



# **Analysis of the patent portfolio of the ETH- Domain**

**Appendix**

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# 1 Technology Definitions

## 1.1 Security Elements

Security elements encompass a wide range of security measures that are applied by companies and consumers to protect digital information and final products against internal and external, malicious and accidental threats.

Regarding IT systems, the key problem is ensuring that the access to data is authorized as well as guaranteeing that the origin of the data is authentic and the use of the data is secure. To achieve this, hardware and networks have to be protected against hackers. Hardware that needs to be protected can often be found in the form of end-point devices such as desktop or laptop computers as well as tablets and smartphones. Moreover, due to the Internet of Things, there is an increasing number of smart, sensor-enabled devices that can communicate and coordinate with one another, that also need to be protected against hackers.

The first line of defense of an endpoint is often a personal login with a password or biometric systems such as fingerprints or facial recognition. In addition, both devices and networks are usually protected by a firewall that checks data flows to and from the network in real time. Because firewalls do not always detect nor stop all types of viruses or malware, anti-virus software or an intrusion prevention system (IPS) can be implemented to increase protection against intruders.

Another possibility to guarantee endpoint and network security is cryptography, i.e. the coding and decoding of information. Endpoint encryption fully encrypts all enterprise data on any endpoint, including laptops, mobile devices and removable storage devices like CDs and USB drives. Whenever confidential information is sent via the web browser, it should be sent using encryption technologies to ensure secure communication. In the case of web-based communication, a so-called protocol such as SSL (Secure Socket Locker) and TLS (Transport Layer Security) is used for this purpose.

Regarding products and services, it is important that security is considered in every aspect of the product life cycle. Authentication is crucial for companies to be able to guarantee their customers the authenticity, security and genuineness of their final products. Authentication of final products depends heavily on the type of product. Examples of applications are copy protection of videos, authenticity of licenses, digital certificates of websites, security features in paper currencies and passports, or security measures for the use of digital payment systems in e-commerce.

## 1.2 Quantum Technology

Quantum physics and quantum mechanics explain the behaviour and nature of matter and energy at atomic and sub-atomic scales which cannot be explained by classical physics. In the first quantum revolution, quantum mechanics have been essential in the development of many technologies from lasers to computer chips to MRI ma-

chines.<sup>1</sup> However, it was long impossible to control individual quantum systems such as individual atoms, electrons or light particles (photons). The control of individual quantum systems has opened the door to new quantum technologies that are often described as the second quantum revolution. These new quantum technologies are expected to become innovation drivers in the coming decades. Potential applications include extremely rapid computers (quantum computing), intercept-proof communications (quantum cryptography) and hyper-sensitive measuring methods (quantum sensing). While the development of quantum computers is still in its early stages of development, quantum cryptography and quantum sensing are already close to commercialisation and products have started to appear.

Quantum states are very sensitive to magnetic, electric or gravitational fields or for movement such as acceleration, rotation and time. Therefore, quantum technology is a perfect fit for sensors. Photons and electrons can be applied as sensors in measurements of forces, gravitation, electric fields etc. For example, quantum sensors could be used as instruments that measure variations in gravitation to find minerals, water or embedded pipelines or as warning systems for earthquakes. Moreover, quantum high-precision sensors will likely be beneficial to carmakers that try to improve the accuracy of their autonomous vehicles. Quantum sensors could also be used inside human bodies as chemical changes in living cells can be spotted.<sup>2</sup>

Another promising application for quantum technologies is the field of quantum computers. While traditional computers operate on bits, which have the value 0 or 1, quantum computers work with quantum bits or qubits, which can have both the value 0 and 1 at the same time as a result of superposition. Therefore, quantum computers are expected to soon exceed the computing power of today's supercomputers.<sup>3</sup> As a consequence, quantum computers will likely be used in various complex fields such as machine learning, AI and modelling of simulations.<sup>4</sup>

Quantum technologies will also be beneficial in the field of cryptography. In our modern digital societies, the security of data transmission is of crucial relevance. Quantum technologies can make an essential contribution by enhancing encryption technology.<sup>5</sup> With quantum cryptography, the sender will be able to use individual photons to send an encryption key to the recipient. As it is impossible to measure a photon without it being affected, one can be certain of detecting outsiders that try to steal the encryption key.<sup>6</sup>

### 1.3 Digital Image Analysis

The term image analysis describes the extraction of meaningful information from images, mainly from digital images by computer algorithms. Potential image sources include photographs, screen shots, infra-red photographs and video, radar screens ultrasound, EKG, EEG, MRI, echo cardiograms, seismographs and others. Image analysis requires specialized computer equipment fitted with an imaging device, such

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<sup>1</sup> <https://phys.org/news/2016-06-quantum-technologies-revolutionize-21st-century.html>

<sup>2</sup> <https://www.economist.com/news/essays/21717782-quantum-technology-beginning-come-its-own>

<sup>3</sup> <https://www.chalmers.se/en/centres/wacqt/what%20is/the%20foru%20areas/Pages/default.aspx>

<sup>4</sup> <https://irishtechnews.ie/the-power-of-quantum-technology-in-2018/>

<sup>5</sup> [https://www.akademienunion.de/fileadmin/redaktion/user\\_upload/Publikationen/Stellungnahmen/3Akad\\_Stellungnahme\\_Quantentechnologien\\_EN\\_final.pdf](https://www.akademienunion.de/fileadmin/redaktion/user_upload/Publikationen/Stellungnahmen/3Akad_Stellungnahme_Quantentechnologien_EN_final.pdf)

<sup>6</sup> <https://www.chalmers.se/en/centres/wacqt/what%20is/the%20foru%20areas/Pages/default.aspx>

as a camera, coupled to a microscope or a macroviewer and makes heavy use of pattern recognition, digital geometry, and signal processing. The applications of digital image analysis are continuously expanding and the technology is now used in countless areas of science and industry including astronomy, defense, machine vision, medicine, robotics and many more.

The use of image analysis is common in the medical field. Image analysis based on magnetic resonance imaging, computed tomography, or ultrasound helps tracking disease status and assessing treatment effects.<sup>7</sup> Interpretation of the resulting images depends on sophisticated image processing methods that enhance visual interpretation, and image analysis methods that provide tissue detection, measurement and characterization. For example, computer-aided diagnosis aims to increase the predictive value of mammography diagnosis by pre-reading mammograms to indicate the locations of suspicious abnormalities. However, analyzing 3D biological structures such as lung tissue still remains challenging due to its complexity.

Digital image analysis in the form of facial recognition is having an impact on the security industry. For example, facial recognition complements current security measures such as fingerprint and iris scanners, offering a higher level of security. Facial recognition has the potential to be applied in many different security areas, including monitoring public spaces with surveillance cameras, identity management, and document verification. The technology is also increasingly used by companies such as social media companies that use facial recognition to identify people in photos and videos. However, the increasing application of facial recognition is also linked to rising privacy concerns.

The technology plays also a crucial role for the development of autonomous vehicles such as drones and self-driving cars, since these vehicles require detailed mapping of travel routes, including speed limits, intersections, traffic signals/signs, and identifying permanent stationary objects. One particular issue is that self-driving cars need to be able to recognize driving patterns of human drivers and other autonomous cars. In order to achieve this, the ability to image and process their surroundings by using camera hardware and computer algorithms is extremely important and remains a major challenge.

Moreover, digital image analysis can assist in creating 3D models, for example of cities, based on photographs or other images. This can help to improve the understanding of a city's static composition, to monitor available parking spots, automatic measurements of building sizes or wall surfaces and so on.

## **1.4 Advanced Materials**

Advanced materials are materials that are either newly developed, high-performance materials or conventional materials which properties have been enhanced. Therefore, advanced materials typically offer superior properties such as toughness, hardness, durability and elasticity. Some of the most interesting kinds of advanced materials are nanomaterials, smart polymers, aerogels and carbon graphene.

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<sup>7</sup>[http://dbe.unibas.ch/public/dbe/research/ImagingandComputationalMedicine/cian/cian\\_research/ImageSegmentation.html](http://dbe.unibas.ch/public/dbe/research/ImagingandComputationalMedicine/cian/cian_research/ImageSegmentation.html)

Nanomaterials are engineered constructions of minuscule size wherein at least one dimension of the material is less than 100 nanometers (a nanometre is  $1 \times 10^{-9}$  metres (a billionth of a metre)). The smallness is associated with very useful properties such as an enormous increase in the surface area. Moreover, the small size of nanomaterials enables them to form mixtures with other materials that can enhance the properties of the materials. Nanomaterials are now regularly used in many different types of products such as paints, cosmetics, textiles, sports equipment, electronic and medtech products. In the future, they also have the potential to serve as an important tool for the desalination and purification of water. While nanomaterials have many benefits, some also pose health or environmental risks. For example, inhaling certain nanoparticles could potentially be carcinogenic. Therefore, further research is necessary to ensure safety of nanomaterials.

Smart polymers, or stimulus-responsive polymers, are polymers that respond strongly to slight changes in their environment. Linear and matrix smart polymers exist which can be responsive to different characteristics including pH, temperature, ionic strength, electric or magnetic fields, and light. Smart polymers are mainly used in biotech applications. In particular, the most prevalent use of smart polymers is for specifically targeted drug delivery as researchers employ them to control the release of drugs until the desired target has been reached.<sup>8</sup> In addition, smart polymers can also be beneficial for tissue engineering, for minimally invasive surgery, for textile and packaging applications, and for optical data storage.

Graphene is another promising advanced material. Graphene is a two-dimensional carbon allotrope that is one of the lightest, strongest, thinnest, best heat- and electricity- conducting material known. Due to these reasons, it is being considered for a wide range of applications ranging from optics, aerospace, energy, automotive to electronics. For example, graphene could revolutionize electricity production and distribution from power plants in the future. However, research on graphene is still in its early stages since the material was only discovered in 2004. Hence, it will likely take many years before it will be used cost-effectively in many real-world applications.

Aerogel is a gel in which the liquid component has been replaced with a gas (usually air). The result is a solid with extremely low density and low thermal conductivity. The most common type of aerogels are silica aerogels. Aerogels are extremely light and can be used for many applications such as thermal and acoustic insulators, adsorbents, filters, catalyst supports, and electrodes for hydrogen and electrical storage.

## 1.5 Nanostructures

Nanostructures are defined as structures that range between 1 nanometer (molecular scale) and 100 nanometers in at least one dimension. Materials often change their properties dramatically when the material dimensions are reduced to the nanometer length range. Most nanostructures are synthetic and can be engineered to a wide range of physical properties. Common examples of nanostructures are nanotextured surfaces, nanofibers, nanotubes, nanosheets, nanoparticles and quantum dots.

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<sup>8</sup> <https://www.thebalance.com/smart-polymers-375577>

These nanostructures are the building blocks of nanomaterials (see definition of advanced materials).

The different forms of nanostructures can be differentiated by the number of dimensions in the volume of an object which are on the nanoscale. For example, nanotextured surfaces have only one dimension on the nanoscale (only the thickness of the surface is smaller than 100 nm), whereas nanotubes have two dimensions and nanoparticles have three dimensions on the nanoscale.

There has been extraordinary scientific interest in semiconductor nanostructures in the last several years. Semiconductor nanostructures, especially quantum dots, display a broad range of unique optical and electronic properties. These nanoscale particles intermediate between those of bulk semiconductors and discrete molecules. The unique size and properties of quantum dots make them appealing for a variety of applications and new technologies. Their small size means that electrons do not have to travel as far as with larger particles, thus electronic devices can operate faster. Therefore, quantum dots are used in circuit boards, transistors, quantum computing and many other applications.<sup>9</sup> In addition, they are particularly attractive for optical applications such as LEDs, lasers and displays due to their bright, pure colors, their ability to emit colors, their high efficiencies and long lifetimes. Quantum dots can also be used for biosensors in medical applications.

Nanostructured materials are also employed in food science where nanostructures such as polymeric nanoparticles, liposomes, nanoemulsions, and microemulsions are used. These materials can help to improve solubility, increase bioavailability and food shelf life, facilitate controlled release, and protect bioactive components during manufacture and storage.<sup>10</sup> Moreover, nanostructures offer advantages for packaging compared to polymers such as better mechanical and heat-resistant properties along with biodegradability. However, there remain concerns about the use of nanostructures as food ingredients or as packaging materials because certain nanoproperties such as nanoscale, large surface area, and high reactivity, may pose a health threat to humans and other organisms. Therefore, further research about potential risks to human health is essential before nano food products will become commercially available in larger numbers.

## 1.6 Additive Manufacturing

Additive manufacturing subsumes production technologies by which 3D-objects are constructed from sequential layers of material. The basic materials used in the process are various metals, plastics and composites. Additive manufacturing encompasses many technology subsets like 3D printing, rapid prototyping, direct digital manufacturing, layered manufacturing and additive fabrication. Additive manufacturing complements conventional production processes, enabling designers and engineers to enhance existing process chains, as well as allowing new opportunities for production.

Additive manufacturing has some advantages over conventional manufacturing methods: its production costs are attractive for small volumes and it allows for more

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<sup>9</sup> <https://www.sigmaaldrich.com/technical-documents/articles/materials-science/nanomaterials/quantum-dots.html>

<sup>10</sup> <https://www.sciencedirect.com/science/article/pii/S1021949817300583>

complex designs, more customized products, faster market launches, waste reduction and decentralized production. However, there also remain serious disadvantages that need to be addressed by further research such as higher costs for large production volumes, a limited range of materials and size limitations for the components produced.

The technology is increasingly being used beyond its initial use as a process for concept modelling and rapid prototyping in manufacturing. The possible fields for application of this technology are widespread, ranging from production equipment (tools and machines) to consumer goods to health care products. Early adopters of additive manufacturing processes were high-end technology industries such as aerospace, defense and automotive. In these industries, additive manufacturing enabled engineers to design customized parts that are lighter and more durable than conventionally produced parts. Moreover, research and development activities are often based on additive manufacturing since it allows creating test designs more quickly than traditional designs.

