclass 7250W wherein at least one of the carbon atom constituting the buckyball carbon cage is replaced by a dissimilar atom or molecule.
- 7216D Carbon nanotubes (CNTs):**
Subject matter under 7135N wherein the fullerene specifically has a cylindrical or tubular (non-spherical) carbon-cage molecular structure.
- 7254D Having specified tube end structure (e.g., close-ended shell or open-ended tube, etc.):**
Subject matter under subclass 7216D wherein the carbon nanotube end has a particular structure.
- 7258R Having atom interior to the carbon cage:**
Subject matter under subclass 7216D wherein the CNT includes an additional atom or molecule interior to the carbon-cage molecular structure, e.g., farctate nanotube, etc.
- 7259W Having a modified surface:**
Subject matter under subclass 7216D wherein the surface of the CNT is functionalized with a dissimilar atom or molecule.
- 7260Y Modified with biological, organic, or hydrocarbon material:**
Subject matter under subclass 7259W wherein the surface of the CNT is functionalized by a material relating to a living organism, or a carbon-based or hydrocarbon-based material.
- 7372D Modified with an enzyme:**
Subject matter under subclass 7260Y wherein the surface of the CNT is functionalized by an enzyme.
- (1) Note. An enzyme is any of numerous proteins or conjugated proteins produced by living organisms functioning as chemical catalysts in living organisms.
- 7261C Modified with atoms or molecules bonded to the surface:**
Subject matter under subclass 7259W wherein the surface of the CNT is modified by bonding or attaching a dissimilar atom or molecule to the surface.
- 7262H Modified with dissimilar atoms or molecules substituted for carbon atoms of the CNT (e.g., impurity doping or compositional substitution, etc.):**
Subject matter under subclass 7259W wherein the carbon atom constituting the CNT cage is replaced by a dissimilar atom or molecule.
- 7255Y Single-walled:**
Subject matter under subclass 7216D wherein the CNT possesses only one wrapped layer of graphene.

- 7256C** **With specified chirality and/or electrical conductivity, (e.g., chirality of (5,4), (5,5), (10,5), etc.):**
Subject matter under subclass 7255Y wherein the single-walled CNT has a specified chirality or bandgap.
- (1) Note. Chirality refers to the particular orientation in which the planar carbon sheet, i.e., graphene, is wrapped upon itself. This subclass groups chirality and electrical conductivity together because each chiral species of CNTs has an associated, inherent energy bandgap; and the CNT may also alter the bandgap while functionalizing.
 - (2) Note. A bandgap is a function of or related to the CNT's chirality.
- 7257H** **Multi-walled:**
Subject matter under subclass 7216D wherein the CNT possesses plural, concentrically wrapped layers of graphene.
- 7218C** **With polymeric or organic binder:**
Subject matter under 7135N wherein a polymeric, i.e. formed by polymer, or organic, i.e., containing carbon atom, binder serves as a host matrix or adhesive for attaching, bonding or connecting a fullerene structure to other structures, e.g., to other Fullerenes, nanosized structures, supporting substrates, conventional structures, etc.
- (1) Note. Polymer is a high-molecular-weight natural or synthetic compound composed of repeated linked units, usually comprised of the same chemical elements.
- 7220N** **Dendrimer (i.e., serially-branching or "tree-like" structure):**
Subject matter under 7200E wherein the nanostructure is a polymer having a serially branching structure, i.e., including a branching structure wherein at least one of the branches, in turn, possesses a second branching structure).
- (1) Note. The "serially branching structure" requirement of this subclass is included for the purpose of excluding from this subclass structures that only have one or more non-repeating branches, e.g., a straight-chain hydrocarbon molecule with one or more ethyl groups that are respectively attached only to the hydrocarbon chain itself, etc.
 - (2) Note. Under this subclass, the n^{th} -order branching structure may be the same as, or different from, the $(n^{\text{th}}-x)$ -order branching structure.
- 7086T** **Nanosheet or quantum barrier/well (i.e., layer structure having one dimension or thickness of 100 nm or less):**
Subject matter under subclass 7200E wherein only one dimension of the nanostructure is 100 nm or less.
- (1) Note. As used herein, "nanosheet," is not only generic to the terms, "quantum well" and "quantum barrier," but also is broader than both of these terms combined. For a layer to be a "nanosheet," it must merely have a physical thickness of 100 nm or less.
 - (2) Note. This subclass includes nanosheet or quantum barriers/wells that are not otherwise provided for in the U.S. Patent Classification System.
 - (3) Note. Class 257, subclasses 9-39 generally takes priority for the classification of quantum-well, quantum-barrier and superlattice structures. To reduce duplication, nanostructures that are classifiable under those subclasses are generally excluded

from cross-reference classification under 7086T unless some other nanosized structure, feature, or characteristic provides an additional basis for cross-reference classification. Subclasses 7263R-7268D of Class 977 are non-exhaustive examples of nanosized structures, features, and characteristics that would warrant cross-reference classification in the Class 977 schedule.

- (4) Note. Class 257, subclasses 94-97 generally takes priority for the classification of double-heterojunction (non quantum-well) light emitting diodes (LEDs) wherein the active layer or any other layer has a sub-100 nm thickness. To reduce duplication, such nanosized layers provided within LEDs should be excluded from cross-reference classification under 7086T unless some other nanosized structure, feature, or characteristic provides an additional basis for cross-reference classification.
- (5) Note. Class 257, subclasses 183-201 generally takes priority for the classification of all semiconductor devices that have nanosized heterostructure layers. To reduce duplication, such nanosized layers should be excluded from cross-reference classification under 7086T unless some other nanosized structure, feature or characteristic provides an additional basis for cross-reference classification. This general exclusion specifically includes: (1) nanosized lattice-mismatch or buffer layers (Class 257/190); (2) compositionally-graded layers (Class 257/191) unless the structure is a superlattice with a graded effective bandgap such that classification is proper under 7265T; and (3) nanosized layers that are provided in heterojunction field effect transistors (Class 257/192, 257/194).

7373H

Lipid layer:

Subject matter under subclass 7086T including a nanoscale layer that is lipid, e.g., lipid monolayer or bilayer, etc.

7374C

Layer containing protein:

Subject matter under subclass 7373H wherein the nanoscale lipid layer contains a protein molecule.

7263R

Mono-atomic layer or δ -doped (delta-doped) sheet:

Subject matter under subclass 7086T wherein the nanosheet specifically has a single atomic layer thickness.

- (1) Note. Synonyms of “mono-atomic layer” include “monolayer,” “ML” and “delta-doped layer/sheet.”
- (2) Note. One characteristic setting delta-doped sheets apart from other nanosheets is that the impurity concentrations for δ -doped sheets are most typically (but not always) set forth in units of atoms/cm² (squared) instead of a conventional nanosheet layer’s impurity units of atoms/cm³ (cubed).

7264W

Quantum well dimensioned for intersubband transitions (e.g., for use in unipolar light emitters or quantum well infrared photodetectors):

Subject matter under subclass 7086T wherein the quantum well has dimensions that enable intrasubband transitions between plural discrete energy levels that exist within either the conduction band alone or the valence band alone (as opposed to interband transitions between the conduction and valence bands).

7265T

Superlattice with graded effective bandgap (e.g., “CHIRP-graded” superlattice, etc.)

Subject matter under subclass 7086T wherein a graded effective bandgap is realized by serially altering the dimensions or compositions of quantum wells or barriers within a superlattice.

(1) Note. Such superlattices are commonly referred to as **Coherent Hetero-Interfaces for Reflection and Penetration-** or **CHIRP-graded** superlattices.

(2) Note: A superlattice is an active layer thin enough to permit carrier transmission.

SEE OR SEARCH THIS CLASS, SUBCLASS:

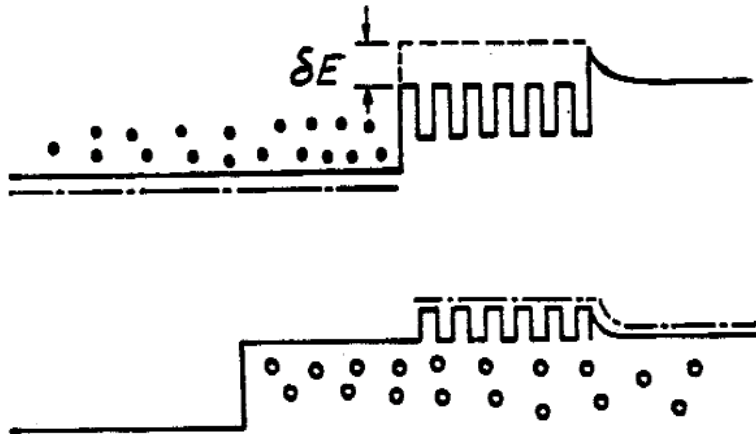
7266E, for superlattice with effective bandgap that is greater than the bulk barrier bandgap.