Additive manufacturing is also expected to become more relevant for consumer goods in the coming years as products such as lamps, jewelry and furniture can be created in more unique designs and customers can choose from a more personalized selection.

In health care, additive manufacturing applications can roughly be divided into medical and dental implants, surgical guides, surgical instruments and hearing aids.<sup>11</sup> The key advantage of additive manufacturing in health care is that this technology will soon allow the production of highly individualized health solutions in order to meet patients' needs in circumstances that require patient-specific implants or other devices. In addition, specialized surgical instruments can be made with the help of 3D printing with parts so precise and small that they cannot be produced without 3D printing processes such as laser sintering.<sup>12</sup>

## 1.7 Mass Spectroscopy

Mass spectrometers are machines that enable scientists to analyze the composition and origin of a material by quantifying its atoms and molecules. In order to achieve this, mass spectrometry (MS) ionizes chemical species, sees how those ions react to a magnetic field and then sorts the ions based on their mass-to-charge ratio. Mass spectrometry is used in many different applications in biology, chemistry, physics and clinical research.

There are many different kinds of mass spectrometers, but a typical mass spectrometer consists of an ion source, some sort of a mass analyzer and a detector.<sup>13</sup> After solid or liquid samples are converted into gas (vaporization), the mass spectrometer turns them into ions, for example, by bombarding them with a stream of electrons. The ions are then accelerated and pass through the mass analyzer where the magnetic or electrical field disrupts the stream of atoms or molecules passing by. The

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<sup>11</sup> <https://www.3dmedtechprintingconference.com/>

<sup>12</sup> <http://www.economist.com/news/science-and-technology/21697802-3d-printingcoming-age-manufacturing-technique-printed-smile>

<sup>13</sup> <https://nationalmaglab.org/education/magnet-academy/learn-the-basics/stories/mass-spectrometry>

heavier the particle's mass, the more it will resist the pull of the magnet. Finally, the deflector produces a mass spectrum for the substance under study which reveals how many isotopes of a given element are to be found in the material.

Mass spectroscopy as an analytical technique possesses key advantages including a better sensitivity than most other analytical techniques. It also offers information about molecular weight and the isotopic abundance of elements.

Specific applications of mass spectrometry include drug testing and discovery, food contamination detection, pesticide residue analysis and isotope ratio determination.<sup>14</sup> For example, pharmacokinetics is often studied with mass spectrometry because of the need for high sensitivity. Mass spectrometry has also become an important method for the characterization and sequencing of different proteins.<sup>15</sup> The technology is also used for space-related applications such as observing air quality of manned space mission or examining the composition of planetary atmospheres. Moreover, mass spectrometry is becoming increasingly used in geologic research for petroleum composition measurement and carbon dating.

## 1.8 Drones

Drones, more formally known as unmanned aerial vehicles (UAV), are essentially flying robots without a human pilot aboard. Drones can be under the control of a human operator or can fly autonomously through software-controlled flight plans in their embedded systems working in conjunction with on-board sensors and GPS. At first, drones were primarily employed in the military sector for reconnaissance, detection, protection and surveillance tasks. Personal drones for entertainment purposes such as videos or photography were the second large application of drones.

While military drones still account for the vast majority of global spending on drones and personal drones are the most important in terms of total numbers, there are also more and more business applications.<sup>16</sup> Commercial drones are already beneficial in applications that take advantage of their ability to gather visual information. Aerial surveillances that could previously only be completed occasionally with planes or helicopters can now be done cheaper and more frequently. For example, drones are projected to provide productivity gains and cost savings in agriculture because they can help track water use, crop health, and soil analysis. Moreover, drones are increasingly used by companies for inspecting and monitoring facilities. For example, in order to reduce costs, oil and gas companies are already using drones to inspect their offshore rigs, pipelines and other infrastructure. Drones are also helpful in disaster management as they can be used for search and rescue operations.

Drones are also expected to have a massive impact on the e-commerce and the logistics sector. Many companies are working on drone delivery services that can deliver goods faster and cheaper to customers. However, there remain hurdles: For example, developers must prove that drones operate safely and don't cause accidents. Moreover, heavier packages cannot be carried by drones and the traveling range of

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<sup>14</sup><https://www.thermofisher.com/ch/en/home/industrial/mass-spectrometry/mass-spectrometry-learning-center/mass-spectrometry-applications-area.html>

<sup>15</sup> <https://www.news-medical.net/life-sciences/Mass-Spectrometry-Applications.aspx>

<sup>16</sup> <https://www.economist.com/technology-quarterly/2017-06-08/civilian-drones>

drones is limited by their batteries. In fact, there's an inverse relationship between payload weight and flight endurance. Moreover, it is not clear yet where drones are supposed to unload packages exactly - at customer's doorsteps or in special drone delivery stations. Another problem is that drones can be hijacked by hackers.

Therefore, more research is necessary to further improve the safety and efficiency of drones. Self-flying drones are even harder to build than self-driving cars since mapping the environment and planning a path needs to be done in three dimensions. Hence, the operating computer software must be able to properly control the drones' steering in the safest and most efficient manner in order to dodge obstacles and collisions. Unfortunately, drones typically cannot carry much computing power due to weight restrictions.<sup>17</sup> Growth in commercial and personal drones also poses regulatory challenges due to safety concerns, namely midair collisions. Unlike airplanes, which take off from and land at airports, drones are able to begin and end their trips anywhere. Therefore, air traffic management systems need to be developed for autonomous drones so they can communicate with each other and with manned aircraft.<sup>18</sup>

## 1.9 Radiation Detectors

Radiation detectors, also known as particle detectors, are instruments that are employed to detect, track, and measure ionizing particles from radioactive materials, cosmic radiation, or reactions in a particle accelerator. Such particles include electrons, protons, neutrons, alpha particles, gamma rays, and numerous mesons and baryons. Radiation detectors are mainly employed in experimental and applied particle physics, nuclear physics, and nuclear engineering, but also have many industrial applications.

There are different kinds of radiation detectors, but the two most commonly employed are ionization detectors and scintillation detectors. Ionization detectors detect the ionising effect of radiation upon a gas-filled sensor. One of the oldest ionization detectors is the Geiger counter. Scintillation counters measure radiation by using the excitation effect of incident radiation on a scintillator material, and detecting the resultant light pulses. Scintillation counters can measure both the intensity and the energy of incident radiation.

Radiation detectors are widely used for radiation detection and protection within the nuclear, medical and environmental fields. For example, there are scintillation counters designed for freight terminals, border security, ports, weigh bridge applications, and contamination monitoring of nuclear waste. Moreover, radiation detectors for medical imaging play an important role in the detection, diagnosis, and treatment of many diseases. Modern applications of radiation detectors in the medical field include silicon drift detectors (SDD) which are widely employed in X-ray spectroscopy and electron microscopy.<sup>19</sup> SDDs measure the energy of an incoming photon by the amount of ionization it produces in the detector material.

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<sup>17</sup> <https://www.technologyreview.com/s/610246/drones-that-dodge-obstacles-without-guidance-can-pursue-you-like-paparazzi/>

<sup>18</sup> <https://slate.com/technology/2018/01/how-air-traffic-control-could-work-when-we-have-drones-and-flying-cars.html>

<sup>19</sup> <http://cerncourier.com/cws/article/cern/56607>

However, the most advanced radiation detectors are those being used at large international laboratories such as Fermilab in Batavia, Illinois, and CERN in Geneva, Switzerland. In these labs, colliding beam accelerators have been constructed that produce collisions of particles, such as electrons and positrons at CERN, and protons and anti-protons at Fermilab. Collisions can take place in the accelerators that create large amounts of energy available for the production of other particles. Radiation detectors are constructed and employed around these collision points.

These modern detectors are huge, both in size and in cost. They consist of layers of subdetectors, each designed to look for specific properties, or different types of particle. The detectors collect information about the particles – including speed, mass and charge – that enables physicists to detect a particle's identity.<sup>20</sup>

### **1.10 Bioprinting, Biosensors, Lab-on-a chip**

Bioprinting, Biosensors and Lab-on-a-chip are three cutting edge technologies that have the potential to play an important role in the Life Sciences sector in the future.

Biosensors are analytical devices that convert biological responses into electrical signals. There are various different types of biosensors being used such as enzyme-based, tissue-based, immunosensors, DNA biosensors, thermal and piezoelectric biosensors. Most biosensor applications are based on the concept that they use organisms which respond to certain substances to warn of their presence. Biosensors are currently mainly used in the food industry, in medicine and in environmental monitoring. In the food industry, biosensors help to check the quality and safety of food products. In the medical field, biosensors are used to detect, diagnose and control diseases. For example, glucose biosensors play an important role in the diagnosis of diabetes mellitus, which requires control over blood-glucose levels. The further development of biosensors requires multidisciplinary research in chemistry, biology, and engineering. Moreover, the use of nanomaterials offers opportunities for creating a new generation of biosensor technologies.

Bioprinters utilize 3D printing technology and so-called bioinks, substances made of living cells, to create tissue-like structures that are later used in medical and tissue engineering fields. Bioprinters are still in the early stage of development, but they have the potential to have a substantial impact on medical practice in the coming years. For example, bioprinting is already used to print tissues and organs for drug testing and in the future, bioprinting could be useful in the field of regenerative medicine as it might be possible to print entire organs for transplantation in patients with organ failure. However, before bioprinting can be used more widely, it is necessary to improve existing bioinks to create materials that can be dispensed and remain stable when printed, that are biocompatible and nontoxic, and that will also be degraded over time as the healing process takes over.

A lab-on-a-chip (LOC) is a device that integrate one or several laboratory techniques into a system that fits a single chip of only millimetres to a few square centimeters in size. The technology is based on two core technologies: microfluidics and molecular biology. LOCs are so far mainly used for human diagnostics and DNA analysis, but

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<sup>20</sup> <https://home.cern/about/how-detector-works>

they can also be applied for the analysis and synthesis of chemicals and, therefore, could be used for a range of industrial applications and environmental monitoring. The ability to perform laboratory operations on small scales has several advantages including cost efficiency, diagnostic speed and sensitivity.<sup>21</sup> Another key benefit is that LOCs allow samples to be analyzed at the point of need rather than at a laboratory which is particularly beneficial in emerging countries with few healthcare resources – for example in the diagnosis of HIV. However, the design and production is challenging and for LOCs to be used in developing countries it is important that they are easy to use and have a long shelf life even in sub-optimal conditions.

### **1.11 Wearables Bionics**

Wearables are electronics that can be worn on the body. This includes products such as hearing aids that have been used for decades and innovative new product categories such as activity trackers and smartwatches. Wearables appear prominently in consumer electronics, but they are also increasingly being employed in textiles and healthcare. One of the major features of wearables is their ability to connect to the internet, enabling data to be exchanged between a network and the device. Thus, wearables are also an important subset of the Internet of Things (IoT).

In the coming years, augmented reality will likely become a major wearables application. Augmented reality describes the integration of digital information with the user's environment in real time. While virtual reality creates a totally artificial environment, augmented reality overlays new information on top of the existing environment of the user. Smart glasses and heads-up displays in car windshields are well-known examples of consumer augmented reality products. Smart clothing is also expected to gain in relevance including anything from connected shirts, belts with fitness tracker skills, shoes boasting run tracking, to sports apparel measuring athletes' performance.

While the number of wearables will certainly increase in the coming years, there are a number of challenges. For example, limited battery life, dependence on a secondary computing device (usually a smartphone) as well as poor connectivity and latency are still limiting the use of wearables. Privacy and security issues are further obstacles. In general, an important research topic regarding wearables is sensor technology because sensors are a crucial part concerning the accuracy of wearables.

The term bionics describes the application of biological methods to the study and design of engineering systems and modern technology. An example of a bionics application is sonar technology that mimics animal echolocation. In the medical field, bionics includes the replacement of organs or other body parts by mechanical versions.

Another promising bionics application are exoskeletons. Exoskeletons are powered wearables that work in tandem with the user and that allow for increased strength and endurance. For example, orthotic exoskeletons can be used in physical therapy or can even make it possible for a paralyzed person to walk instead of using a wheelchair. Exoskeletons also have the potential to fulfill needs in military and industrial

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<sup>21</sup><https://www.elveflow.com/microfluidic-tutorials/microfluidic-reviews-and-tutorials/introduction-to-lab-on-a-chip-2015-review-history-and-future/>

applications because they enable humans to move faster, carry more and lift heavier loads.

However, while some exoskeletons have already reached the market, most applications are still in an early development stage. A key technological challenge is to build exoskeletons that allow quick and agile movements, yet are also safe to operate. Another hurdle is the power supply since a lot of energy is required to sustain a powered exoskeleton for more than a few hours.

## 1.12 Radiation Diagnosis and Therapy

Radiation diagnosis utilizes medical imaging technologies in the diagnostic evaluation of patients. It covers a broad spectrum of imaging modalities such as Ultrasound, Computed Tomography (CT), Magnetic Resonance Imaging (MRI) and Positron Emission Tomography (PET) scanning. Thanks to these images, doctors are able to locate tumour or other diseases inside a patient's body with very high accuracy.

Radiation therapy is one of the three main cancer treatment modalities along with surgery and chemotherapy. Most cancer types can be treated with radiation therapy in some way. Less commonly, radiation therapy is also used to treat thyroid disease, blood disorders, and noncancerous growths.

Radiation therapy is based on using ionizing radiation to control or kill malignant cells. Simply speaking, it breaks up the DNA of cancer cells in order to disrupts their growth and division leading to cellular death. While radiation therapy is in itself painless, it can cause dose- dependent short- or long-term side effects such as cardiovascular complications, thyroid dysfunction, and pituitary axis dysfunction.