7266E

Superlattice with well or barrier thickness adapted for increasing the reflection, transmission, or filtering of carriers having energies above the bulk-form conduction or valence band energy level of the well or barrier (i.e., well or barrier with $n_{\text{integer}}\lambda_{\text{carrier}}/4$ thickness):

Subject matter under subclass 7086T including (1) quarter-wave superlattices that increase the reflection of carriers of at least one energy in the classical continuum ($t_{\text{barrier,well}} = n_{\text{odd-integer}}\lambda_{\text{carriers}}/4$); (2) half-wave superlattices that increase the transmission of carriers of at least one energy in the classical continuum ($t_{\text{barrier,well}} = n_{\text{even-integer}}\lambda_{\text{carriers}}/4 = n_{\text{integer}}\lambda_{\text{carriers}}/2$); (3) superlattices including combinations of quarter-wave-thickness and half-wave-thickness regions for filtering carriers of at least one energy in the classical continuum; or (4) superlattices including distinct regions that reflect or transmit carriers of distinct energies for providing a graded effective bandgap that is greater than that of the bulk barrier bandgap.

(1) Note. See the illustration, below, for a graphic example of a quarter-wave-thickness or reflection superlattice wherein the effective conduction-band barrier height is increased above the bulk barrier height by an energy δE , thereby reflecting electrons having energies less than that depicted by the dashed line.



(2) Note. It should be emphasized that the quarter-wavelength thicknesses of the wells or barriers are set according to the wavelength of carriers (i.e., electrons or holes) incident upon the reflection superlattice—NOT the wavelength of any photons/light waves that might be absorbed by, or emitted from, the superlattice or by/from any surrounding areas.

- 7237C Nanowire or quantum wire (axially elongated structure having two dimensions of 100 nm or less):**
Subject matter under subclass 7200E wherein the nanostructure has two physical dimensions that are of 100 nm or less.
- (1) Note. The term, “quantum wire” refers to an elongated structure having a carrier affinity that is larger than that of the material or vacuum that surrounds it, and having a diameter small enough (typically on the order of 20 nm or less) to support discrete or quantized allowed energy levels.
 - (2) Note. As used herein, the term “nanowire,” is broader than “quantum wire” because a “nanowire” must merely have a physical diameter that is 100 nm or less. Thus, “nanowire” also reads on various, additional sub-100 nm wires, such as: (1) relatively large electron affinity wires supporting/having overlapping or non-quantized energy levels; or (2) any other sub-100 nm-thick wire irrespective of its carrier affinity relative to its surroundings.
 - (3) Note. Common synonyms for nanowire or quantum wire include quantum or nanowhiskers, quantum, or nanolines; quantum or nanorods, one-dimensional wires/lines/rods; and one-dimensional wires/lines/rods.
- 7269Y Formed along or from crystallographic terraces or ridges:**
Subject matter under subclass 7237C wherein a nanowire is formed along, atop, or in between the supporting surface of crystallographic terraces or ridges, or wherein these crystallographic terraces or ridges, themselves, form the nanowire.
- (1) Note: Crystallographic terraces or ridges are atomic-scale, periodic protrusions that may extend in either a straight or meandering direction along the surface of certain crystalline planes, e.g., along the (5 5 12) plane, etc.
- 7270T With specified packing density:**
Subject matter under subclass 7237C wherein either a wire array or a surrounding host matrix structure has a specified pitch; i.e. packing density.
- 7123Y With specified cross-sectional profile (e.g., belt-shaped, etc.):**
Subject matter under subclass 7237C wherein the wire has a specified cross-sectional profile (e.g., circular, rectangular or belt-shaped, hexagonal, etc.).
- 7271E Bent wire (i.e., having nonlinear longitudinal axis):**
Subject matter under subclass 7237C wherein the nanowire has a non-linear or non-straight longitudinal axis.
- 7375H Mesh structure:**
Subject matter under subclass 7271E wherein a plurality of nanowires are interweaved or interlaced.
- 7272N Helical wire:**
Subject matter under subclass 7271E wherein the longitudinal axis of the nanowire curves are in a spiral configuration.
- 7376R Formed with nucleic acid:**
Subject matter under subclass 7272N wherein the nanowire is constituted of a nucleic acid.

- 7377W** **Formed with polyamide polymers:**
Subject matter under subclass 7272N wherein the nanowire is constituted of a polymer having repeated amide groups (i.e. CONH₂ groups).
- 7273D** **Nanoring:**
Subject matter under subclass 7271E wherein the longitudinal axis of the nanowire curves in a planar, open-ended, or close-ended circular configuration.
- 7378T** **Formed from circular biomolecule (e.g., DNA, heme, chelator, etc.):**
Subject matter under subclass 7273D wherein the nanoring is formed via circular structure biomolecules such as DNA plasmids or vectors, heme-type molecules, or coordination complex molecular structures.
- SEE OR SEARCH CLASS:
536, Organic Compounds, subclass 23.1, for general biotechnology plasmids or vectors.
- 7085W** **Nanoparticles (structure having three dimensions of 100 nm or less):**
Subject matter under subclass 7200E wherein all three of the nanostructure's physical dimensions are of 100 nm or less.
- SEE OR SEARCH THIS CLASS, SUBCLASS:
7274Y, for quantum dots.
- 7274Y** **Exhibiting three-dimensional carrier confinement (e.g., quantum dots, etc.):**
Subject matter under subclass 7085W wherein the nanoparticle has a carrier affinity that is larger than that of the material or vacuum that surrounds it.
- (1) Note. The term, "quantum dot" refers to a substantially ball-shaped, cube-shaped, or cluster-shaped structure having a carrier affinity that is larger than that of the material or vacuum that surrounds it, and having a width/diameter small enough (typically on the order of 20 nm or less) to support discrete or quantized allowed energy levels.
 - (2) Note. As used herein, the term "nanodot," is broader than "quantum dot" because a "nanodot" must merely have a physical diameter that is 100 nm or less. Thus, "nanodot" also reads on various, additional sub-100 nm structures, such as: (1) clusters of atoms which have a relatively large electron affinity but which support non-quantized or overlapping energy levels; or (2) any other sub-100 nm-diameter structure irrespective of its carrier affinity relative to its surroundings.
 - (3) Note. This subclass is intended to include (1) true "quantum dots" (wherein the energy levels are quantized) and also (2) other dot structures that possess relatively large carrier affinities or that are used for their (semi)/conducting or electronic characteristics, even though the energy levels supported by the dots overlap or are not quantized.
 - (4) Note. While this schedule distinguishes nanoparticles from quantum dots for classification purposes, many references use these terms interchangeably. Common synonyms for quantum dots include: nanodots, quantum or nanoparticles, quantum or nanoclusters, quantum or nanopowders, artificial atoms, zero-dimensional dots, and 0-D dots.

- 7090W Nanosized powder or flake (e.g., nanosized catalyst, etc.):**
Subject matter under subclass 7085W wherein the nanoparticle is composed of a nanosized powder or flake, especially stand-alone powders or flakes that are not further disposed, suspended, or dissolved within a host/barrier/matrix composition, compound, or solution.
- SEE OR SEARCH CLASS:
- 75, Specialized Metallurgical Processes, Compositions for Use Therein, Consolidated Metal Powder Compositions, and Loose Metal Particulate Mixtures, appropriate subclasses for subject matter based on metal powder composition.
- 501, Compositions: Ceramic, appropriate subclasses for subject matter based on metal powder composition.
- 7091T Ceramic powder or flake:**
Subject matter under subclass 7090W wherein the nanosized powder or flake is composed of a specified ceramic.
- 7092E Metallic powder or flake:**
Subject matter under subclass 7090W wherein the nanosized powder or flake is specifically composed of a specified metallic composition or alloy.
- 7076Y Within specified host or matrix material (e.g., nanocomposite films, etc.):**
Subject matter under subclass 7200E directed towards a specified host/barrier/matrix composition, compound, or solution in which at least one nanosized structure (e.g., fullerene, nanowire, etc.) is formed, disposed, suspended, or dissolved.
- SEE OR SEARCH CLASS:
- 428, Stock Material or Miscellaneous Articles, appropriate subclasses, particularly 323+ for layer containing structurally defined particles and subclasses 411.1+ for non-structural laminates. .
- 7225R Possessing nanosized particles, powders, flakes or clusters other than simple atomic impurity doping:**
Subject matter under subclass 7076Y wherein the host/barrier/matrix composition, compound or solution possesses a nanostructure of specified composition wherein all three dimensions are of 100 nm or less.
- (1) Note. Simple atomic, impurity doping is excluded from coverage because this would read on virtually every solid-state semiconductor device, as they are all doped with shallow-level impurities (i.e., n-doped or p-doped) and/or deep-level impurities.
- 7275C Possessing fully-enclosed nanosized voids or physical holes:**
Subject matter under subclass 7076Y wherein the host/barrier/matrix composition, compound or solution contains a fullyenclosed nanosized physical hole, void or bubble of gas or vacuum.
- (1) Note. "Physical hole" as used in this subclass is distinguished from the meaning of "hole" as commonly employed in semiconductor physics to mean the absence of an electron.