Radiation therapy can either be given from outside (external beam) or from inside the body (brachytherapy). The most common version is external beam radiotherapy where a radiation beam is pointed at the affected body part using a Linac (linear accelerator). Research in this field is focused on narrowing the targets of external beams for best effect and fewer side effects. Traditionally, X-rays and electron beams are the most widely used sources for external beam radiotherapy. However, there are new state-of-the-art versions based on the use of protons. Proton therapy allows doctors to treat tumours more precisely while minimizing the damage to the surrounding healthy tissue.<sup>22</sup>

In brachytherapy, radioactive material is placed inside the body, close to or inside the tumour. Brachytherapy is mainly used to treat cancer of the cervix, womb, vagina or prostate.<sup>23</sup>

One promising research field in radiation therapy focuses on drugs that sensitize tumors, but not surrounding tissue to the therapy. This would boost response rates and reduce side effects. Moreover, so-called therapeutic agents are currently being developed that stimulate tissue-healing post-therapy. However, one challenge with these types of agents is to avoid protecting or stimulating tumor cells as well.

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<sup>22</sup> <https://www.psi.ch/media/added-value-for-cancer-patients>

<sup>23</sup> <http://www.uhs.nhs.uk/OurServices/Cancer/Radiotherapy/Diagnosisandtreatment.aspx>

### 1.13 Protein Engineering

The term protein engineering describes the process by which novel proteins with desired properties are developed for a wide range of medical and industrial applications. In order to create these novel proteins, the process of protein engineering changes protein sequences to achieve a desired result, such as a change in the substrate specificity, or increased stability to the temperature, organic solvents, and/or extremes of pH.<sup>24</sup> Research in the field has increased substantially over the last years since protein engineering plays a central part in creating stimulus-responsive drugs. These so-called smart drugs can respond appropriately to varying physiological and pathological signals and are, therefore, more effective and cause fewer side effects.

In general, there are three common methods used for protein engineering: knowledge-based mutagenesis (KBM), computational protein design (CPD), and directed evolution (DE).<sup>25</sup> Knowledge-based mutagenesis is the simplest form of protein engineering. It is based on general biochemical principles and knowledge gained from prior studies to guide mutagenesis of native proteins with the goal of achieving improved or novel structural and/or functional properties. This has the advantage of being inexpensive and technically easy, but its major drawback is that detailed structural knowledge of a protein is often unavailable as few enzymes have been studied this intensively.

Computational protein design is another protein engineering method. Predictive molecular modeling programs are employed to identify amino acid sequences that will fold into a desired structure and are most likely to influence protein function. However, a major challenge for computational protein design is that a fast and accurate energy function needs to be identified that can distinguish optimal sequences from similar suboptimal ones.

The third widely used protein engineering method is called directed evolution. This method introduces desired properties such as enzymatic activity into proteins via random mutation or gene recombination. Variants having desired traits are then selected through screening or selection. As a result, directed evolution changes the function of an enzyme without the need for exhaustive structural and functional data. In addition, it is not necessary to predict what effect a given mutation will have in advance. This method mimics natural evolution and often produces better results than the other two methods. However, a disadvantage is that high-throughput screening is a prerequisite in order to measure the effects of a large number of different random mutations which is not feasible for all proteins. Moreover, it often requires expensive robotic equipment.

As all methods have strength and weaknesses, the different protein engineering methods are often merged. Together, these approaches offer a powerful toolset enabling scientists to manipulate an enzyme's input and output sensitivity. Still, the identification of protein sequences that will display desired activities remains challenging.

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<sup>24</sup> <https://www.sciencedirect.com/topics/neuroscience/protein-engineering>

<sup>25</sup> <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4931902/>

## 1.14 Drug Discovery Systems

The term drug discovery describes the process by which new medications are discovered. Today, the process of finding a new drug against a chosen usually involves the use of high throughput screening (HTS) of large compounds libraries against isolated biological targets (protein, DNA, RNA, metabolite, etc.). Compounds with a desired size of effects are called hits and are, then, further tested in cells and in animals in order to increase the affinity, selectivity, efficacy/potency, metabolic stability, and oral bioavailability. If a compound can fulfill all the requirements, the process of drug development prior to clinical trials begins. Traditionally, drugs were mainly organic small molecules produced through chemical synthesis, but biopharmaceuticals produced through biological processes are becoming increasingly more common.

However, modern drug discovery is a very complicated, expensive and time-consuming process, and most drugs fail in pre-clinical and clinical trials. Even if a drug development is successful, it takes on average about 15 years and costs up to \$800 million to bring a drug to the market.<sup>26</sup> Therefore, pharma companies are continuously trying to improve drug discovery processes. One approach that is gaining in popularity is the employment of rational, structure-based drug design (SBDD) with the help of computational methods.<sup>27</sup> Structure-based drug design is based on knowledge of the three dimensional structure of the biological target gained by methods such as x-ray crystallography, NMR spectroscopy or homology models of the target. This knowledge helps to identify promising new drug candidates.

There are currently three main methods for structure-based drug design: First, virtual screening (VS) can be used to identify new ligands for a given receptor by searching large databases of 3D structures of small molecules to find those fitting the binding pocket of the receptor using fast approximate docking programs. Virtual screening is beneficial in finding interesting new scaffolds rather than many hits.<sup>28</sup> Hence, VS serves as a more cost-effective approach to drug discovery. A second method is the de novo drug design approach. In this method, a prediction is made of chemicals that might fit into an active site of the target enzyme. A key advantage of the de novo drug design approach is that novel structures, not contained in any database, can be suggested and designed.<sup>29</sup> A third approach is the optimization of known ligands by evaluating proposed analogs within the binding cavity.

Systems biology, that aims to understand the operation of complex biological systems and to develop predictive models of human disease, is also increasingly used in modern drug design. Gene, protein and metabolite measurements ('omics') can accelerate hypothesis generation and testing in disease models. Moreover, computer simulations integrating knowledge of organ and system-level responses are used to prioritize targets and design clinical trials.<sup>30</sup> For complex diseases such as cancer, drug combinations are a promising option to improve therapies. However, the successful discovery of effective combinations is a challenging task, since biological pathways are complex, convoluted and interconnected.

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<sup>26</sup> [http://www.sciencemag.org/site/products/ddbt\\_0207\\_Final.xhtml](http://www.sciencemag.org/site/products/ddbt_0207_Final.xhtml)

<sup>27</sup> <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4443793/>

<sup>28</sup> <https://www.tandfonline.com/doi/full/10.1517/17460441.2013.761204?src=recsys>

<sup>29</sup> <https://www.sciencedirect.com/science/article/pii/S2001037014600398>

<sup>30</sup> <https://www.ncbi.nlm.nih.gov/pubmed/15470465>

## 1.15 Classic Organic Pharmaceutical Active Substances

The category Classical Organic Pharmaceutical Active substances encompasses new chemical compounds that will later be used for the development of new pharmaceutical drugs. Chemical compounds are chemical substances consisting of two or more different chemically bonded chemical elements. One common method to classify chemical compounds is based on the specific elements present. For instance, oxides contain one or more oxygen atoms, whereas hydrides contain one or more hydrogen atoms. Compounds with a backbone of carbon atoms are classified as organic compounds, and the remaining compounds are characterized as inorganic.

Newly discovered chemical compounds are often first registered as chemistry patents. An explanation for this is that a patent claim to a chemical compound results in absolute patent protection of that substance, regardless of the intended use. A compound claim is the strongest way to claim a chemical invention. It defines the inventor's new compound by structural formula.

As a result, the use of this substance for an alternative application by competitors is blocked for the protection period of the patent, even if the inventor did not know of or did not claim such an alternative application. Inventors can claim more compounds than they actually make because they can employ variable groups of related chemical compounds to broaden the scope of the invention. These variable groups are referred to as so-called Markush groups since a Markush structure is a representation of chemical structure used to indicate a related group of compounds.

This absolute product protection for chemical compounds or groups of compounds is of considerable economic importance for pharma researchers due to the significant research and development spending and the high risks associated with the development of a new drug. Therefore, drug discovery project teams typically apply for patents to claim and protect the chemical space around their lead series from which clinical development candidates may be chosen later.<sup>31</sup>

## 1.16 Organic & Perovskite Photovoltaic

The commercial photovoltaics market is dominated by traditional crystalline silicon cells that currently hold around 90% market share. However, there is substantial research in new photovoltaic cells using technologies that are based on new materials and that have the potential to overcome current efficiency limits and lower the cost of solar energy. Two particularly promising areas of research are organic photovoltaic cells and perovskite photovoltaic cells.

Perovskite cells are photovoltaic cells which include a perovskite structured compound, most commonly a hybrid organic-inorganic lead or tin halide-based material, as the light-harvesting active layer. A perovskite structure is any compound that has the same structure as the perovskite mineral.

A key advantage of perovskite solar cells compared to traditional cells is that they can absorb light across almost all visible wavelengths, which enables them to transform

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<sup>31</sup> <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3812171/>

more of the sunlight that reaches them into electricity. Over the last years, the efficiency of perovskite cells has risen impressively. The power conversion efficiencies of these cells are already exceeding 20% in the lab. Traditional silicon-based cells, with decades of research behind them, reach close to 25% efficiency in the lab and around 18% in real-world applications.<sup>32</sup> Moreover, perovskite solar cells are relatively easy and cheap to produce. Unlike traditional solar cells, perovskite cells can also be sprayed on to a surface, similar to inks or paints. This opens up a range of new applications because the light-gathering film can be attached to flexible materials.

However, perovskite solar cells are still in the early stages of commercialization since there remain disadvantages compared to silicon-based cells. For example, cheap perovskite solar cells only have a short lifespan and also deteriorate rapidly in the presence of moisture. While this is not an issue regarding short-lived disposable products such as cellphones, it so far excludes the technology from the use in large-scale solar farms. Another problem is the disposal of perovskite cells since they usually contain lead. Therefore, further research is necessary to improve the stability and life span of perovskite cells and to replacing toxic materials with safer ones.

Apart from perovskite cells, there is also substantial research invested into organic solar cells as they also promise to achieve the goal of producing low-cost, high-efficiency solar cells. Most organic solar cells are based on polymer solar cells and do not contain toxic elements. Organic solar cells have the potential to provide decent power conversion efficiencies combined with low costs and a light weight. Organic solar cells can also be printed as a thin film on to a flexible substrate. However, organic solar cells also have stability issues and power conversion efficiencies are still significantly lower than from traditional solar cells.

## **1.17 Wastewater, Biomass, Carbon Capture**

Wastewater treatment, biomass and carbon capture are three technologies that play an important role regarding sustainable development. The process of wastewater treatment is employed to convert wastewater (i.e. sewage, industrial or agricultural wastewater, leachate) into an effluent that can be returned to the water cycle or directly reused. During the wastewater treatment contaminants including bacteria, chemicals and other toxins in the wastewater are reduced to acceptable levels to make the water safe for discharge back into the environment. Depending on the type of water pollution, the contaminants are either removed by physical processes such as settling and filtration, chemical processes such as disinfection and coagulation or biological processes such as slow sand filtration. Reused water can either be used for certain needs in residences (e.g. toilet flushing), businesses, agriculture and industry, but it can also be treated to reach drinking water standards (potable reuse).

One challenge regarding wastewater treatment is to reduce the amount of energy used because wastewater treatment plants are typically the largest energy consumers in most cities.<sup>33</sup> Current technologies that are developed to reduce this amount of energy include optimizing system processes by modifying and improving pumping and aeration equipment or the use of fine screens in primary biological treatment. In addi-

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<sup>32</sup> <https://www.theguardian.com/sustainable-business/2017/may/04/solar-renewables-energy-thin-film-technology-perovskite-cells>

<sup>33</sup> <http://info.oxymem.com/blog/4-major-operational-challenges-facing-wastewater-treatment-plants>

tion to energy saving, it is also important to reduce the emission of greenhouse gases (GHG) in wastewater treatment plans. In the future, the use of nanotechnology is expected to play an important role in creating wastewater plants that are environmentally friendly and more cost-effective.

The term biomass refers to plant-based materials (such as corn, sugarcane, agricultural and municipal wastes) that are not used for food, but as an energy source either directly via combustion to produce heat, or indirectly after converting it to various sorts of biofuel. Energy generation from biomass releases carbon emissions, but it is considered a renewable energy source because biomass can re-grow over a relatively short period of time. Current research focuses on developing bioenergy from sewage sludge from wastewater treatment. In order to create biofuels, fermentation processes are employed. Fermentation refers to a series of chemical reactions that convert sugars into organic acids, gases, or alcohol. However, there are concerns about the use of biofuels including issues such as the effect on food prices, deforestation and soil erosion, loss of biodiversity, impact on water resources, as well as efficiency.

The term carbon capture describes the process of capturing CO<sub>2</sub> from fossil fuel power plants and industrial sites, transporting it to a storage site, and depositing it. The goal of carbon capture is to reduce the release of CO<sub>2</sub> into the atmosphere to counteract global warming. The captured CO<sub>2</sub> is typically stored in deep geological formations. However, there are certain downsides of carbon capture including concerns about the safety and durability of underground storage. Moreover, carbon capture reduces plant efficiency as it uses a considerable amount of the energy produced by a power station. Therefore, further research is necessary to improve efficiency and safety of carbon capture before a large-scale carbon capture deployment becomes feasible. Current research also focuses on capturing CO<sub>2</sub> directly from the air.