- 7223C Possessing nanosized surface openings that extend partially into or completely through the host material:**
Subject matter under subclass 7076Y wherein the host/barrier/matrix composition or compound has a surface that contains downward-extending, nanosized physical concavity, depression, recess, groove, via-hole or pore that is not fully enclosed.
- 7224H Possessing nanosized physical convexity, ridge or protrusion extending upward from the host's surface:**
Subject matter under subclass 7076Y wherein the host/barrier/matrix composition or compound contains a nanosized physical, convexity, ridge protrusion, or bump extending upward from surface.
- 7379E Biological host/matrix (e.g., lipid, etc.):**
Subject matter under subclass 7076Y wherein the nanosized structure in the host/barrier/matrix composition, compound or solution is relating to or derived from a living organism, e.g., lipid, etc.
- 7277R Electrically conducting, semi-conducting or semi-insulating host material:**
Subject matter under subclass 7076Y wherein the host/barrier/matrix composition, compound, or solution has the ability to transmit or conduct electrical current; i.e., electrically conducting, semi-conducting, or semi-insulating.
- 7278W Electrically insulating host material:**
Subject matter under subclass 7076Y wherein the host/barrier/matrix composition, compound or solution is unable to transmit or conduct electrical current; i.e., electrically insulating.
- 7380H Fluidic host/matrix containing nanomaterials:**
Subject matter under subclass 7076Y wherein the host/matrix constitutes a substance that can flow, i.e., fluidic substance such as liquid or gas, in which nanostructures are present (e.g., nanoparticles in aqueous solutions)
- 7381R Colloidal fluid:**
Subject matter under subclass 7380H wherein the fluidic substance contains a suspension of very small, insoluble and nondiffusible particles, i.e., colloidal particles that may or may not be nanostructures themselves.
- 7382W Biological nanomaterial:**
Subject matter under subclass 7381R wherein the nanostructures present in the colloidal fluid are derived from or relating to a living organism, e.g., biological nanoparticles in a cloudy solution.
- 7383T Viscous Fluid:**
Subject matter under subclass 7380H wherein the fluidic substance containing nanostructure has a relatively high resistance to flow.
- 7215N Of specified organic or carbon-based composition:**
Subject matter under subclass 7200E wherein either (1) a nanostructure itself is composed of an organic carbon-based material/composition, or (2) a substrate or host structure is composed of an organic carbon-based material and is specifically adapted for bonding with, supporting or containing a nanostructure.

- (1) Note: This subclass and its indents are intended to broadly cover organic or carbon-based chemical structures, materials or compositions that constitute, include, or are specifically attached to nanosized structures.
- (2) Note: This subclass and its indents exclude inorganic carbon based structures, compositions or materials, such as carbon-based Fullerenes and $C_xSi_yGe_z$ compounds.

SEE OR SEARCH THIS CLASS, SUBCLASS:

7135N, for Fullerenes.

7287D, for inorganic $C_xSi_yGe_z$ compounds.

- 7384E In array format:**
Subject matter under subclass 7215N wherein the organic carbon based nanostructures are orderly arranged in some type of pattern.
- 7385N With heterogeneous nanostructures:**
Subject matter under subclass 7384E wherein the array consists of dissimilar organic carbon-based nanostructures (e.g., biological entity particles like proteins, etc.).
- 7386D Molecular array:**
Subject matter under subclass 7385N wherein the organic carbon-based nanostructures have different molecular structures.
- 7387Y Nucleic acid array (e.g., human genome array, etc.):**
Subject matter under subclass 7386D wherein the organic carbon-based nanostructures are dissimilar nucleic acids.
- 7388C Protein array:**
Subject matter under subclass 7386D wherein the organic carbon-based nanostructures are dissimilar proteins.
- 7389H Chemical library array:**
Subject matter under subclass 7385N wherein the organic carbon-based nanostructures are different in chemical properties, generally not biological in nature.
- 7213T Composed of biological material:**
Subject matter under subclass 7215N wherein the organic carbon-based material or composition is relating to or derived from a living organism.
- 7214E For electrical or electronic purpose:**
Subject matter under subclass 7213T wherein the biological material or composition possesses a specified electrical property or is used within an electronic device or for an electro-biological application.
- 7390N Lipid particle:**
Subject matter under subclass 7215N wherein the organic carbon-based nanostructures is a lipid particle type material, e.g., vesicle or spherical lipid structure, etc..
- 7391D Having internalized material:**
Subject matter under subclass 7390N wherein the lipid particle contains another material inside its structure or boundary, e.g., spherical container, etc.
- 7392Y Containing biological material:**
Subject matter under subclass 7391D wherein the material that is internalized in the lipid particle is derived from or relating to a living organism.

- 7393C Nucleic acid (e.g., DNA or RNA, etc.):**
Subject matter under subclass 7392Y wherein the biological material internalized in the lipid particle is a nucleic acid.
- 7394H Drug:**
Subject matter under subclass 7392Y wherein the biological material internalized in the lipid particle is a medicine, i.e., a chemical substance utilized in biological disease or condition treatment.
- 7395R Virus based particle:**
Subject matter under subclass 7215N wherein the nanostructure composition is made up virus or viral particle.
- 7396W Containing biological material in its interior:**
Subject matter under subclass 7395R wherein a material that is internalized within a virus interior space is derived from or relating to a living organism.
- 7397T Containing nucleic acid:**
Subject matter under subclass 7396W wherein the biological material is a nucleic acid.
- 7398E Containing drug:**
Subject matter under subclass 7396W wherein the biological material is a medicine, i.e. a chemical substance utilized in biological disease or condition treatment.
- 7399N With exterior chemical attachment:**
Subject matter under subclass 7395R wherein the virus based particle is externally modified with a chemical attachment (e.g., display phage modification)
- 7400D Exterior attachment for detection:**
Subject matter under subclass 7399N wherein the exterior chemical attachment is adapted for a tracking purpose, e.g., used for recognizing the virus based particle.
- 7401Y Exterior attachment for targeting (e.g., drug targeting, etc.):**
Subject matter under subclass 7399 wherein the exterior chemical attachment is adapted for directing the virus based particle to a target site (e.g., chemical delivery to a specific site for therapeutic purposes).
- 7078H Organic film on silicon:**
Subject matter under subclass 7215N wherein the organic material or composition is specifically formed on a doped or undoped silicon layer/substrate, either directly or indirectly by means of an intermediate/buffer layer.
- SEE OR SEARCH CLASS:
428, Stock materials or Miscellaneous Articles, particularly subclass 446 and subclass 451 for laminates comprising a layer of silicon and a layer of silicon next to addition polymers.
- 7284T Of specified metal or metal alloy composition:**
Subject matter under subclass 7200E wherein the nanostructure is constituted of or surrounded by a material that is a metal or a metal alloy.
- SEE OR SEARCH CLASS:
420, Alloys or Metallic Composition, appropriate subclasses for alloy compositions.

428, Stock Materials, appropriate subclasses, particularly subclasses 544+ for structures of all metal or with adjacent metals

- 7285E Of specified metal oxide composition (e.g., conducting or semiconducting compositions such as ITO, ZnOx, etc.):**
Subject matter under subclass 7200E wherein the nanostructure is composed of, includes, or is surrounded by a material that is specifically composed of a metal oxide.
- 7286N Perovskites and superconducting composition (e.g., $\text{Ba}_x\text{Sr}_{1-x}\text{TiO}_3$):**
Subject matter under subclass 7285E wherein the metal oxide is specifically composed of a perovskite or superconductor material.
- 7084R Of specified inorganic semiconductor composition (e.g., periodic table group IV-VI compositions):**
Subject matter under subclass 7200E wherein at least one nanostructure is composed of, includes, or is surrounded by a material that is specifically composed of an inorganic semiconductor material, regardless of whether this material is degeneratively doped, moderately doped, lightly doped or undoped.
- SEE OR SEARCH CLASS:
428 Stock Materials or Miscellaneous Articles, particularly subclasses 688+ for non-structural laminates of inorganic materials and subclass 620 for all metal composite where one of the layers is a semiconductor layer.
- 7287D Group IV based elements and compounds (e.g., $\text{C}_x\text{Si}_y\text{Ge}_z$):**
Subject matter under subclass 7084R wherein the inorganic semiconductor material is specifically a group IV element or alloy.
- (1) Note: Examples include $\text{C}_x\text{Si}_y\text{Ge}_z$, wherein $0 \leq x, y, z \leq 1$ and $x + y + z = 1$.
- 7288Y Group III-V based compounds (e.g., $\text{Al}_x\text{Ga}_y\text{In}_z\text{N}_x\text{P}_y\text{As}_z$):**
Subject matter under subclass 7084R wherein semiconductor-based material is specifically composed of a periodic table Group III-V semiconductor compound or alloy.
- 7289C III-N based compounds (e.g., $\text{Al}_x\text{Ga}_y\text{In}_z\text{N}$):**
Subject matter under subclass 7288Y wherein group III-V semiconductor-based material is specifically composed of a nitride-based semiconductor compound or alloy.
- (1) Note. Examples include $\text{Al}_x\text{Ga}_y\text{In}_z\text{N}$, wherein $0 \leq x, y, z \leq 1$ and $x + y + z = 1$.
- 7290E High-indium-content InGaN pooling or clusters:**
Subject matter under subclass 7289C wherein the InGaN-based semiconductor material has an In concentration that is sufficiently high (e.g., In concentration approximately on the order of $\text{In}_{0.1}\text{Ga}_{0.9}\text{N}$ to $\text{In}_{0.4}\text{Ga}_{0.6}\text{N}$, or higher) so as to produce an In pooling or clustering effect: i.e., wherein the layer separates into clusters or regions of relatively high In concentration (quantum or potential wells) and surrounding regions of relatively low In concentration (quantum or potential barriers).
- 7291N III-P based compounds (e.g., $\text{Al}_x\text{Ga}_y\text{In}_z\text{P}$):**
Subject matter under subclass 7288Y wherein group III-V semiconductor-based material is specifically composed of a phosphide-based semiconductor compound or alloy.
- (1) Note. Examples include $\text{Al}_x\text{Ga}_y\text{In}_z\text{P}$, wherein $0 \leq x, y, z \leq 1$ and $x + y + z = 1$.