## 2 National Comparison

### 2.1 Security Elements

Rank	Name	Total patents	World-class patents
1	Leonhard Kurz Stiftung	124	80
2	SICPA Holding	129	64
3	Koenig & Bauer	67	31
4	ETH Domain	63	17
5	BASF	37	16
6	Omya AG	6	6
7	U-NICA	11	5
8	Orell Fuessli	18	3
9	Fortress Paper Ltd.	10	3
10	Boegli-Gravures	5	3
11	People's Bank of China	4	3
12	Gemalto	16	2
13	Diebold Nixdorf	9	2
14	Bundesdruckerei	6	2
15	3M	3	2
16	Wendel	3	2
17	Bank Of Canada	2	2
18	Technicolor	2	2
19	Crane Co.	13	1
20	De La Rue	5	1
21	Glory Ltd	5	1
22	CCL Industries	4	1
23	Avery Dennison	3	1
24	Giesecke & Devrient	3	1
25	Il Property Holding	3	1
26	Advent International	2	1
27	Alpvision Sa	2	1
28	Bi Ming	2	1
29	European Central Bank	2	1
30	Alphabet	1	1
31	Bed Industrie Elektronik	1	1
32	Friedrich Kisters Ch	1	1
33	Hersch Roger	1	1
34	Identif	1	1
35	Inpeco Holding	1	1
36	Landkart	1	1
37	Merck KGaA	1	1
38	Schreiner Group	1	1
39	Texmag GmbH	1	1
40	Ypsomed	1	1

## 2.2 Quantum Technologies

Rank	Name	Total patents	World-class patents
1	ETH Domain	22	7
2	Universal Display	5	3
3	BASF	3	2
4	University of California	3	2
5	Bracco	2	2
6	Caris	2	2
7	Novartis	2	2
8	ID Quantique	10	1
9	Universities	9	1
10	Alpes Lasers	8	1
11	GlobalFoundries	5	1
12	Provenance Asset Group	3	1
13	Research Institutions	3	1
14	Caltech	2	1
15	FASTREE3D	2	1
16	Alphabet	1	1
17	CNRS	1	1
18	Enraytek Optoelectronics Co., Ltd.	1	1
19	Intel	1	1
20	Lumentum	1	1
21	Nanalysis	1	1
22	University of Paris-Sud	1	1
23	University of Pennsylvania	1	1
24	University of Southern California	1	1
25	UVSQ France	1	1
26	IBM	8	0
27	Fraunhofer	3	0
28	Microsoft	3	0
29	Texas Instruments	3	0
30	ams AG	2	0
31	Avantama	2	0
32	BAM	2	0
33	Bruker	2	0
34	EXALOS	2	0
35	G RAY Switzerland	2	0
36	Samsung	2	0
37	Anjarium Biosciences Ag	1	0
38	Bar-Ilan University	1	0
39	Bilcare	1	0
40	DECTRIS	1	0

## 2.3 Digital Image Analysis

Rank	Name	Total patents	World-class patents
1	ETH Domain	81	19
2	Alphabet	40	13
3	Hexagon	38	13
4	Walt Disney	107	9
5	Intel	17	6
6	Universities	20	4
7	Philips	10	4
8	Bracco	8	4
9	Samsung	8	4
10	Abg Sundal Collier Holding Asa	4	4
11	Danaher	18	3
12	Roche	8	3
13	Stryker	6	3
14	Dentsply Sirona	3	3
15	IBM	18	2
16	Apple	7	2
17	MI Netherlands C V	7	2
18	Qualcomm	6	2
19	Technicolor	6	2
20	AO Technology	5	2
21	Koenig & Bauer	5	2
22	GE	4	2
23	Mitsubishi Electric	4	2
24	Nokia	4	2
25	Swisscom	4	2
26	Lego	3	2
27	Novartis	3	2
28	Philip Morris	3	2
29	Dartfish Sa	2	2
30	Leonhard Kurz Stiftung	2	2
31	Schindler Holding	2	2
32	SICPA Holding	8	1
33	Kudelski	7	1
34	ABB	6	1
35	ams AG	6	1
36	Logitech	5	1
37	Toyota Motor	5	1
38	Intellectual Ventures	4	1
39	Swatch	4	1
40	Tylerton International Inc.	4	1

## 2.4 Advanced Materials

Rank	Name	Total patents	World-class patents
1	ETH Domain	100	57
2	BASF	34	16
3	Omya AG	16	14
4	Swatch	25	10
5	Imerys	11	9
6	DowDuPont	10	6
7	Ivoclar Vivadent	11	5
8	Swiss Krono Group	11	4
9	OC Oerlikon	7	4
10	MIT	4	4
11	EMS-Chemie	8	3
12	Max Planck	8	3
13	Philip Morris	7	3
14	Altria Group	6	3
15	DSM	6	3
16	Rolex	6	3
17	Huntsman	5	3
18	Norwegian Univ. of Sci. & Tech.	5	3
19	University of California	4	3
20	Novartis	3	3
21	IBM	20	2
22	Universities	9	2
23	ABB	5	2
24	Essity	5	2
25	SCHOTT	4	2
26	Datalase Ltd	3	2
27	Debiotech	3	2
28	Nantero	3	2
29	Nestle	3	2
30	WIFAG-Polytype Holding AG	3	2
31	Bracco	2	2
32	Roche	2	2
33	Toyota Motor	2	2
34	Milux Holdings	11	1
35	Research Institutions	8	1
36	Caltech	6	1
37	Johnson & Johnson	4	1
38	Merck KGaA	3	1
39	Biotronik	2	1
40	Evonik	2	1

## 2.5 Nanostructures

Rank	Name	Total patents	World-class patents
1	ETH Domain	132	48
2	BASF	48	22
3	Omya AG	18	15
4	Universities	31	14
5	EMS-Chemie	22	14
6	Leonhard Kurz Stiftung	18	12
7	Swatch	33	11
8	DowDuPont	24	10
9	Roche	16	10
10	Novartis	16	7
11	MIT	8	7
12	IBM	70	6
13	Philip Morris	9	6
14	University of California	8	6
15	Huntsman	7	6
16	DSM	25	5
17	Altria Group	9	5
18	OC Oerlikon	8	5
19	Research Institutions	18	4
20	ABB	14	4
21	Norwegian Univ. of Sci. & Tech.	7	4
22	Max Planck	9	3
23	Johnson & Johnson	8	3
24	Bracco	5	3
25	BioNTech	4	3
26	GlobalFoundries	30	2
27	Ivoclar Vivadent	11	2
28	Harvard	7	2
29	Koch Industries	7	2
30	CNRS	5	2
31	Essity	5	2
32	Otsuka Holdings	5	2
33	SICPA Holding	5	2
34	Geistlich	4	2
35	WIFAG-Polytype Holding AG	4	2
36	Biogen	3	2
37	Datalase Ltd	3	2
38	Debiotech	3	2
39	Imerys	3	2
40	Nantero	3	2

## 2.6 Additive Manufacturing

Rank	Name	Total patents	World-class patents
1	BASF	47	23
2	Ansaldo Energia	56	17
3	Roche	33	17
4	IGM GROUP	26	10
5	Ivoclar Vivadent	32	8
6	Swatch	32	8
7	3D Systems	21	8
8	Hexagon	7	6
9	Siena Biotech	7	5
10	Nestle	23	4
11	Danaher	11	4
12	Universities	9	4
13	DowDuPont	7	4
14	Huntsman	7	4
15	Johnson & Johnson	12	3
16	MIT	6	3
17	Harvard	7	2
18	Vienna University of Technology	6	2
19	EMS-Chemie	5	2
20	Novartis	5	2
21	Zimmer Biomet	4	2
22	Edwards Lifesciences	2	2
23	Fluid Solids Ag	2	2
24	Sonova	43	1
25	Dentsply Sirona	5	1
26	GE	5	1
27	Philip Morris	4	1
28	Stryker	4	1
29	Autodesk	3	1
30	Bosch	3	1
31	Sensirion	3	1
32	Sika AG	3	1
33	Eli Lilly	2	1
34	Gaebelin	2	1
35	Hribar	2	1
36	Imerys	2	1
37	Koerber-Stiftung	2	1
38	Michelin	2	1
39	Mohawk Industries	2	1
40	Rieter Holding	2	1

## 2.7 Mass Spectroscopy

Rank	Name	Total patents	World-class patents
1	Melexis	24	13
2	ETH Domain	59	12
3	Bruker	135	9
4	Qualcomm	9	9
5	Lem Holding	15	5
6	Universities	40	2
7	Hilti	15	2
8	Nestle	14	2
9	ABB	9	2
10	Krohne	8	2
11	IONWERKS INC	6	2
12	Sanken Electric	4	2
13	Senis	4	2
14	University of California	4	2
15	Bank Of Montreal	3	2
16	Bmo Capital	3	2
17	Caprotec Bioanalytics Gmbh	3	2
18	Petroleum Geo-Services	3	2
19	Bracco	2	2
20	Hk Pharmaceuticals	2	2
21	CNRS	6	1
22	Schlumberger	5	1
23	University of Lyon	4	1
24	Danaher	3	1
25	Monolithic Power Systems	3	1
26	Tetra Laval	3	1
27	Thermo Fisher	3	1
28	Harvard	2	1
29	Hexagon	2	1
30	Philips	2	1
31	Semtech Corp	2	1
32	WILCO AG	2	1
33	X-Fab Silicon	2	1
34	Agena Bioscience	1	1
35	Ammann Group Holding Ag	1	1
36	Biocrates Life Sciences Ag	1	1
37	Boehringer Ingelheim	1	1
38	Canton of St. Gallen-Hospital	1	1
39	Charité	1	1
40	Chevron	1	1

## 2.8 Drones

Rank	Name	Total patents	World-class patents
1	ETH Domain	11	8
2	Amazon	10	4
3	Hexagon	6	3
4	Parrot	4	2
5	Verity Studios	4	1
6	Niederberger Engineering Ag	3	1
7	Alphabet	2	1
8	Walt Disney	2	1
9	Danaher	1	1
10	Fujitsu	1	1
11	Lely	1	1
12	Swisscom	1	1
13	Twing Tec	1	1
14	Unibap	1	1
15	Meteomatics	3	0
16	Bluebotics	2	0
17	Continental	2	0
18	ABB	1	0
19	Autel Robotics Usa	1	0
20	Bosch	1	0
21	Flyability	1	0
22	GE	1	0
23	GoPro	1	0
24	Hayek Holding	1	0
25	IBM	1	0
26	Innosense	1	0
27	Intellectual Ventures	1	0
28	Minebea Mitsumi	1	0
29	Ms Mottale Sima	1	0
30	Mt Robot	1	0
31	Nicola Foglia	1	0
32	Openstratosphere	1	0
33	Plantcare	1	0
34	Rheinmetall	1	0
35	Schindler Holding	1	0
36	SICPA Holding	1	0
37	Solaris Holdings Ltd	1	0
38	Swiss Aerobotics	1	0
39	Swiss Re	1	0
40	Terabee S A S	1	0

## 2.9 Radiation Detectors

Rank	Name	Total patents	World-class patents
1	ETH Domain	29	16
2	Siemens	13	7
3	Thermo Fisher	2	2
4	Varian Medical	11	1
5	CERN	6	1
6	Netherlands Org. for Scientific Res.	5	1
7	DECTRIS	4	1
8	G Ray Switzerland	4	1
9	Roche	4	1
10	University of Erlangen-Nuremberg	2	1
11	Atrnahs Pharma UK	1	1
12	ChemChina	1	1
13	Chinese Academy of Sciences	1	1
14	Ion Beam Applications	1	1
15	Quarterhill	1	1
16	Tetra Laval	1	1
17	Van Loef Edgar Valentin Dieuwer	1	1
18	Universities	6	0
19	Arktis Radiation Detectors	5	0
20	Research Institutions	5	0
21	ams AG	4	0
22	Czech Technical University in Prague	2	0
23	Zecotek	2	0
24	AGH University	1	0
25	Biosensors International	1	0
26	CNRS	1	0
27	Fondazione Per Adroterapia Oncologica-Tera	1	0
28	GlobalFoundries	1	0
29	Gray Ind	1	0
30	Helmholtz Association	1	0
31	ID Quantique	1	0
32	Institute Of Electron Technology	1	0
33	Microchip Technology	1	0
34	Philips	1	0
35	Polish Academy of Sciences	1	0
36	Swan Analytische Instrument	1	0
37	University of Strasbourg	1	0
38	Yale University	1	0
39	1st Order Pharmaceuticals	0	0
40	2h System	0	0

## 2.10 Biosensors, Lab-on-a-Chip, Bioprinting

Rank	Name	Total patents	World-class patents
1	Roche	112	38
2	ETH Domain	53	16
3	Abbott Laboratories	19	5
4	Novartis	14	5
5	IBM	34	4
6	Biocartis Group Nv	13	4
7	Universities	12	4
8	Fluidigm	4	3
9	BASF	3	3
10	Grifols	7	2
11	Endress+Hauser	6	2
12	Tecan Group	6	2
13	University of California	5	2
14	Caprotec Bioanalytics Gmbh	3	2
15	Dacadoo	3	2
16	OPKO Health	3	2
17	AC Immune	2	2
18	Celgene	2	2
19	Hk Pharmaceuticals	2	2
20	Quidel	2	2
21	SoSACorp	2	2
22	Research Institutions	10	1
23	Bayer	7	1
24	Milux Holdings	7	1
25	Harvard	6	1
26	Spinomix Sa	6	1
27	Tylerton International Inc.	4	1
28	ADLENS, LTD.	3	1
29	AMPHASYS AG	3	1
30	Danaher	3	1
31	Merck KGaA	3	1
32	MIT	3	1
33	Qiagen	3	1
34	University of Pennsylvania	3	1
35	Artificial Sensing Instruments Asi Ag	2	1
36	Dbs System	2	1
37	Mayo Foundation	2	1
38	Neurimmune	2	1
39	OC Oerlikon	2	1
40	Picodrill Sa	2	1