- 7292D III-As based compounds (e.g., Al_xGa_yIn_zAs, etc.):**
 Subject matter under subclass 7288Y wherein group III-V semiconductor-based material is specifically composed of an arsenide-based semiconductor compound or alloy.
 (1) Note. Examples include Al_xGa_yIn_zAs, wherein $0 \leq x, y, z \leq 1$ and $x + y + z = 1$.
- 7293Y III-Sb based compounds (e.g., Al_xGa_yIn_zSb, etc.):**
 Subject matter under subclass 7288Y wherein group III-V semiconductor-based material is specifically composed of an antimonide-based semiconductor compound or alloy.
 (1) Note. Examples include Al_xGa_yIn_zSb, wherein $0 \leq x, y, z \leq 1$ and $x + y + z = 1$.
- 7294C Mixed group V compounds (e.g., III-N_xP_y):**
 Subject matter under subclass 7288Y wherein group III-V semiconductor-based material is specifically composed of plural group V elements, irrespective whether the compound includes one or plural group III elements.
 (1) Note. Examples include Al_aGa_bIn_cN_xP_yAs_z, wherein $0 \leq a, b, c \leq 1$, $a + b + c = 1$; and $0 < x, y, z < 1$ and $x + y + z = 1$.
- 7295H Boron-containing compounds:**
 Subject matter under subclass 7288Y wherein group III-V compound semiconductor material specifically includes boron (B) as a compositional (/non-dopant) element.
 (1) Note. Examples include alloys of B(Al)(Ga)N (or B_aAl_bGa_cN, wherein $0 < a \leq 1$; $0 \leq b, c < 1$; and $a + b + c = 1$).
- (2) Note. Specifically excluded from this subclass are semiconductor elements or compounds that have such a small amount of boron that the boron present merely constitutes an impurity (e.g., on the order of $1e20$ atoms/cm³ or less) in a non-carbon composition (e.g., boron-doped SiGe, etc.).
- 7296R Tl-containing or Bi-containing compounds:**
 Subject matter under subclass 7288Y wherein group III-V compound semiconductor material specifically includes thallium (Tl) and/or bismuth (Bi) as compositional (/non-dopant) element(s).
- (1) Note. Specifically excluded from this subclass are semiconductor elements or compounds that have such a small amount of thallium or bismuth that the atoms of these elements present merely constitute impurities (e.g., on the order of $1e20$ atoms/cm³ or less) in a non-bismuth, non-thallium composition (e.g., thallium doped or bismuth-doped SiGe).
- 7297W Group II-VI nonoxide compounds (e.g., Cd_xMn_yTe) :**
 Subject matter under subclass 7084R wherein the compound semiconductor is specifically composed of group II-VI elements other than oxide-based II-VI compounds.
- SEE OR SEARCH THIS CLASS, SUBCLASS:
 7285E, for Oxide-based compounds or metal oxide nanomaterial, such as ITO, ZnOx, etc.
 7286N, for Perovskites and superconducting materials (e.g., Ba_xSr_{1-x}TiO₃, etc.).

- 7298T Heterojunction formed between semiconductor materials that 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)):**
Subject matter under subclass 7084R wherein the nanostructure includes at least one heterojunction composed of two adjacent semiconductor layers that belong to different periodic table-group families.
- 7299E Nonstoichiometric semiconductor compounds (e.g., III_xV_y ; $x \neq y$):**
Subject matter under subclass 7084R wherein the compound semiconductor has a substantially non-stoichiometric composition: i.e., wherein the composition's net charge is NOT substantially equal to 0.
- (1) Note. Examples include III_xV_y or II_xVI_y ; $x \neq y$.
 - (2) Note: Excluded from this subclass are substantially stoichiometric compound semiconductors that are merely p-doped or n-doped.
- 7088N Formed from hybrid organic/inorganic semiconductor composition:**
Subject matter under subclass 7200E wherein the nanosized structure or device is composed of, or includes, a first structure, region or portion that is composed of an organic material/composition (whether biological or not), and a second structure, region or portion that is composed of, or includes, an inorganic semiconductor material/composition.
- (1) Note. The subclass is intended to generally cover all organic materials/compositions that are interconnected to, or functionally associated with, inorganic semiconductors regardless of whether the organic material/composition, itself, also possesses semiconducting properties.
- SEE OR SEARCH THIS CLASS, SUBCLASS:
7135N, for Fullerene and Fullerene-like structures.
7251T, for Bucky Ball nanostructure having a surface functionalized with an organic material.
7260Y, for carbon nanotube structure having a surface functionalized with an organic material.
7218C, for carbon fullerenes having a polymeric or organic binder.
7088N, for hybrid organic/inorganic semiconductor structures in the event that the inorganic material/composition is specifically a Fullerene or Fullerene-like structure.
- 7150R Biological composition interconnected with inorganic material:**
Subject matter under subclass 7088N wherein the organic material/composition portion is specifically a biological material/composition.
- 7151W Organic or biological core coated with inorganic shell:**
Subject matter under subclass 7088N wherein the organic material/composition forms a central core or nucleus that is substantially or entirely surrounded by, or coated with an inorganic material.
- 7152T Inorganic core or cluster coated with organic or biological shell:**
Subject matter under subclass 7088N wherein the inorganic material forms a central core or nucleus that is substantially or entirely surrounded by, or coated with a shell of organic or biological material.

- 7153E Of specified ceramic or electrically insulating compounds:**
Subject matter under subclass 7200E wherein the nanostructure is composed of a ceramic or other insulating materials/compounds (e.g., a ceramic nanopowder composed of a specified material).
- SEE OR SEARCH CLASS:
428 Stock Materials or Miscellaneous Articles, particularly subclasses 689+ for Non- structural laminates of inorganic metal compound containing layer (e.g. ceramics).
- 7154N Having specified property (e.g., lattice-constant, thermal expansion coefficient, etc.):**
Subject matter under subclass 7200E wherein the material constituting the nanostructure or nanodevice possesses a specified physical property.
- SEE OR SEARCH THIS CLASS, SUBCLASS:
7091T, for ceramic, e.g., electrically insulating, etc., nanosized powder or flake
7092E, for metallic, e.g., electrically conducting, etc., nanosized powder or flake
7214E, for organic, biological or polymeric carbon-based composition with electrical property or for electronic purposes
7284T, for metal, e.g., electrically conducting, etc., nanomaterial
7285E, for metal oxide, e.g., electrically conducting or semiconducting, etc., nanomaterial
7084R, for inorganic semiconducting nanomaterial
7088N, for hybrid organic/inorganic semiconducting nanomaterial
7153E, for electrically insulating nanomaterial
7277R, for electrically conducting, semi-conducting or semi-insulating host material in which nanosized material is disposed
7278W, for electrically insulating host material in which nanosized material is disposed
- 7331T Thermal property of nanomaterial (e.g., thermally conducting/insulating or exhibiting Peltier or Seebeck effect, etc.):**
Subject matter under subclass 7154N wherein the specified physical property of the material is relating to or caused by heat.
- 7332E Optical properties of nanomaterial (e.g., specified transparency, opacity, or index of refraction, etc.):**
Subject matter under subclass 7154N wherein the specified physical property of the material is an optical property, e.g., refractive, reflective, etc.
- 7333N Chemical or nuclear reactivity/stability of composition or compound forming nanomaterial:**
Subject matter under subclass 7154N wherein the specified physical property of the material is relating to its chemical or nuclear reactivity or stability.
- 7402C Having biological reactive capability:**
Subject matter under subclass 7333N wherein the physical property is characterized by its function of reacting with a living organism, e.g., reacts with a particular biological target, such as a cancer cell, etc.
- 7155D Piezoelectric property of nanomaterial:**
Subject matter under subclass 7154N wherein the specified physical property of the material is its capability of generating electrical signal subjected to a mechanical stress or capability of generating a mechanical stress subjected to an applied voltage, i.e. piezoelectric property.