## 2.11 Wearables Bionics

Rank	Name	Total patents	World-class patents
1	ETH Domain	40	9
2	Hocoma	9	5
3	Alphabet	27	4
4	Stryker	6	3
5	Roche	9	2
6	Johnson & Johnson	6	2
7	Swisstom Ag	4	2
8	Samsung	3	2
9	Adidas	2	2
10	Verto Analytics	2	2
11	Intel	17	1
12	Walt Disney	9	1
13	Swatch	8	1
14	Smith & Nephew	5	1
15	Apple	4	1
16	Myotest Sa	4	1
17	Nestle	4	1
18	Universities	4	1
19	Biovotion Ag	3	1
20	IBM	3	1
21	Novartis	3	1
22	Sensimed	3	1
23	Harman (in: Samsung)	2	1
24	Helen of Troy	2	1
25	Mindmaze Holding	2	1
26	Sensirion	2	1
27	Accenture	1	1
28	Alfred Mann Foundation	1	1
29	Balgrist Schweiz Paraplegikerzentrum	1	1
30	Honeywell	1	1
31	Immersion	1	1
32	INVISIO MEDICAL	1	1
33	KITRIS AG	1	1
34	Leonhard Kurz Stiftung	1	1
35	List Technology Ag	1	1
36	Merck KGaA	1	1
37	MINDMAZE	1	1
38	Pixium Vision	1	1
39	Presbia Ireland le	1	1
40	ResMed	1	1

## 2.12 Radiation Diagnosis and Therapy

Rank	Name	Total patents	World-class patents
1	ETH Domain	50	22
2	Universities	48	15
3	Roche	31	14
4	Novartis	14	10
5	Siemens	50	8
6	Bracco	22	6
7	Varian Medical	59	5
8	Abbott Laboratories	7	5
9	Biogen	5	4
10	Merck KGaA	11	3
11	Philogen	10	3
12	Johnson & Johnson	9	3
13	AO Technology	4	3
14	Neurimmune	6	2
15	Research Institutions	4	2
16	AbbVie	3	2
17	Dentsply Sirona	2	2
18	Navigo Proteins Gmbh	2	2
19	Nerviano Medical Sciences	2	2
20	Stryker	9	1
21	Philips	7	1
22	GE	6	1
23	Danaher	5	1
24	Piramal Enterprises	5	1
25	CNRS	4	1
26	Tylerton International Inc.	4	1
27	Fondazione Per Adroterapia Oncologica-Tera	3	1
28	G Ray Switzerland	3	1
29	Nestle	2	1
30	Salk Institute	2	1
31	Swatch	2	1
32	60C	1	1
33	Angiotech Pharma	1	1
34	Athersys Inc	1	1
35	Berlin Institute of Technology	1	1
36	Boehringer Ingelheim	1	1
37	Cascination	1	1
38	Celgene	1	1
39	Chinese Academy of Sciences	1	1
40	Cirad	1	1

## 2.13 Protein Engineering

Rank	Name	Total patents	World-class patents
1	Roche	489	267
2	Novartis	311	158
3	Universities	196	53
4	Nestle	126	47
5	ETH Domain	122	40
6	Merck KGaA	79	24
7	AstraZeneca	26	22
8	Glaxosmithkline	33	20
9	Evolva	24	18
10	ChemChina	53	17
11	MIT	22	17
12	DSM	84	13
13	AC Immune	24	13
14	Celgene	13	13
15	Research Institutions	24	12
16	CSL Limited	32	11
17	Philogen	30	11
18	Bayer	22	11
19	ADC Therapeutics	12	11
20	Novo Nordisk	24	10
21	Biogen	19	10
22	Polyphor	36	9
23	Shire	31	9
24	Philip Morris	22	9
25	Glenmark Pharmaceuticals	20	9
26	Amgen	19	8
27	Johnson & Johnson	18	8
28	Yale University	12	8
29	Novimmune	23	7
30	Xigen	21	7
31	Arrowhead Pharmaceuticals	18	7
32	University of Pennsylvania	12	7
33	CureVac	9	7
34	KU Leuven	8	7
35	Rhizen Pharma.	8	7
36	Scripps Research Institute	8	7
37	Broad Institute	7	7
38	Sanofi	29	6
39	Boehringer Ingelheim	14	6
40	Agenus	10	6

## 2.14 Drug Discovery Systems Biology

Rank	Name	Total patents	World-class patents
1	Roche	62	13
2	Novartis	22	9
3	Universities	11	6
4	Codexis	4	3
5	Bicycle Therapeutics Limited	3	2
6	Abbott Laboratories	2	2
7	Caris	2	2
8	ETH Domain	19	1
9	Johnson & Johnson	5	1
10	MIT	5	1
11	Biogen	2	1
12	ChemChina	2	1
13	Dana-Farber	2	1
14	GE	2	1
15	Max Planck	2	1
16	Novimmune	2	1
17	Nuevolution A/S	2	1
18	Polyphor	2	1
19	Research Institutions	2	1
20	Stanford University	2	1
21	UMass Memorial Health Care	2	1
22	AbbVie	1	1
23	AstraZeneca	1	1
24	Ballivet Marc	1	1
25	Bicyclerd Gb	1	1
26	Biocartis Group Nv	1	1
27	BP	1	1
28	CureVac	1	1
29	F-star Biotech	1	1
30	Glenmark Pharmaceuticals	1	1
31	Government of the United Kingdom	1	1
32	Henrik Pedersen	1	1
33	IPRIS	1	1
34	JSR	1	1
35	Kauffman (Inventors)	1	1
36	Kauffman Stuart Alan	1	1
37	Merck & Co	1	1
38	Navigo Proteins Gmbh	1	1
39	Neuvolution	1	1
40	Novozymes	1	1

## 2.15 Classic Organic Pharmaceutically Active Substances

Rank	Name	Total patents	World-class patents
1	Roche	626	156
2	Novartis	497	149
3	Idorsia Pharma	104	33
4	ChemChina	106	23
5	Johnson & Johnson	89	20
6	Merck KGaA	89	17
7	Eli Lilly	34	13
8	BASF	52	12
9	Boehringer Ingelheim	79	9
10	DSM	47	9
11	AstraZeneca	12	8
12	Nestle	30	7
13	Bayer	25	6
14	Siena Biotech	11	6
15	Glenmark Pharmaceuticals	13	5
16	Pfizer	4	4
17	Merck & Co	22	3
18	Mallinckrodt	21	3
19	Addex Therapeutics	14	3
20	Givaudan	13	3
21	Array Biopharma	8	3
22	UCB Belgium	5	3
23	PDL BioPharma	4	3
24	Symrise	4	3
25	Riboscience	3	3
26	Universities	31	2
27	AbbVie	18	2
28	Teva Pharma	16	2
29	Vifor Pharma	16	2
30	Takeda Pharma	15	2
31	Helsinn Healthcare S.A.	13	2
32	Genkyotex Sa	11	2
33	Glaxosmithkline	9	2
34	Otsuka Holdings	9	2
35	Rhizen Pharma.	9	2
36	CNRS	8	2
37	Arena Pharma	7	2
38	Bristol-Myers Squibb	4	2
39	Gilead Sciences	3	2
40	PTC Therapeutics	3	2

## 2.16 Organic Perovskite Tandem Photovoltaics

Rank	Name	Total patents	World-class patents
1	BASF	46	26
2	ETH Domain	43	24
3	Universal Display	17	9
4	Flisom	15	4
5	Flexterra Inc	5	4
6	Max Planck	4	4
7	Saint Gobain	3	3
8	Changzhou Institute Of Energy Storage Materials	2	2
9	University of Cambridge	2	2
10	Idemitsu Kosan	16	1
11	Avantama	4	1
12	Abengoa	3	1
13	Designergy Sa	2	1
14	Eppstein Technologies	2	1
15	Hanwha Corp	2	1
16	Beiersdorf	1	1
17	Harvard	1	1
18	JGC	1	1
19	Kaunas Univ. of Technology	1	1
20	Meyer Burger	1	1
21	Norwegian Univ. of Sci. & Tech.	1	1
22	Pilegrowth Tech S.R.L.	1	1
23	Research Institutions	1	1
24	Samsung C&T	1	1
25	Sensient Technologies	1	1
26	Ses Societe D'energie Solaire Sa	1	1
27	Swissinso Holding Us	1	1
28	Thin Film Electronics	1	1
29	TU/e	1	1
30	University of Ulm	1	1
31	University of Valencia	1	1
32	Samsung	10	0
33	Tokyo Electron	9	0
34	Sefar	6	0
35	Leonhard Kurz Stiftung	5	0
36	Autonomous University of Madrid	3	0
37	Evatec	3	0
38	Helmholtz Association	3	0
39	Merck KGaA	3	0
40	Universities	3	0

## 2.17 Waste Water, Biomass, Carbon Capture

Rank	Name	Total patents	World-class patents
1	Omya AG	36	30
2	ETH Domain	28	14
3	Aquis	23	6
4	BASF	8	6
5	GE	6	5
6	Vestergaard Sa	9	4
7	Nestle	7	4
8	ESSDE GMBH	4	4
9	Sulzer AG	7	3
10	Holger Blum	5	2
11	Suez Environnement	5	2
12	DowDuPont	4	2
13	Brita	3	2
14	ChemChina	3	2
15	Geberit	3	2
16	Ophardt Hygiene	3	2
17	Clariant	2	2
18	Emstec	2	2
19	Endress+Hauser	2	2
20	Ineos	2	2
21	Koenig & Bauer	2	2
22	Lonza	2	2
23	Plasco Energy	2	2
24	BLUM HOLGER	7	1
25	Hitachi Zosen	6	1
26	Dct Double Cone Technology	4	1
27	GEA Group	4	1
28	Advent International	3	1
29	Climeworks	3	1
30	Creaholic Sa	2	1
31	Evoca Group	2	1
32	Jura Elektroapparate	2	1
33	LafargeHolcim	2	1
34	RIPRUP	2	1
35	Sonatec Inter	2	1
36	Xylem	2	1
37	ABB	1	1
38	AELLA	1	1
39	Aep Advanced Ecopower Patents	1	1
40	Albis Plastic De	1	1

### 3 International comparison

#### 3.1 Security Elements (World Class Patents)

Instit/ Year	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17
ETH Domain	0	2	2	0	0	2	4	3	3	4	5	5	5	5	7	9	13	17
CNRS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fraunhofer	0	0	0	1	2	3	3	4	6	11	15	21	24	29	39	41	50	58
Oxford	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Stanford	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Harvard	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
MIT	0	1	1	1	1	1	0	1	1	0	0	0	0	0	0	0	0	0
California	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1
Japan STA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chinese AS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tsinghua	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

#### 3.2 Quantum Technologies (World Class Patents)

Instit/ Year	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17
ETH Domain	0	0	1	0	1	1	1	1	1	1	3	5	4	5	5	5	6	7
CNRS	0	0	0	0	0	0	0	0	0	1	1	2	2	2	2	2	5	6
Fraunhofer	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1
Oxford	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	6
Stanford	0	0	1	1	0	0	1	0	0	0	3	0	2	2	3	1	1	3
Harvard	0	0	0	0	2	3	4	7	12	11	11	8	10	11	12	22	20	21
MIT	4	5	6	9	9	12	15	11	14	15	19	16	18	15	21	23	25	39
California	1	1	1	2	2	5	5	5	9	14	15	15	20	24	25	21	22	23
Japan STA	0	0	0	0	1	1	1	4	3	4	3	4	3	3	3	2	2	3
Chinese AS	0	0	0	0	0	0	0	0	0	0	0	0	0	2	6	10	14	12
Tsinghua	0	0	0	0	1	0	0	3	3	3	3	1	2	3	4	5	5	3

### 3.3 Digital Image Analysis (World Class Patents)

Instit/ Year	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17
ETH Domain	0	1	2	2	0	1	2	2	1	2	2	2	3	2	9	7	10	19
CNRS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	5	7
Fraunhofer	2	0	1	1	1	1	1	3	3	4	5	10	13	15	20	22	25	29
Oxford	0	0	0	0	0	0	0	0	0	1	1	1	3	3	3	4	16	19
Stanford	1	1	3	3	3	3	4	4	4	7	9	8	10	8	10	13	15	22
Harvard	0	0	0	0	0	0	0	0	1	1	1	2	1	0	0	3	4	5
MIT	0	0	0	1	1	0	1	1	2	4	6	5	10	13	14	16	19	19
California	1	2	3	3	5	5	4	3	4	5	11	6	9	12	12	17	33	35
Japan STA	0	0	0	0	0	0	1	2	1	2	2	3	3	3	3	3	2	4
Chinese AS	0	0	0	0	0	0	0	0	0	0	0	0	1	2	7	9	17	17
Tsinghua	0	0	0	0	0	0	0	0	0	4	5	7	10	18	19	23	31	35

### 3.4 Advanced Materials (World Class Patents)

Instit/ Year	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17
ETH Domain	1	1	2	4	3	4	5	4	6	8	9	8	14	15	16	30	42	57
CNRS	1	2	2	4	5	6	7	9	10	15	19	26	29	38	40	45	52	60
Fraunhofer	1	0	1	1	3	4	5	5	4	4	5	5	6	8	11	14	15	15
Oxford	0	0	0	0	0	1	1	1	1	1	1	1	2	2	1	2	9	7
Stanford	2	1	3	2	3	7	3	3	4	4	9	7	12	13	14	13	17	23
Harvard	1	1	1	3	5	7	13	9	21	13	16	17	20	22	27	42	48	58
MIT	6	10	12	18	18	26	31	19	32	52	68	50	85	67	109	109	103	126
California	2	5	8	15	7	11	11	13	21	27	32	36	46	51	56	74	135	151
Japan STA	0	0	0	2	3	4	6	9	11	10	10	10	12	15	14	19	23	28
Chinese AS	0	0	0	0	0	0	0	0	0	0	1	1	6	19	33	38	73	138
Tsinghua	0	0	0	0	1	0	2	4	8	19	32	65	78	97	117	140	155	173