- 7156Y Magnetic property of nanomaterial:**
Subject matter under subclass 7154N wherein the specified physical property of the material is an electromagnetic property.
- 7226W MATHEMATICAL ALGORITHMS, E.G., COMPUTER SOFTWARE, ETC., SPECIFICALLY ADAPTED FOR MODELING CONFIGURATIONS OR PROPERTIES OF NANOSTRUCTURE:**
Subject matter under the class definition directed to the theoretical modeling of a nanostructure's configuration or associated physical properties, as opposed to physical structures, themselves.
- (1) Note: Tools, aids and means specifically designed or intended for carrying out, or assisting in, the modeling of nanostructures are also included in this subclass.
- 7300N MANUFACTURE, TREATMENT, OR DETECTION OF NANOSTRUCTURE:**
Subject matter under the class definition directed to a process or an apparatus for making a nanostructure, altering a nanostructure, or determining a characteristic of a nanostructure.
- (1) Note: The apparatus performing the manufacture, treatment, or detection of the nanostructure is not limited to the nanoscale and may include structure of macroscopic dimensions such as in a scanning probe.
- (2) Note: The detection of 7300N is distinct from the detection under 7173N in that the focus of 7300N is on nanostructures as the object of detection whereas the focus of 7173N is on nanostructures as the objects doing the detecting.
- 7301D Environmental containment or disposal of nanostructure material:**
Subject matter under 7300N for the confinement of nanostructure material so as to minimize dispersal into the environment, or for the removal of nanostructure material from the environment.
- (1) Note. The disposal may be, for example, the conversion of the nanostructure by chemical or physical means to a less harmful form which may be safely disposed of in an ordinary municipal landfill.
- (2) Note. This subclass does not include nanofiltration processes for removing bacteria from air/etc
- SEARCH CLASS:
588, Hazardous or Toxic Waste Destruction or Containment, appropriate subclasses for processes for the destruction or containment of hazardous materials.
- 7345T For carbon nanotube or fullerenes:**
Subject under subclass 7300N wherein the nanostructure is a fullerene or a carbon nanotube.
- 7347N Gas Phase Catalytic Growth (i.e., chemical vapor deposition):**
Subject matter under subclass 7345T wherein the fullerene or nanotube structure is grown by a process that involves the contact of a carbon-containing gas and a catalyst material under heated conditions.
- 7348D Growth by vaporization or dissociation of carbon source using a high-energy heat source (e.g., electric arc, laser, plasma, e-beam, etc.):**
Subject matter under subclass 7345T wherein the fullerene or nanotube structure is grown by a process that involves using a high-energy heat source to vaporize a carbon target or

dissociate a carbon source into its elemental components, whereby the nanostructure is produced under the high-energy conditions, with or without the aid of a catalyst.

7349Y

Purification or separation of fullerenes or nanotubes:

Subject matter under subclass 7345T wherein the process or apparatus is adapted to extract the fullerene or nanotube from the material that accompanies the growth process (e.g. residual catalyst, amorphous carbon, graphite) or to sort or divide the fullerene or nanotube based upon their physical or chemical properties (e.g. separation by size, chirality, etc.)

7350T

Internal modifications (e.g., filling, endohedral modifications, etc.) :

Subject matter under subclass 7345T wherein the process or apparatus is adapted to treat the region inside the carbon cage of the fullerene or nanotube.

(1) Note: This includes the processes or apparatuses that treat the opening or closing of the nanotube.

7351E

Surface modifications (e.g., functionalization, coating, etc.):

Subject matter under subclass 7345T wherein the process or apparatus is adapted to treat the surface of the carbon cage of the fullerene or nanotube or the surface of the nanostructure itself.

7352N

Tube end modifications (e.g., capping, joining, splicing, etc.):

Subject matter under subclass 7345T wherein the process or apparatus is adapted to treat the nanotube that affects the end of the tube or the tube cap.

7100T

With scanning probe:

Subject matter under 7300N including a device having at least a tip of nanometer sized dimensions capable of performing manufacture, treatment, or detection in the nanometer range e.g., scanning tunneling microscope (STM), atomic force microscope (AFM), magnetic force microscope (MFM), and near-field optical scanning probe.

7101E

Scanning probe control process:

Subject matter under subclass 7100T including a control method of using a scanning probe in manufacture, treatment, or detection of nanostructures.

7104Y

Particular movement or positioning of scanning tip:

Subject matter under subclass 7101E including specified details of the movement or positioning of the scanning probe tip relative to the object being detected or processed (e.g. tapping mode, non-contact, positioning feedback control, etc.).

7105C

For detection of specific nanostructure sample or nanostructure-related property:

Subject matter under subclass 7100T wherein the scanning probe is used to detect a particular sample or to measure a particular nanoscale property of the sample, e.g., shape, resistivity, charge density, etc.)

SEE OR SEARCH CLASS:

73, Measuring and Testing, appropriate subclasses for detection processes of mechanical properties of a sample, subclass 105 for testing of roughness of a sample.

250, Radiant Energy, appropriate subclasses relating to microscopy of samples, subclasses 306+ for inspecting a sample using charged particles.

324, Electricity: Measuring and Testing, appropriate subclasses for detection processes of electrical properties of a sample.

374, Thermal Measuring and Testing, appropriate subclasses for detection processes of thermal properties of a sample.

- 7125H** **Biological sample:**
Subject matter under 7105C wherein the sample is biological in nature.
- SEE OR SEARCH CLASS:
435, Chemistry: Molecular Biology and Microbiology, appropriate subclasses for detection of biological samples.
436, Chemistry: Analytical and Immunological Testing, appropriate subclasses for detection of biological samples.
- 7126R** **Semiconductor sample:**
Subject matter under 7105C wherein the sample is a semiconductor material.
- SEE OR SEARCH CLASS:
438, Semiconductor Device Manufacturing: Process, subclasses 14+ for semiconductor measuring and testing.
- 7106H** **For manufacture of nanostructure:**
Subject matter under subclass 7100T wherein the scanning probe tip is used in a manufacturing process of nanostructure.
- 7107R** **Including etching/cutting:**
Subject matter under subclass 7106H wherein the scanning probe tip is used for removing material from a substrate, forming grooves or indents in a substrate, or cutting a nanostructure.
- SEE OR SEARCH CLASS:
216, Etching a Substrate: Processes, appropriate subclasses for material removal.
- 7108W** **Including coating:**
Subject matter under subclass 7106H wherein the scanning probe tip is used for depositing material on a substrate (such as in dip pen nanolithography).
SEE OR SEARCH CLASS:
427, Coating Processes, appropriate subclasses for depositing material.
- 7109T** **Including positioning/mounting nanostructure:**
Subject matter under subclass 7106H wherein the scanning probe tip is used for positioning or mounting nanostructure on a substrate.
- 7110C** **Including substrate treatment:**
Subject matter under subclass 7106H wherein the scanning probe tip is used to form or modify nanostructure on a substrate by modify the characteristic of the substrate, e.g., scanning probe tip is used to modify a chemical, thermal, electrical, magnetic, or other property of the substrate.
- 7112R** **Scanning probe structure:**
Subject matter under 7100T including structural details of the scanning probe.
- 7127W** **Scanning tunneling probe:**
Subject matter under 7112R wherein the scanning probe is constructed to operate based upon a quantum tunneling effect in which the probability of electron transmission between the tip and an object being manufactured, treated, or detected is related to a gap between the tip and the object.

- 7128T** **Near-field probe:**
Subject matter under 7112R wherein the tip is formed with an integral waveguide wherein the diameter of the waveguide is smaller than the wavelength of the wave propagated in the waveguide.
- 7129E** **Atomic force probe:**
Subject matter under 7112R wherein the scanning probe is constructed to operate based upon interaction forces between atoms such as Van der Waals forces between the tip and an object being manufactured, treated, or detected.
- (1)Note: Van der Waals force (aka London or dispersion force) is an induced dipole - induced dipole interaction that depends on the polaris ability of the interacting molecules and is inversely proportional to the sixth power of separation.
- 7130H** **Electrostatic force probe:**
Subject matter under 7112R wherein the scanning probe is constructed to operate based upon electrostatic forces between the tip and an object being manufactured, treated, or detected.
- Note: (1) Electrostatic force generally results from static charges within one material reacting with an electric field generated by another material.
- SEE OR SEARCH CLASS:
324, Electricity: Measuring and Testing, appropriate subclasses for electrostatic force measurements.
- 7131R** **Magnetic force probe:**
Subject matter under 7112R wherein the scanning probe is constructed to operate based upon magnetic forces between the tip and an object being manufactured, treated, or detected.
- (1) Note: Magnetic force generally results from currents, or moving charges, within one material reacting with an external magnetic field generated by another material such as iron or nickel based materials that have intrinsic magnetic properties.
- SEE OR SEARCH CLASS:
324, Electricity: Measuring and Testing, appropriate subclasses for magnetic force measurements.
- 7132W** **Scanning capacitance probe:**
Subject matter under 7112R wherein the scanning probe is constructed to operate based upon a capacitive effect between the tip and an object being manufactured, treated, or detected.
- (1) Note: The capacitive effect is a change in capacitance which occurs when the distance between the tip, acting as a first electrode of a capacitor, and the object, acting as a second electrode of a capacitor, changes as the tip is scanned relative to the object.
- SEE OR SEARCH CLASS:
324, Electricity: Measuring and Testing, appropriate subclasses for capacitive measurements.

- 7133T Scanning thermal probe:**
Subject matter under subclass 7112R wherein the scanning probe is constructed to operate based upon a thermal effect between the tip and an object being manufactured, treated, or detected.
- (1) Note. The thermal effect may be a heating of the object by the tip or a temperature detection of the object by the tip or a combination of both heating and temperature detection between the tip and object as the tip is scanned relative to the object.
- SEE OR SEARCH CLASS:
374, Thermal Measuring and Testing, appropriate subclasses for thermal measurements.
- 7114T With optical means:**
Subject matter under subclass 7112R including optical means to facilitate the operation of the scanning probe.
- SEE OR SEARCH CLASS:
356, Optics: Measuring and Testing, appropriate subclasses for generic optical means used for detection, and subclass 501 for an interferometer device usable with an atomic force microscope.
359, Optics: Systems and Elements, for generic details of optical elements.
- 7134E Optical microscope:**
Subject matter under subclass 7114T wherein the scanning probe is combined with an optical microscope that examines a sample being manufactured, detected, or treated by the scanning probe tip.
- 7157C Optical lever arm for reflecting light:**
Subject matter under subclass 7114T wherein the optical means is used to reflect light from a holder of the scanning probe tip.
- 7158H With environmental regulation means:**
Subject matter under subclass 7112R including means to adjust temperature, pressure, humidity, or other environmental factors of the scanning probe.
- 7159R Positioner:**
Subject matter under subclass 7112R including details of a mechanism such as a piezoelectric, electrostatic, magnetic, or other type of actuator that adjusts the position of the tip relative to the nanostructure being manufactured, detected, or treated.
- SEE OR SEARCH CLASS:
310, Electrical Generator or Motor Structure, appropriate subclasses for positioning mechanisms, and subclasses 310/311+ for piezoelectric elements, per se.
- 7160D Tip holder:**
Subject matter under subclass 7112R including a projecting member such as a cantilever that maintains the tip of the probe.
- 7116H Probe tip array:**
Subject matter under subclass 7112R including a plurality of scanning probe tips.
- 7118Y With tip detail:**
Subject matter under subclass 7112R including structural characteristics of the tip of the scanning probe, i.e. material, shape, surface treatment, or chemical functionalizing of the tip.

- 7117D Nanotube tip:**
Subject matter under subclass 7118Y wherein the tip includes a nanotube.
- 7119C Chemically functionalized:**
Subject matter under subclass 7118Y wherein the tip is chemically modified to react with a certain type of nanostructure.
- 7120E Shape/taper:**
Subject matter under subclass 7118Y wherein the physical form of the tip or the degree of slope or angle of the tip is specified.
- 7121N Material:**
Subject matter under subclass 7118Y wherein the material forming the tip is specified.
- 7303C With arrangement, process, or apparatus for testing:**
Subject matter under subclass 7300N including process or apparatus for detecting or testing a nanostructure.
- SEE OR SEARCH THIS CLASS, SUBCLASS:
7105C, for detection of specific sample using scanning probe.
- SEE OR SEARCH CLASS:
73, Measuring and Testing, for a method and/or apparatus for testing.
324, Electricity: Measuring and Testing, appropriate subclasses for a method and/or apparatus for electrical testing.
356, Optics: Measuring and Testing, appropriate subclasses for optical measuring and testing.
435, Chemistry: Molecular Biology and Microbiology, appropriate subclasses for a method and/or apparatus for molecular biological and/or microbiological testing.
436, Chemistry: Analytical And Immunological Testing, appropriate subclasses for a method and/or apparatus for chemical and immunological testing.
- 7316Y Microscopy or spectroscopy (e.g., SEM, TEM, etc.):**
Subject matter under subclass 7303C wherein a microscopy instrument such as an electron microscope or a spectroscopic device is used to measure or test the nanostructure.
- SEE OR SEARCH CLASS:
250, Radiant Energy, subclass 311 for electron microscopes.
359, OPTICAL: SYSTEMS AND ELEMENTS, subclass 368 for a microscope.
356, OPTICS: MEASURING AND TESTING, subclass 300 for a spectroscope.
- 7304H Assembling of separate components (e.g., by attaching, etc.):**
Subject matter under subclass 7300 N including process or apparatus for bringing together distinct parts to make a desired nanostructure.
- 7353D Fluidic self-assembly (FSA):**
Subject matter under subclass 7304H wherein a gas or liquid, i.e., a fluid, carrying a plurality of nanostructures is flowed over a substrate in a manner that causes the nanostructures to be simultaneously deposited into selected locations on the substrate's surface.
- 7403H Assembled via biorecognition entity:**
Subject matter under subclass 7304H wherein molecular biology identification entity i.e., biorecognition entity, is utilized for attaching separate components together, e.g.,

protein/ligand binding pair, the electrodeposition of the biorecognition nanomolecules in self-assembling, etc.

7404R

Via nucleic acid hybridization:

Subject matter under subclass 7403H wherein the biorecognition utilizes nucleic acid hybridization, e.g., nucleic acid polymer hybridization to its complementary polymeric strand forming double-stranded nucleic acid structure, etc.

7405W

Via protein recognition:

Subject matter under subclass 7403H wherein biorecognition utilizes protein substrate or binding site recognition for attaching separate components, e.g., protein receptor/ligand binding or protein/enzyme substrate binding recognition, etc.

7354Y

Nanoimprint lithography (i.e., nanostamp):

Subject matter under subclass 7300N wherein manufacturing of the nanostructure includes a mold or stamp used to transfer pattern of nanometer dimensions onto a substrate.

7305R

Shaping or removal of materials (e.g., etching, etc.):

Subject matter under subclass 7300N including process or apparatus for forming a nanostructure by removing material from the nanostructure.

SEE OR SEARCH CLASS:

204, Chemistry: Electrical and Wave Energy, subclass 192.32 for a process of sputter etching.

216, Etching A Substrate: Processes, for a process of chemical etching.

7306W

By laser ablation:

Subject matter under subclass 7305R wherein the material removing is done by focusing coherent electromagnetic radiation, i.e., laser, onto the surface of the nanostructure.

SEE OR SEARCH CLASS:

216, Etching A Substrate: Processes, subclasses 22+ for the shaping of an article by removing a portion by electrical or wave energy, e.g., laser ablation wherein no chemical etchant is employed, etc.

7313E

Deposition of materials (e.g., coating, CVD, or ALD, etc.):

Subject matter under subclass 7300 N including process or apparatus for layering or coating to form a nanostructure.

(1) Note. The deposition could be performed by chemical vapor deposition, i.e., CVD, or atomic layer deposition, i.e., ALD.

SEE OR SEARCH CLASS:

118, Coating Apparatus, appropriate subclasses for coating apparatus.

427, Coating Processes, appropriate subclasses for coating processes, per se.

7319R

Vapor phase deposition:

Subject matter under subclass 7313E wherein the coating material is in a gaseous state.

SEE OR SEARCH CLASS:

118, Coating Apparatus, appropriate subclasses for coating apparatus.

427, Coating Processes, appropriate subclasses for coating processes, per se.

7320D

Liquid phase deposition:

Subject matter under subclass 7313E wherein the coating material is in a liquid state.

SEE OR SEARCH CLASS:

118, Coating Apparatus, appropriate subclasses for coating apparatus.

427, Coating Processes, appropriate subclasses for coating processes, per se.

7406T

Deposition in pores (molding) with subsequent removal of mold:

Subject matter under subclass 7313E wherein pores are deposited with nanomaterial that is subsequently freed via removal of the surrounding molding material, e.g., molding in the nanosized pores of a membrane which may be dissolved, etc.

7307T

Having step or means utilizing biological growth:

Subject matter under subclass 7300N wherein the process or apparatus uses a living organism growth process or growth behavior to manufacture, treat, or detect a nanostructure.

SEE OR SEARCH CLASS:

435, Chemistry: Molecular Biology and Microbiology, for a method and/or apparatus of propagating a microorganism.

7308E

Having step or means utilizing chemical property:

Subject matter under subclass 7300N wherein the process or apparatus uses chemical factors of an element or compound (e.g., chemical reactions) to manufacture, treat, or detect a nanostructure.

7309N

Chemical synthesis (i.e., chemical bonding or breaking):

Subject matter under subclass 7308E wherein the process or apparatus uses chemical synthesis to manufacture a nanostructure.

(1) Note. The chemical synthesis is a process of uniting chemical elements or simpler compounds, or by the degrading a compound, i.e., process typically occurs by bonding chemicals or by breaking up chemical compounds, combination reaction process, or process of creating a chemical compound involving plural chemical reactions.

7407E

Polymerization:

Subject matter under subclass 7309N wherein a nanostructure is formed via a chemical process that links two or more monomers together to form a polymer.

7310R

Enzymatic:

Subject matter under subclass 7309N wherein the chemical synthesis utilizes proteins or conjugated proteins produced by living organisms and functioning as catalysts in chemical reactions to manufacture nanostructure.

SEE OR SEARCH CLASS:

435, Chemistry: Molecular Biology and Microbiology, subclass 183 for an enzyme, per se.

7311W

Electrolytic:

Subject matter under subclass 7309N wherein the process or apparatus involves **electrolysis of a chemical element to manufacture a nanostructure.**

(1) Note. Electrolysis is a process including conduction of an electric current between two or more electrodes through a substance (an electrolyte) and resulting in a chemical change, e.g., oxidation, reduction, etc.

SEE OR SEARCH CLASS:

205, Electrolysis: Processes, Compositions Used Therein, and Methods Of Preparing the Compositions, appropriate subclasses for an electrolytic process.