### 3.5 Nanostructures (World Class Patents)

Instit/ Year	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17
ETH Domain	1	1	1	2	5	7	6	8	10	13	11	15	18	20	21	30	40	48
CNRS	0	0	0	0	3	3	6	9	12	20	25	34	39	54	55	58	63	76
Fraunhofer	0	0	0	1	3	3	5	5	4	5	7	9	11	11	15	16	19	21
Oxford	0	0	0	0	0	1	0	2	2	2	3	2	4	5	4	8	18	22
Stanford	0	0	2	2	2	3	3	3	4	5	13	14	18	19	22	21	29	36
Harvard	0	0	0	3	4	8	14	14	32	20	30	30	36	45	55	95	115	147
MIT	2	2	3	24	30	30	19	24	39	86	105	102	113	132	151	159	167	203
California	2	2	5	9	11	17	19	23	33	48	51	59	72	82	88	111	130	260
Japan STA	0	0	0	4	3	7	12	17	23	25	26	29	28	32	31	35	40	44
Chinese AS	0	0	0	0	0	0	0	0	0	0	1	1	6	23	38	44	76	95
Tsinghua	0	0	0	0	1	1	3	5	10	24	37	77	97	132	150	174	210	209

### 3.6 Additive Manufacturing (World Class Patents)

Instit/ Year	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17
ETH Domain	0	0	0	0	0	0	1	0	1	0	0	0	0	1	1	0	0	0
CNRS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	3
Fraunhofer	0	0	0	0	0	1	1	0	0	0	1	3	2	3	6	8	8	9
Oxford	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Stanford	0	0	0	0	2	1	1	1	1	2	2	3	4	4	3	3	3	5
Harvard	0	0	0	1	0	2	2	6	9	13	12	12	14	14	17	23	57	70
MIT	0	0	0	0	1	2	2	4	8	8	8	8	9	10	7	10	11	47
California	0	0	0	0	0	1	2	0	2	1	2	2	3	3	2	10	11	13
Japan STA	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1
Chinese AS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	10	8
Tsinghua	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	4	3

### 3.7 Mass Spectroscopy (World Class Patents)

Instit/ Year	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17
ETH Domain	0	0	0	0	0	0	0	0	0	0	1	1	2	5	7	5	10	12
CNRS	0	1	1	1	0	0	0	0	0	2	1	3	4	4	5	5	5	6
Fraunhofer	0	0	0	1	1	1	1	1	1	1	1	2	3	6	5	5	5	6
Oxford	0	0	0	0	0	0	0	0	0	0	0	1	1	2	3	3	2	7
Stanford	1	2	4	6	8	8	7	6	4	6	7	6	5	5	5	6	6	10
Harvard	0	0	0	0	0	1	1	3	3	4	5	1	8	2	3	10	10	11
MIT	0	2	2	1	2	4	4	3	8	9	6	5	8	8	10	12	13	12
California	1	1	1	1	2	5	10	12	12	11	11	9	14	14	15	17	17	18
Japan STA	0	0	0	0	1	1	2	2	1	2	4	2	2	1	1	1	1	3
Chinese AS	0	0	0	0	0	0	0	0	0	0	0	1	2	2	6	10	14	12
Tsinghua	0	0	0	0	0	0	0	0	0	0	0	3	3	11	9	12	10	19

### 3.8 Drones (World Class Patents)

Instit/ Year	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17
ETH Domain	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	8
CNRS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fraunhofer	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Oxford	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Stanford	0	0	0	1	1	0	1	1	0	1	2	1	1	0	0	1	1	1
Harvard	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MIT	0	0	0	0	0	0	0	0	0	0	2	1	3	1	1	2	2	4
California	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Japan STA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chinese AS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tsinghua	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1

### 3.9 Radiation Detectors (World Class Patents)

Instit/ Year	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17
ETH Domain	0	0	0	0	0	0	0	0	0	5	8	11	11	10	14	13	13	16
CNRS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fraunhofer	0	0	0	0	1	1	1	1	1	1	1	1	0	0	0	1	1	2
Oxford	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Stanford	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0
Harvard	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
MIT	0	0	0	0	1	1	0	0	0	0	1	0	2	2	2	1	3	4
California	0	0	0	0	1	0	0	0	0	0	1	1	1	1	1	1	1	1
Japan STA	0	0	0	1	1	1	1	1	2	2	2	1	2	1	1	1	2	1
Chinese AS	0	0	0	0	0	0	0	0	0	0	0	1	1	2	4	3	3	4
Tsinghua	0	0	0	0	0	0	0	0	0	0	1	2	2	3	6	8	9	12

### 3.10 Biosensors, Lab-on-a-chip, Bioprinting (World Class Patents)

Instit/ Year	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17
ETH Domain	0	0	1	1	1	3	3	3	3	4	5	5	5	5	7	7	15	16
CNRS	0	0	0	1	1	1	2	5	5	6	10	11	10	12	17	15	15	19
Fraunhofer	0	0	0	1	1	2	2	2	2	2	2	2	1	2	4	3	5	5
Oxford	0	0	0	0	0	1	0	0	0	0	1	1	1	2	3	5	5	10
Stanford	1	1	1	2	1	3	5	1	3	3	12	11	13	14	18	18	19	22
Harvard	1	1	1	4	7	8	15	20	26	20	20	22	26	31	40	69	86	123
MIT	0	1	5	8	8	13	12	20	12	27	30	14	15	19	36	28	50	61
California	1	2	4	6	5	9	12	15	20	21	25	29	37	43	48	56	67	74
Japan STA	0	0	0	0	2	2	4	4	4	5	6	5	5	5	5	6	7	7
Chinese AS	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	2	6	8
Tsinghua	0	0	1	1	3	2	3	5	5	5	5	4	5	7	8	9	10	9

### 3.11 Wearables, Bionics (World Class Patents)

Instit/ Year	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17
ETH Domain	0	0	1	0	0	1	1	1	1	1	1	1	4	4	6	6	7	9
CNRS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fraunhofer	0	0	0	0	0	0	0	0	0	0	1	1	1	2	3	2	4	5
Oxford	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Stanford	1	1	4	1	3	3	3	4	3	3	3	4	4	4	4	6	7	6
Harvard	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	11
MIT	1	3	3	2	2	4	3	3	2	4	7	5	6	8	11	12	12	32
California	0	0	0	1	0	1	0	0	2	2	4	5	7	8	13	13	21	24
Japan STA	0	0	0	0	0	0	0	1	1	0	0	1	1	1	1	1	1	1
Chinese AS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	3
Tsinghua	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

### 3.12 Radiation Diagnosis and Therapy (World Class Patents)

Instit/ Year	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17
ETH Domain	1	0	1	1	1	1	1	1	1	6	11	13	11	11	17	14	15	22
CNRS	0	1	1	1	0	0	0	0	1	0	0	2	1	3	3	5	7	7
Fraunhofer	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1	1	2
Oxford	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
Stanford	1	1	5	6	6	7	7	5	5	9	13	10	8	9	9	12	13	15
Harvard	0	0	0	0	0	0	0	1	6	6	7	3	4	5	5	8	9	7
MIT	0	1	2	2	2	3	3	4	5	9	11	8	12	9	14	14	16	16
California	6	1	1	7	5	5	12	15	16	20	18	19	21	22	25	28	30	33
Japan STA	0	0	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	0
Chinese AS	0	0	0	0	0	0	0	0	0	0	0	1	1	2	3	4	5	6
Tsinghua	0	0	0	0	0	1	0	1	1	5	4	8	10	11	16	17	22	25

### 3.13 Protein Engineering (World Class Patents)

Instit/ Year	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17
ETH Domain	1	0	6	12	4	9	8	7	7	7	8	9	13	14	28	22	30	40
CNRS	2	4	4	6	6	9	11	14	17	18	20	22	36	48	52	56	64	86
Fraunhofer	0	0	1	0	1	3	2	4	5	5	3	4	4	5	4	4	5	10
Oxford	0	2	2	2	5	5	8	8	9	8	10	8	12	13	15	20	23	47
Stanford	10	18	25	24	24	32	37	47	21	62	54	38	42	45	54	64	70	86
Harvard	7	2	2	5	10	17	32	39	49	46	60	33	41	50	65	167	225	288
MIT	7	13	16	21	26	31	38	38	45	57	81	70	80	86	102	127	170	218
California	58	80	81	96	105	141	73	78	90	107	111	117	129	133	151	182	204	232
Japan STA	0	0	0	1	2	8	9	11	11	9	9	8	8	11	12	13	15	15
Chinese AS	0	0	0	0	0	0	0	0	0	0	1	1	5	10	10	18	17	25
Tsinghua	0	0	1	1	3	6	3	5	5	5	6	4	8	8	12	11	12	12

### 3.14 Drug Discovery Systems (World Class Patents)

Instit/ Year	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17
ETH Domain	0	0	1	0	0	1	1	1	1	1	2	1	1	1	1	1	1	1
CNRS	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1
Fraunhofer	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Oxford	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Stanford	0	0	3	0	0	4	3	5	5	8	8	9	9	9	12	14	14	15
Harvard	0	0	0	0	2	2	2	2	2	2	2	2	4	4	10	8	13	42
MIT	0	0	1	2	2	4	3	1	2	1	3	2	3	3	5	5	11	28
California	0	0	1	3	6	6	8	10	9	10	16	15	14	12	16	21	18	23
Japan STA	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	1	0
Chinese AS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Tsinghua	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1

### 3.15 Classic organic pharmaceutically active substances (World Class Patents)

Instit/ Year	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17
ETH Domain	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
CNRS	0	2	3	4	2	2	2	2	4	3	4	9	9	10	11	11	12	12
Fraunhofer	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Oxford	0	0	0	0	0	0	0	0	0	0	1	1	1	0	1	2	1	1
Stanford	0	2	1	1	1	1	0	0	0	1	1	1	1	0	0	0	0	0
Harvard	1	0	1	1	1	1	1	0	2	2	3	4	2	4	3	4	3	15
MIT	1	0	1	2	1	1	1	1	1	1	1	2	2	2	3	2	3	4
California	1	1	1	1	1	3	3	4	4	6	7	6	9	9	9	13	10	11
Japan STA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chinese AS	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2	2	2	5
Tsinghua	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

### 3.16 Organic Perovskite Tandem Photovoltaics (World Class Patents)

Instit/ Year	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17
ETH Domain	0	0	1	0	1	2	1	1	2	3	5	5	8	9	10	12	15	24
CNRS	0	1	2	2	2	2	3	4	4	3	3	3	6	7	10	8	10	10
Fraunhofer	0	0	0	0	0	0	0	0	0	0	0	1	3	4	4	4	5	6
Oxford	0	1	1	2	3	3	5	4	5	6	5	5	5	6	6	9	10	16
Stanford	0	0	0	0	0	0	0	0	0	0	0	1	1	1	2	2	3	4
Harvard	0	0	0	0	1	2	3	3	2	2	4	4	5	6	6	6	6	6
MIT	0	0	0	0	1	0	2	3	1	7	2	3	4	4	5	6	6	13
California	0	0	0	3	3	3	2	3	3	5	7	8	10	9	12	14	15	17
Japan STA	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0
Chinese AS	0	0	0	0	0	0	0	0	0	0	0	1	4	4	3	5	10	11
Tsinghua	0	0	0	0	0	0	0	0	0	1	0	1	2	2	2	2	2	2

### 3.17 Waste Water, Biomass, Carbon Capture (World Class Patents)

Instit/ Year	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17
ETH Domain	0	0	1	1	2	3	3	1	6	8	5	6	8	8	8	9	14	14
CNRS	4	3	3	1	0	1	1	0	2	2	2	3	5	5	9	10	15	26
Fraunhofer	1	2	2	3	3	2	3	2	4	4	8	10	9	8	10	11	9	15
Oxford	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2
Stanford	0	0	0	0	1	2	0	1	3	4	1	2	3	4	4	5	5	7
Harvard	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	2	2
MIT	0	0	1	1	2	2	3	3	6	4	6	11	13	23	32	29	30	42
California	0	0	2	3	4	3	7	9	17	16	22	21	20	21	25	30	29	33
Japan STA	0	0	0	0	0	1	1	1	1	0	2	1	1	1	2	2	3	3
Chinese AS	0	0	0	0	0	0	0	0	0	0	0	1	12	17	23	38	62	97
Tsinghua	0	0	0	0	0	0	0	0	0	0	0	1	3	4	10	13	19	27

## 4 Patent classes for technology definitions

Patent documents are classified worldwide into specific patent classification classes depending upon their technological content. Technologies are defined by identifying the relevant patent classes. The following chapter lists the relevant patent classes per technology.

Three search procedures are used: the International Patent Classification (IPC) schema, the Cooperative Patent Classification System (CPC) and in rare cases by applying specific search terms.

The International Patent Classification (IPC) is implemented worldwide by all patent offices. Currently there are around 70,000 different classifications<sup>34</sup>.

The Cooperative Patent Classification System (CPC) is another important classification system. It was developed as a joint venture between the European Patent Office and the United States Patent and Trademark Office (USPTO), and implemented in 2013. The CPC is based upon the former European classification system ECLA, which is based in turn upon the International Patent Classification IPC. The CPC is more detailed than the IPC which allows for more precise and efficient patent searches. Many patent offices classify patent documents according to the CPC in addition to the IPC<sup>35</sup>.

The following chapter lists the relevant patent classes per defined technology and in some cases the additional search terms applied.