- 7314N** **Having step or means utilizing mechanical or thermal property (e.g., pressure, heat):**
Subject matter under subclass 7300N including process or apparatus that uses solely mechanical means (e.g., pressing or grinding) or thermal means (e.g., heating or curing) to manufacture a nanostructure.
- 7315D** **Having step or means utilizing radiant energy (e.g., x-ray, electron beam, etc.):**
Subject matter under subclass 7300N wherein the process or apparatus uses electromagnetic irradiation to manufacture a nanostructure.
- (1) Note. The electromagnetic irradiation may be of the visible light range (i.e., optical) or may be in the form of x-rays or electron beams.
- 7140N** **SPECIFIED USE OF NANOSTRUCTURE:**
Subject matter under the class definition wherein a nanostructure is a component of a device or system or is used as part of a process with a particular function or purpose.
- (1) Note. This subclass covers combination claims which includes a nanostructure as part of a subcombination wherein subclass 7200N covers only the particular details of the nanostructure subcombination.
(2) Note. This subclass covers process of use claims that include nanostructures provided to accomplish a specified functional requirement.
- 7302Y** **Use of nanostructure for conversion, containment, or destruction of environmentally hazardous material:**
Subject matter under subclass 7140N for the use of nanostructure material for the containment or destruction of a material which would be deleterious to living organisms if released into the environment.
- 7001T** **For medical, immunological, body treatment, or diagnosis:**
Subject matter under subclass 7140N wherein the nanostructure is used in a process or apparatus for medical evaluation or treatment of a condition of a living body or for prevention of a disease.
- 7202D** **Specially adapted for travel through blood circulatory system:**
Subject matter under subclass 7001T wherein the use comprises a process or device for moving through the network for supplying blood in a body.
- SEE OR SEARCH CLASS:
435, Molecular Biology and Microbiology, appropriate subclasses for cell culture, general molecular biology, etc.
436, Chemistry: Analytical and Immunological Testing, subclass 66 for blood testing.
424, Drug, Bioaffecting and Body Treating Compositions, subclasses 9.3 + for in vivo diagnosis or in vivo testing.
514, Drug, Bioaffecting and Body Treating Compositions, appropriate subclasses for gene therapy, protein therapy, etc.
- 7335Y** **Drug delivery:**
Subject matter under subclass 7001T wherein the nanostructure is adapted for delivery of a therapeutic compound or composition to living organs, tissues, or cells.
- 7336C** **Liposome:**
Subject matter under subclass 7335Y wherein the nanostructure used for delivery of the therapeutic agent includes a liposome.

(1) Note. Liposomes are particles, the shells of which include a lipid bilayer.

- 7408N Mechanical repair performed/surgical:**
Subject matter under subclass 7001T wherein the nanostructure is used for *in vivo or in vitro* repair of cells or tissue, e.g., in surgery, etc.
- SEE OR SEARCH CLASS:
128, Surgery, appropriate subclasses for a surgical process.
600, Surgery, appropriate subclasses for a surgical process.
- 7409D Obstruction removal:**
Subject matter under subclass 7408N wherein the nanostructure is used for removing obstruction, e.g., removal of plaque, etc.
- 7410W Strengthening cell or tissue:**
Subject matter under subclass 7408N wherein the nanostructure is used for reinforcing the cells or tissue.
- 7411T Cancer cell destruction:**
Subject matter under subclass 7408N wherein the nanostructure is used for killing/eliminating cancer cells or tissue.
- 7412E Cancer cell repair:**
Subject matter under subclass 7408N wherein the nanostructure is used for converting cancerous cells or tissue into normal cells or tissue.
- 7413N Stem cell therapy implantation:**
Subject matter under subclass 7408N wherein the nanostructure is used for transplanting stem cells for treating a disease.
- 7338R Protein engineering:**
Subject matter under subclass 7001T wherein the nanostructure is adapted for use in the synthesis of polypeptides.
- SEE OR SEARCH CLASS:
530, Chemistry, Natural Resins or Derivatives; Peptides or Proteins; Lignins or Reaction Products Thereof, particularly subclasses 333-342 for synthesis of polypeptides.
- 7075D Therapeutic or pharmaceutical composition:**
Subject matter under subclass 7001T comprising a chemical compound constructed to treat an affliction or a disease of a body.
- SEE OR SEARCH CLASS:
424, Drug, Bio-Affecting and Body Treating Compositions, appropriate subclasses for a therapeutic composition, per se.
435, Chemistry: Molecular Biology and Microbiology, appropriate subclasses for plasmids, vectors, and cells comprising a vector.
514, Drug, Bio-Affecting and Body Treating Compositions, appropriate subclasses for a therapeutic composition, per se.
- 7339W Gene therapy:**
Subject matter under subclass 7075D wherein the nanostructure is utilized for the insertion, deletion, addition, or substitution of a nucleotide or nucleotides in an already existing DNA sequence, e.g., gene, plasmid, cosmid, a viral or phage DNA, etc., wherein the DNA sequence is then used for treating a disease.

(1) Note. Examples of processes intended for this subclass include administering nucleic acid (DNA, RNA) into animals by intramuscular, intraperitoneal, intravenous, oral, or any other route.

SEE OR SEARCH THIS CLASS, SUBCLASS:

7335Y, for nanostructure used for delivering a modified gene into living organs, tissue, or cells.

7340Y

Vaccine:

Subject matter under subclass 7075D wherein the nanostructure is part of an adjuvant adapted for producing an immunological response and vaccination against a disease or infection.

(1) Note. The nanostructure may increase the immunological response of a nucleic acid or protein delivered.

7006C

Immunological:

Subject matter under subclass 7001T wherein a substance comprising a nanostructure is used to prevent a disease in a body.

SEE OR SEARCH CLASS:

424, Drug, Bio-Affecting and Body Treating Compositions, subclasses 130.1 + for an immunoglobulin, antiserum, or antibody treating composition.

436, Chemistry: Analytical And Immunological Testing, for immunological analysis and testing.

7141D

Dental:

Subject matter under subclass 7001T wherein the nanostructure is used in a process or device for treating teeth.

SEE OR SEARCH CLASS:

433, Dentistry, appropriate subclasses for a process and device for treating human teeth.

7009W

Detection of biochemical:

Subject matter under subclass 7001T wherein the nanostructure is used for the detection of a biological chemical.

7414D

Of toxic chemical:

Subject matter under subclass 7009W wherein the nanostructure is used for the detection of a toxic chemical or molecule.

7415Y

Of explosive material:

Subject matter under subclass 7009W wherein the nanostructure is used for the detection of an explosive material.

7238H

Cell culture:

Subject matter under subclass 7001T wherein the nanostructure is adapted for providing a support surface for growing cells in culture.

SEE OR SEARCH CLASS:

435, Chemistry: Molecular Biology and Microbiology, subclasses 395-403 for solid supports and methods of culturing cells on solid supports.

- 7239R** **Using nanostructure as support of DNA analysis:**
Subject matter under subclass 7001T wherein the nanostructure is adapted for providing a support surface in DNA analysis, e.g., DNA sequencing, etc.
- 7002E** **Bioelectrical:**
Subject matter under subclass 7001T wherein the nanostructure is used in an electrical process or device for treating a living organism.
- SEE OR SEARCH CLASS:
607, Surgery: Light, Thermal, and Electrical Application, appropriate subclasses for a process of bioelectrically treating a human body.
- 7012H** **Topical chemical (e.g., cosmetic or sunscreen, etc.):**
Subject matter under subclass 7001T wherein the nanostructure is used for exterior surface of the body.
- 7013R** **Diagnostic contrast agent:**
Subject matter under subclass 7001T wherein a nanostructure is used in a diagnosis process or to enhance image differences between body tissues in the diagnosis process.
- 7416C** **X-ray agent:**
Subject matter under subclass 7013R wherein the nanostructure is used as a contrast agent in the x-ray process.
- 7417H** **Ultrasound contrast agent:**
Subject matter under subclass 7013R wherein the nanostructure is used as a contrast agent in an ultrasound process.
- 7418R** **MRI contrast agent:**
Subject matter under subclass 7013R wherein the nanostructure is used as a contrast agent in an MRI process.
- SEE OR SEARCH CLASS:
424, Drug, Bio-Affecting and Body Treating Compositions, subclass 9.3 for chemical compound or compositions used as contrast agents in magnetic imaging devices.
- 600, Surgery, subclass 407 for nuclear, electromagnetic, or ultrasonic diagnostic devices using diagnostic contrast agents.
- 7014W** **Medical device coating:**
Subject matter under subclass 7001T wherein the nanostructure is used to layer a medical implement.
- 7161Y** **For electronic or optoelectronic` application:**
Subject matter under subclass 7140N wherein a nanostructure is used in an electronic or optoelectronic device or process.

(1) Note. This subclass and those indented below are primarily intended for electronic or optoelectronic devices and applications employing fullerenes, i.e., buckyballs, nanotubes; quantum confinement structures, i.e., quantum dots, quantum wires; molecular, or atomic structures as significant components of the electronic or optoelectronic devices.

(2) Note. Solid-state semiconductor based circuits or circuit components (e.g., MOSFETS, etc.) which recite dimensions of nanometer scale is insufficient for placement herein.

7165W Spintronics or quantum computing:
Subject matter under subclass 7161Y wherein the device or process uses electron-spin or nuclear-spin properties to perform functions or to process information.

- (1) Note. The term “spintronics” is also referred to as spin electronics, magnetoelectronics, or quantum computing.
- (2) Note. There are of two stable spins (up and down). Electron spin causes magnetism on the atomic level.

7179W Giant magnetoresistance (GMR):
Subject matter under subclass 7165W wherein the spintronic device exhibits or produces a large change in electrical resistance upon application of an external magnetic field (i.e., GMR) effect.

- (1) Note. “Giant” refers to the very large electrical signal of a GMR device.
- (2) Note. GMR devices are widely used to sense magnetic field, as read-head sensors in hard disk drives, and magnetic random access memory.

SEE OR SEARCH CLASS:

324, Electricity: Measuring and Testing, appropriate subclasses for measuring magnetic property.

360, Dynamic Magnetic Information Storage and Retrieval, subclasses 313+ for magnetoresistance heads.

7180Y Spin dependent tunnel (SDT) junction (e.g., tunneling magnetoresistance (TMR), etc.):
Subject matter under subclass 7165W wherein the spintronic device exhibits or produces a large change in resistance through a normally insulating layer, depending on the predominant electron spin in a free layer.

7164R Single electron transistor:
Subject matter under subclass 7161Y wherein the nanostructure is used in a three terminal switching device that can transfer electrons individually.

7162C Nanoelectronic circuit or nanocircuit element:
Subject matter under subclass 7161Y wherein a circuit includes a nanostructure which modifies or enhances the function of the circuit.

- (1) Note. Included herein are nanocircuits which combine a plurality of nanostructures to perform analog electrical functions such as amplification, filtering, signal conversion in addition to circuit elements such as rectifiers and transistors formed from individual nanostructures.

SEE OR SEARCH CLASS:

307, Electrical Transmission or Interconnection Systems, appropriate subclasses for circuits providing electrical transmission or interconnection.

327, Miscellaneous Active Electrical Nonlinear Devices, Circuits, and Systems, appropriate subclasses for miscellaneous circuits.

- 7163H** **Logic circuit:**
Subject matter under subclass 7162C wherein the nanostructure is used in an electronic circuit that performs combinational or sequential digital logic functions.
- (1) Note. Included herein are circuits having nanostructures that used for Boolean operations to form counters, shift registers, or other devices used in digital computation.
- SEE OR SEARCH CLASS:
326, Electronic Digital Logic Circuitry, appropriate subclasses for combinational or sequential logic.
- 7419W** **DNA computation:**
Subject matter under subclass 7163H wherein the nanostructure in the logic circuit is a nucleic acid (e.g., DNA molecule).
- 7420Y** **Protein computation:**
Subject matter under subclass 7163H wherein the nanostructure in the logic circuit is a protein.
- 7166T** **Information storage or retrieval using nanostructure:**
Subject matter under subclass 7161Y wherein the nanostructure is used for storing or retrieving information.
- SEE OR SEARCH CLASS:
365, Static Information Storage or Retrieval, appropriate subclasses for writing and reading of static information, subclass 151 for information storage on the molecular or atomic level.
369, Dynamic Information Storage or Retrieval, appropriate subclasses for generic writing and reading of dynamic, i.e., erasable and rewritable, information.
- 7421C** **Biochemical memory:**
Subject matter under subclass 7166T wherein the information storage or retrieval is a biochemical molecule.
- 7422H** **Protein memory:**
Subject matter under subclass 7421C wherein the information storage or retrieval is a protein.
- 7423R** **Nucleic acid memory:**
Subject matter under subclass 7421C wherein the information storage or retrieval is a nucleic acid.
- 7167E** **With scanning probe instrument:**
Subject matter under 7166T wherein a nanosized tip is used to perform the information storage or retrieval, e.g. nanosized tip is used to read or write information data, etc.
- SEE OR SEARCH THIS CLASS, SUBCLASS:
7100T+, for scanning probes used in the manufacture, treatment, or detection of nanostructures.

- 7168N** **Radiation emitter using nanostructure:**
Subject matter under subclass 7161Y wherein the nanostructure is used to convert electric energy into emitting radiant energy.
- SEE OR SEARCH CLASS:
- 250, Radiant Energy, appropriate subclasses for methods and apparatus for generating radiant energy.
- 7169D** **Electromagnetic energy:**
Subject matter under subclass 7168N wherein the radiant energy is electromagnetic energy, i.e., radio, microwave, infrared, visible light, ultraviolet, x-ray, gamma ray.
- 7170W** **Laser:**
Subject matter under subclass 7169D wherein the electromagnetic energy is a coherent, directional beam of light generated by stimulating electronic, ionic, or molecular transitions to lower energy levels.
- SEE OR SEARCH CLASS:
- 372, Coherent Light Generators, appropriate subclasses for laser generators.
- 7171T** **Electron emitter:**
Subject matter under subclass 7168N wherein the nanostructure is used for electron emission.
- SEE OR SEARCH CLASS:
- 313, Electric Lamp and Discharge Devices, appropriate subclasses for electron generators.
- 7172E** **Display:**
Subject matter under subclass 7161Y wherein the nanostructure is used to convert electric signal into images in visual form such as a cathode ray tube, LCD, or LED display.
- (1) Note. This subclass includes nanostructure and refers to more than simply the molecules found in the cell structure of liquid crystals.
- SEE OR SEARCH CLASS:
- 345, Computer Graphics Processing and Selective Visual Display Systems, appropriate subclasses for displays.
- 349, Liquid Crystal Cells, Elements and System, subclasses 1-18 for particular liquid crystal system.
- 7173N** **Detector using nanostructure:**
Subject matter under subclass 7161Y wherein the device includes a nanostructure to convert a form of a measurement into an electrical signal.
- 7174D** **Of mechanical property:**
Subject matter under subclass 7173N wherein the measurement is mechanical in nature, i.e., strain, stress, pressure, flow rate, size.
- SEE OR SEARCH CLASS:

73, Measuring and Testing, appropriate subclasses for methods and apparatus for detecting mechanical properties.

7175Y

Of chemical property or presence:

Subject matter under subclass 7173N wherein the measurement is chemical in nature (i.e., pH, electrochemical, DNA sequencing, etc.).

SEE OR SEARCH CLASS:

436, Chemistry: Analytical and Immunological Testing, appropriate subclasses for methods and apparatus for detecting chemical properties.

7424W

Of biomolecule property:

Subject matter under subclass 7175Y wherein the measured property is relating to a living organism.

7425T

Of disease state:

Subject matter under subclass 7424W wherein the measured property is a form of a disease.

7176C

Of thermal property:

Subject matter under subclass 7173N wherein the measurement is thermal in nature (e.g., heat, temperature, cooling rate, etc.).

SEE OR SEARCH CLASS:

374, Thermal Measuring and Testing, appropriate subclasses for methods and apparatus for detecting thermal properties.

7177H

Of electrical property:

Subject matter under subclass 7173N wherein the measurement is electrical in nature (i.e., resistivity, conductivity, capacitance, etc.).

SEE OR SEARCH CLASS:

324, Electricity: Measuring and Testing, appropriate subclasses for methods and apparatus for detecting electrical properties.

7178R

Of magnetic property:

Subject matter under subclass 7173N wherein the measurement is magnetic in nature, e.g., magnetic field strength, magnetic hysteresis, magnetoresistance, etc.).

7181C

Of radiant energy:

Subject matter under subclass 7173N wherein the measurement is of radiation e.g., electromagnetic waves, electrons, etc.).

SEE OR SEARCH CLASS:

250, Radiant Energy, appropriate subclasses for methods and apparatus for detecting radiant energy.

7182H

Energy storage/generating using nanostructure (e.g., fuel cell, battery, etc.):

Subject matter under subclass 7161Y wherein the nanostructure facilitates the storage or generation of energy such as in a capacitor or battery fuel cell.

SEE OR SEARCH CLASS:

60, Power Plants, appropriate subclasses for energy conversion to produce power.
136, Batteries: Thermoelectric and Photoelectric, appropriate subclasses for primary, secondary, and thermal batteries.
429, Chemistry: Electrical Current Producing Apparatus, Product, and Process, appropriate subclasses for fuel cells and electrochemical batteries.

7142 Y

For textile treatment:

Subject matter under subclass 7140N wherein the nanostructure is used for altering a condition of a fabric.

SEE OR SEARCH CLASS:

8, Bleaching and Dyeing; Fluid Treatment And Chemical Modification Of Textiles And Fibers, appropriate subclasses for chemical treatment of a textile.

26, Textiles, Cloth Finishing, appropriate subclasses for finishing of a textile.

442, Fabric (Woven, Knitted, or Nonwoven Textile or Cloth, etc.), appropriate subclasses for a textile or fabric, per se.

7035E

For carrying or transporting:

Subject matter under subclass 7140N wherein the nanostructure is used for moving or conveying an article.

SEE OR SEARCH CLASS:

187, Elevator, Industrial Lift Truck, or Stationary Lift For Vehicle, appropriate subclasses for an apparatus for vertically moving an article.

198, Conveyors: Power-Driven, appropriate subclasses for powered conveyors.

224, Package and Article Carriers, appropriate subclasses for an apparatus for carrying an article.

414, Material or Article Handling, appropriate subclasses for an apparatus or method of handling an article.

7600C

MISCELLANEOUS:

Subject matter under the class definition wherein the nanostructure includes details not otherwise provided for in this schedule.

Please send any comments or questions to

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