### 4.1 Security Elements

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(( IPC (smart) = (B29B 11, B32B 38, B41M 3/06, B41M 3/10, B41M 3/12, B41N 1, B41N 99, B42D 15/00, B42D 25, B42D 25/00, B42D 25/20, B42D 25/40, B44F 1, B65D 23/08, B65D 23/12, D21H 19, G02B, G03H, G07D 7, G09F 3/00) OR CPC (smart) = (B29B 11, B32B 38, B41M, B41N 1, B41N 3, B41N 99, B41N2207, B41N2210, B42D 15/00, B42D 25, B42D 25/00, B42D 25/40, B44F 1, B65D 23/008, B65D 23/14, D21H 19, G02B, G03H, G07D 7, G09F 3) ) AND ( Tag = SecurityPrinting_KW_03_18 OR Tag = SecurityPrinting-Companies ) ) OR ( CPC (smart) = (B41F 11/02, B41M 3/14, B42D 15/0013, B42D 15/0033, B42D 15/0053, B42D 25/23, B42D 25/24, B42D 25/25, B42D 25/26, B42D 25/27, B42D 25/28, B42D 25/285, B42D 25/29, B42D 25/30, B42D2033, B42D2035, B42D2037, G07D 7/0006, G07D 7/004, G07D 7/0046, G07D 7/005, G09F 3/04) OR IPC (smart) = (B41F 11/02, B41M 3/14, B42D 25/29, B42D 25/30, B44F 1/12, D21H 21/40, G09F 3/03, G09F 3/04) )
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PatBase Search Syntax (with INPADOC extension) = TAC=((securit\* or authenti\* or genuin\* or identit\* or ID or indicia or fiducia or anticounterfeit\* or antifraud\* or counterfeit\* or forger\* or fraud\* or tamper\* or prohibit\* or prevent\* or bank or promis\* or debt or pass or stock

<sup>34</sup> The IPC Database can be accessed via: <http://www.wipo.int/classifications/ipc/en/index.html>

<sup>35</sup> The CPC Database can be accessed via: [https://worldwide.espacenet.com/classification?locale=en\\_EP](https://worldwide.espacenet.com/classification?locale=en_EP)

or currency or borrower\* or currencies or security or securities or safe\* or identit\* or money)  
W3 (note\* or document? or certificate\* or certify or certified or certified or label\* or sticker\*  
or tag? or tagging\* or ticket? or print\* or stamp\* or emboss\* or offset\* or silkscreen\* or  
intaglio\* or gravur\*))

PatBase Search Syntax (with INPADOC extension) = TAC=((debenture\* or banknote\* or mon-  
ey\* or cash\* or cheque\* or passport\* or currencynote\* or credit\* or card? or financ\* or bond  
or bonds) near (print\* or stamp\* or emboss\* or offset\* or silkscreen\* or intaglio\* or gravur\*  
or siebdruck\* or flexo\*))

PatBase Search Syntax (with INPADOC extension) = TAC=((securit\* or authenti\* or genuin\* or  
identit\* or ID or indicia or fiducia or anticounterfeit\* or antifraud\* or counterfeit\* or forger\*  
or fraud\* or tamperproof\* ) W3 ((pharma\* or medi\*) w packag\*))

### Cooperative Patent Classification (CPC)

CPC/IPC/FI Symbols	Description
B	PERFORMING OPERATIONS; TRANSPORTING
B29	WORKING OF PLASTICS; WORKING OF SUBSTANCES IN A PLASTIC STATE, IN GENERAL (processing doughs A21C; working chocolate A23G; casting of metals B22; working cement, clay B28; chemical aspects, see section C, particularly C08; working glass C03B; candle making C11C5/02; making soap C11D13/00; manufacture of artificial filaments, threads, fibres, bristles or ribbons D01D, D01F; manufacture of articles from cellulosic fibrous suspensions or from papier-mâché D21J)
B29B	PREPARATION OR PRETREATMENT OF THE MATERIAL TO BE SHAPED; MAKING GRANULES OR PREFORMS; RECOVERY OF PLASTICS OR OTHER CONSTITUENTS OF WASTE MATERIAL CONTAINING PLASTICS
<u>B29B11/00</u>	Making preforms (B29C61/06 takes precedence {; combined with blow-moulding B29C49/02, with thermoforming B29C51/02; making preforms for manufacturing of light guides B29D11/00721})
B32	LAYERED PRODUCTS
B32B	LAYERED PRODUCTS, i.e. PRODUCTS BUILT-UP OF STRATA OF FLAT OR NON-FLAT, e.g. CELLULAR OR HONEYCOMB, FORM
<u>B32B38/00</u>	Ancillary operations in connection with laminating processes
B41	PRINTING; LINING MACHINES; TYPEWRITERS; STAMPS (reproduction or duplication of pictures or patterns by scanning and converting into electrical signals H04N)
B41F	PRINTING MACHINES OR PRESSES (machines for manufacturing footwear incorporating printing or embossing apparatus A43D, e.g. A43D8/26, A43D95/14; presses in general B30B; making of printing surfaces B41C, B41D; manifolding devices, office printing machines B41L; stencilling B41L, {B44D}; printing processes not dependent on the use of special machines B41M; duplicating or marking by sublimation or volatilisation of design B41M5/035; thermography B41M5/26; embossing decorations or marks B44B5/00; {applying transfers or decalcomanias B44C1/16}; handling thin or filamentary material B65H; electrography, electrophotography, magnetography G03G)
B41F11/00	Rotary presses or machines having forme cylinders carrying a plurality of printing surfaces, or for performing letterpress, lithographic, or intaglio processes selectively or in combination

CPC/IPC/FI Symbols	Description
<u>B41F11/02</u>	. for securities (security printing B41M3/14)
<u>B41M</u>	PRINTING, DUPLICATING, MARKING, OR COPYING PROCESSES; COLOUR PRINTING, (correction of typographical errors B41J; processes for applying transfer pictures or the like B44C1/16; fluid media for correction of typographical errors by coating C09D10/00; printing textiles D06P)
B41M3/00	Printing processes to produce particular kinds of printed work, e.g. patterns (special designs or pictures per se B44F; {printing apparatus or machines of special type or for particular purposes B41F17/00; manufacturing organic semiconductor devices using printing techniques H01L51/0004}; manufacturing printed circuits using printing techniques H05K3/12)
<u>B41M3/06</u>	. Veined printings; Fluorescent printings; Stereoscopic images; Imitated patterns, e.g. tissues, textiles
<u>B41M3/10</u>	. Watermarks
<u>B41M3/12</u>	. Transfer pictures or the like, e.g. decalcomanias {{processes for producing decorative surface effects B44C1/00; B41M5/0256 takes precedence}}
<u>B41M3/14</u>	. Security printing {{securities B42D25/29}}
B41N	PRINTING PLATES OR FOILS (photosensitive material G03); MATERIALS FOR SURFACES USED IN PRINTING MACHINES FOR PRINTING, INKING, DAMPING, OR THE LIKE; PREPARING SUCH SURFACES FOR USE AND CONSERVING THEM {In this subclass the COPES System is used}
<u>B41N1/00</u>	Printing plates or foils; Materials therefor
<u>B41N3/00</u>	Preparing for use and conserving printing surfaces
<u>B41N99/00</u>	Subject matter not provided for in other groups of this subclass
<u>B41N2207/00</u>	Location or type of the layers in shells for rollers of printing machines
<u>B41N2210/00</u>	Location or type of the layers in multi-layer blankets or like coverings
B42	BOOKBINDING; ALBUMS; FILES; SPECIAL PRINTED MATTER
B42D	BOOKS; BOOK COVERS; LOOSE LEAVES; PRINTED MATTER CHARACTERISED BY IDENTIFICATION OR SECURITY FEATURES; PRINTED MATTER OF SPECIAL FORMAT OR STYLE NOT OTHERWISE PROVIDED FOR; DEVICES FOR USE THEREWITH AND NOT OTHERWISE PROVIDED FOR; MOVABLE-STRIP WRITING OR READING APPARATUS
<u>B42D15/00</u>	Printed matter of special format or style not otherwise provided for
<u>B42D15/0033</u>	. {Owner certificates, insurance policies, guarantees}
<u>B42D15/0053</u>	. {Forms specially designed for commercial use, e.g. bills, receipts, offer or order sheets, coupons}
<u>B42D25/00</u>	Information-bearing cards or sheet-like structures characterised by identification or security features; Manufacture thereof (printing processes to produce identification or security features B41M3/14)
<u>B42D25/20</u>	. characterised by a particular use or purpose
<u>B42D25/23</u>	.. Identity cards
<u>B42D25/24</u>	.. Passports
<u>B42D25/25</u>	.. Public transport tickets (apparatus for printing and issuing G07B)
<u>B42D25/26</u>	.. Entrance cards; Admission tickets
<u>B42D25/27</u>	.. Lots, e.g. lottery tickets
<u>B42D25/28</u>	.. for use in medical treatment or therapy
<u>B42D25/285</u>	.. {Gift cards}
<u>B42D25/29</u>	.. Securities; Bank notes
<u>B42D25/30</u>	. Identification or security features, e.g. for preventing forgery
<u>B42D25/40</u>	. Manufacture
<u>B42D2033/00</u>	Structure or construction of identity, credit, cheque or like information-bearing cards
<u>B42D2035/00</u>	Nature or shape of the markings provided on identity, credit, cheque

CPC/IPC/FI Symbols	Description
	or like information-bearing cards
B44	DECORATIVE ARTS
B44F	SPECIAL DESIGNS OR PICTURES
<u>B44F1/00</u>	Designs or pictures characterised by special or unusual light effects
B65	CONVEYING; PACKING; STORING; HANDLING THIN OR FILAMENTARY MATERIAL
B65D	CONTAINERS FOR STORAGE OR TRANSPORT OF ARTICLES OR MATERIALS, e.g. BAGS, BARRELS, BOTTLES, BOXES, CANS, CARTONS, CRATES, DRUMS, JARS, TANKS, HOPPERS, FORWARDING CONTAINERS; ACCESSORIES, CLOSURES, OR FITTINGS THEREFOR; PACKAGING ELEMENTS; PACKAGES
B65D23/00	Details of bottles or jars not otherwise provided for (closure-securing elements B65D45/00)
B65D23/006	. {Means for indicating refilling of the container}
<u>B65D23/008</u>	.. {by means of a label, e.g. tearable, light sensitive}
<u>B65D23/08</u>	. Coverings or external coatings (wrappers B65D65/00)
<u>B65D23/12</u>	. Means for the attachment of smaller articles
<u>B65D23/14</u>	.. of tags {, labels, cards, coupons, decorations or the like (B65D23/008 takes precedence)}
D	TEXTILES; PAPER
D21	PAPER-MAKING; PRODUCTION OF CELLULOSE
D21H	PULP COMPOSITIONS; PREPARATION THEREOF NOT COVERED BY SUBCLASSES D21C OR D21D; IMPREGNATING OR COATING OF PAPER; TREATMENT OF FINISHED PAPER NOT COVERED BY CLASS B31 OR SUBCLASS D21G; PAPER NOT OTHERWISE PROVIDED FOR
<u>D21H19/00</u>	Coated paper (coated fibreboard D21J1/08); Coating material (recording sheets characterised by the coating used to improve ink, dye or pigment receptivity B41M5/50)
D21H21/00	Non-fibrous material added to the pulp, characterised by its function, form or properties; Paper-impregnating or coating material, characterised by its function, form or properties
D21H21/14	. characterised by function or properties in or on the paper (D21H19/66, D21H27/02 take precedence)
<u>D21H21/40</u>	.. Agents facilitating proof of genuineness or preventing fraudulent alteration, e.g. for security paper (watermarking B41M3/10, D21F1/44; security printing B41M3/14; securities or banknotes characterised by colour effects B42D25/29, B42D25/30; testing paper currency or valuable papers for genuineness G07D7/00)
G	PHYSICS
G07	CHECKING-DEVICES
G07D	HANDLING OF COINS OR OF PAPER CURRENCY OR SIMILAR VALUABLE PAPERS, e.g. TESTING, SORTING BY DENOMINATIONS, COUNTING, DISPENSING, CHANGING OR DEPOSITING
<u>G07D7/00</u>	Testing specially adapted to determine the identity or genuineness of paper currency or similar valuable papers or for segregating those which are alien to a currency or otherwise unacceptable
<u>G07D7/004</u>	. using digital security elements, e.g. information coded on a magnetic thread or strip
<u>G07D7/005</u>	. Testing security markings invisible to the naked eye, e.g. verifying thickened lines or unobtrusive markings or alterations
G09	EDUCATION; CRYPTOGRAPHY; DISPLAY; ADVERTISING; SEALS
G09F	DISPLAYING; ADVERTISING; SIGNS; LABELS OR NAME-PLATES; SEALS (display cases A47F; designs or pictures characterised by special or unusual effects, e.g. changing B44F1/00; disposition of road signs or traffic signals E01F9/00; lighting in general F21; arrangements for controlling light beams G02F1/00; visible signalling arrangements or devices G08B5/00; traffic control sys-

CPC/IPC/FI Symbols	Description
	tems G08G; arrangements or circuits for control of indicating devices using static means to present variable information G09G, {G06F3/14}; static indicating arrangements comprising integral associations of a plurality of light sources H01J, H01K, H01L, H05B33/12)
<u>G09F3/00</u>	Labels, tag tickets, or similar identification or indication means (medals or badges A44C3/00; making labels B31D1/02; sheets temporarily attached together B42F; labelling B65C; labels on record carriers G11B23/38, G11B23/40); Seals; Postage or like stamps
G09F3/02	. Forms or constructions (layered products B32B)
<u>G09F3/03</u>	.. of security seals {(means for indicating unauthorised opening of container closures B65D, e.g. B65D27/30, B65D55/02; theft deterrent tags E05B73/0017)}
<u>G09F3/04</u>	. to be fastened or secured by the material of the label itself, e.g. by thermo-adhesion (by a separate adhesive layer G09F3/10)
<u>G02B</u>	OPTICAL ELEMENTS, SYSTEMS, OR APPARATUS (G02F takes precedence; measuring-instruments, see the relevant subclass of G01, e.g. optical rangefinders G01C; testing of optical elements, systems, or apparatus G01M11/00; spectacles G02C; sound lenses G10K11/30; electron and ion "optics" H01J; X-ray "optics" H01J, H05G1/00; optical elements structurally combined with electric discharge tubes H01J5/16, H01J29/89, H01J37/22; microwave "optics" H01Q; combination of optical elements with television receivers H04N5/72; heating arrangements specially adapted for transparent or reflecting areas H05B3/84; {optical apparatus 42H})
<u>G03H</u>	HOLOGRAPHIC PROCESSES OR APPARATUS (holograms, e.g. point holograms, used as ordinary optical elements G02B5/32; producing stereoscopic or other three-dimensional effects G02B27/22; diffraction-grating systems G02B27/44; systems using moiré fringes G02B27/60; optical logic elements G02F3/00; stereo-photography G03B35/00; photosensitive materials or processes for photographic purposes G03C; {stereo-photographic or similar processes G03C9/00}; apparatus for processing exposed photographic materials G03D; analogue computers performing mathematical operations with the aid of optical elements G06E3/00; authentication by radiation, of concealed information carried by holograms or diffraction gratings G06K19/16; holographic storage G11B7/0065, G11C13/04; {stereoscopic or other three dimensional effects in television systems H04N13/00})

### International Patent Classification (IPC)

IPC Symbols	Description
G	PHYSICS
<b>G02B</b>	OPTICAL ELEMENTS, SYSTEMS, OR APPARATUS (G02F takes precedence; optical elements specially adapted for use in lighting devices or systems thereof F21V1/00 to F21V13/00; measuring-instruments, see the relevant subclass of class G01, e.g. optical rangefinders G01C; testing of optical elements, systems, or apparatus G01M11/00; spectacles G02C; apparatus or arrangements for taking photographs or for projecting or viewing them G03B; sound lenses G10K11/30; electron and ion "optics" H01J; X-ray "optics" H01J, H05G1/00; optical elements structurally combined with electric discharge tubes H01J5/16, H01J29/89, H01J37/22; microwave "optics" H01Q; combination of optical elements with television receivers H04N5/72; optical systems or arrangements in colour television systems H04N9/00; heating arrangements specially adapted for transparent or reflecting areas H05B3/84) [1,7]
<b>G03H</b>	HOLOGRAPHIC PROCESSES OR APPARATUS (holograms, e.g. point holograms, used as ordinary optical elements G02B5/32; analogue computers performing mathematical operations with the aid of optical elements G06E3/00; holographic storage G11B7/0065, G11C13/04) [2]
B	PERFORMING OPERATIONS; TRANSPORTING

IPC Symbols	Description
<b>B41M</b>	PRINTING, DUPLICATING, MARKING, OR COPYING PROCESSES; COLOUR PRINTING (correction of typographical errors B41J; processes for applying transfer pictures or the like B44C1/16; fluid media for correction of typographical errors by coating C09D10/00; printing textiles D06P)

## 4.2 Quantum Technology

(( ( IPC (smart) = (B82Y 10/00, G06N 99) OR CPC (smart) = (B82Y 10/00, G06N 99/002, Y10S 977/933) ) AND Words in abstract and title = ("quantum\*" OR "qubit\*") ) OR ( Tag = Systems\_Quantum\_Technologies\_02\_18 (4) AND Tag = (Computer Technology\_11\_17, Digital Communication\_11\_17) ) OR Words in abstract and title = (NEAR(("quantum\*", "computin\*"), 5) OR "qubit\*") )

Systems\_Quantum\_Technologies\_02\_18

Filter: ( Words in abstract and title = "quantum\*" OR (NEAR(("single\*", "photon\*"), 2, TRUE)) OR (NEAR(("single\*", "electron\*"), 2, TRUE)) OR PatBase search syntax (w/o INPADOC extension) = TAC=(quantum wf3 (comput\* or sens\* or crypto\* or simult\* or metrolo\* or imaging\* or circuit\* or key or dot or dots or bit or bits) or qubit\* or (single wf2 (photon\* or electron\*))) )

### Cooperative Patent Classification (CPC)

CPC/IPC/FI Symbols	Description
B	PERFORMING OPERATIONS; TRANSPORTING
B82	NANOTECHNOLOGY
B82Y	SPECIFIC USES OR APPLICATIONS OF NANOSTRUCTURES; MEASUREMENT OR ANALYSIS OF NANOSTRUCTURES; MANUFACTURE OR TREATMENT OF NANOSTRUCTURES
<u>B82Y10/00</u>	Nanotechnology for information processing, storage or transmission, e.g. quantum computing or single electron logic
G	PHYSICS
G06	COMPUTING; CALCULATING; COUNTING (score computers for games A63B71/06, A63D15/20, A63F1/18; combinations of writing implements with computing devices B43K29/08)
G06N	COMPUTER SYSTEMS BASED ON SPECIFIC COMPUTATIONAL MODELS
<u>G06N99/00</u>	Subject matter not provided for in other groups of this subclass
<u>G06N99/002</u>	. {Quantum computers, i.e. information processing by using quantum superposition, coherence, decoherence, entanglement, nonlocality, teleportation}
Y	GENERAL TAGGING OF NEW TECHNOLOGICAL DEVELOPMENTS; GENERAL TAGGING OF CROSS-SECTIONAL TECHNOLOGIES SPANNING OVER SEVERAL SECTIONS OF THE IPC; TECHNICAL SUBJECTS COVERED BY FORMER USPC CROSS-REFERENCE ART COLLECTIONS [XRACs] AND DIGESTS
Y10	TECHNICAL SUBJECTS COVERED BY FORMER USPC
Y10S	TECHNICAL SUBJECTS COVERED BY FORMER USPC CROSS-REFERENCE ART COLLECTIONS [XRACs] AND DIGESTS
Y10S977/00	Nanotechnology
Y10S977/902	. Specified use of nanostructure

CPC/IPC/FI Symbols	Description
Y10S977/932	.. for electronic or optoelectronic application
<u>Y10S977/933</u>	... Spintronics or quantum computing

### 4.3 Image Analysis

( IPC (smart) = (G06T, G06T 1, G06T 3, G06T 5, G06T 7, G06T 9, G06T 11, G06T 13, G06T 15, G06T 17, G06T 19, G06Tmiss) OR CPC (smart) = (G06T, G06T 1, G06T 3, G06T 5, G06T 7, G06T 9, G06T 11, G06T 13, G06T 15, G06T 17, G06T 19, G06T2200, G06T2201, G06T2207, G06T2210, G06T2211, G06T2213, G06T2215, G06T2219) )

#### Cooperative Patent Classification (CPC)

CPC/IPC/FI Symbols	Description
G	PHYSICS
G06	COMPUTING; CALCULATING; COUNTING (score computers for games A63B71/06, A63D15/20, A63F1/18; combinations of writing implements with computing devices B43K29/08)
<u>G06T</u>	IMAGE DATA PROCESSING OR GENERATION, IN GENERAL
<u>G06T1/00</u>	General purpose image data processing
<u>G06T3/00</u>	Geometric image transformation in the plane of the image, e.g. from bit-mapped to bit-mapped creating a different image
<u>G06T5/00</u>	Image enhancement or restoration, e.g. from bit-mapped to bit-mapped creating a similar image
<u>G06T7/00</u>	Image analysis
<u>G06T9/00</u>	Image coding, e.g. from bit-mapped to non bit-mapped (bandwidth or redundancy reduction for static pictures H04N1/41; coding or decoding of static colour picture signals H04N1/64; methods or arrangements for coding, decoding, compressing or decompressing digital video signals H04N19/00)
<u>G06T11/00</u>	2D [Two Dimensional] image generation
<u>G06T13/00</u>	Animation
<u>G06T15/00</u>	3D [Three Dimensional] image rendering
<u>G06T17/00</u>	Three dimensional [3D] modelling, e.g. data description of 3D objects
<u>G06T19/00</u>	Manipulating 3D models or images for computer graphics
<u>G06T2200/00</u>	Indexing scheme for image data processing or generation, in general
<u>G06T2201/00</u>	General purpose image data processing
<u>G06T2207/00</u>	Indexing scheme for image analysis or image enhancement
<u>G06T2210/00</u>	Indexing scheme for image generation or computer graphics
<u>G06T2211/00</u>	Image generation
<u>G06T2213/00</u>	Indexing scheme for animation
<u>G06T2215/00</u>	Indexing scheme for image rendering
<u>G06T2219/00</u>	Indexing scheme for manipulating 3D models or images for computer graphics

## 4.4 Advanced Materials

(( Tag = (Material\_Carbon\_Graphene\_03\_17, Material\_Nanomaterial\_01\_18, Material\_SmartPolymer\_02\_18) OR CPC (smart) = (B01J 13/0091, B32B2266/126, C01B 33/1585, C01B2204, C01B2204/02, C04B 14/028, C04B 14/064, C04B 14/302, C08G2101/0091, C08J2205/026, F17C2203/0325, Y10S 977/734) OR Words in abstract and title = (NEAR(("bamboo\*", "composite\*"), 3) OR NEAR(("natural\*", "fib\*", "composite\*"), 5) OR NEAR(("kokos\*", "composite\*"), 3) OR NEAR(("hemp", "composite\*"), 3) OR NEAR(("sisal", "composite\*"), 3) OR NEAR(("wood", "composite\*"), 3)) OR IPC (smart) = C01B 33/16 ) OR Words in abstract and title = ("xerogel\*" OR "aerogel\*" OR "graphene\*" OR NEAR(("bamboo\*", "composit\*"), 3) OR NEAR(("touch\*", "sensiti\*", "polymer\*"), 5) OR NEAR(("electro\*", "sensi-ti\*", "polymer\*"), 5) OR "nanowire\*" OR "nanopyramid\*" OR NEAR(("shape\*", "memory\*"), 5)))

### Smart Polymer

( CPC (smart) = (H01L 41/193, H01L 41/45, H04R 17/005, H04R 17/025, Y10S 310/80) OR IPC (smart) = (H01L 41/193, H01L 41/45) ) OR Words in abstract and title = "electro-adhesiv\*" OR NEAR(("piezo\*", "polymer\*"), 3)

### Carbon Graphene

(((( CPC (smart) = (C01B 31/00, C01B 31/02, C01B2202, C01B2204, C01B2204/00, C01B2204/02, C01B2204/04, C01B2204/06, C01B2204/20, D01F 9/12) OR IPC (smart) = (C01B 31/00, C01B 31/02, D01F 9/12) ))) OR ( CPC (smart) = (B82) AND Words in abstract and title = "carbon" OR "graphen" OR "graphene\*" ))

### Nano\_Material

( Words in abstract and title = ((NEAR(("nano", "material\*"), 5))) OR ("nanomaterial\*" OR "nanotube\*" OR "nanowire\*" OR "nanorod\*" AND " or nanocomposite\*") OR (NEAR(("nano\*", "particle\*"), 5) OR (NEAR(("nano\*", "composite\*"), 5) OR (NEAR(("nano\*", "powder\*"), 5) OR (NEAR(("nano\*", "agglomerate\*"), 5) OR "nanoparticle\*" OR PatBase search syntax (w/o INPADOC extension) = TAC=nanoparticle\* OR nanoparticulat\* OR nanopartikel\* OR nanorod\* OR nanowire\* OR nanocluster\* OR nanocomposite\* OR nanopowder\* OR nanoagglomerate\* OR nanocrystal\* and SC=(B22F1\* or B22F9\* or c22c\* or c04B\* or b82\* or c01 or c03) OR Words in abstract and title = "nanoparticle\*" OR "nanoparticulat\*" OR "nanopartikel\*" OR "nanorod\*" OR "nanowire\*" OR "nanocluster\*" OR "nanocomposite\*" OR "nanopowder\*" OR "nanoagglomerate\*" OR "nanocrystal\*" ) AND ( IPC (smart) = (B22F 1, B22F 9, B82, C01, C03, C04B, C22C) OR CPC (smart) = (A61K 9/0092, A61K 9/14, B22F 1, B22F 9, B82, C01, C01P2004/64, C03, C04, C22C, Y10S 977) )

### Cooperative Patent Classification (CPC)

CPC/IPC/FI Symbols	Description
B	PERFORMING OPERATIONS; TRANSPORTING
B01	PHYSICAL OR CHEMICAL PROCESSES OR APPARATUS IN GENERAL (furnaces, kilns, ovens, retorts in general F27)
B01J	CHEMICAL OR PHYSICAL PROCESSES, e.g. CATALYSIS OR COLLOID CHEMISTRY; THEIR RELEVANT APPARATUS
B01J13/00	Colloid chemistry, e.g. the production of colloidal materials or their solutions, not otherwise provided for; Making microcapsules or

CPC/IPC/FI Symbols	Description
	microballoons
<u>B01J13/0091</u>	. {Preparation of aerogels, e.g. xerogels}
B32	LAYERED PRODUCTS
B32B	LAYERED PRODUCTS, i.e. PRODUCTS BUILT-UP OF STRATA OF FLAT OR NON-FLAT, e.g. CELLULAR OR HONEYCOMB, FORM
B32B2266/00	Composition of foam
B32B2266/12	. Gel
<u>B32B2266/126</u>	.. Aerogel, i.e. a supercritically dried gel
C	CHEMISTRY; METALLURGY
C01	INORGANIC CHEMISTRY (processing powders of inorganic compounds preparatory to the manufacturing of ceramic products C04B35/00; fermentation or enzyme-using processes for the preparation of elements or inorganic compounds except carbon dioxide C12P3/00; obtaining metal compounds from mixtures, e.g. ores, which are intermediate compounds in a metallurgical process for obtaining a free metal C21B, C22B; production of non-metallic elements or inorganic compounds by electrolysis or electrophoresis C25B)
C01B	NON-METALLIC ELEMENTS; COMPOUNDS THEREOF; {MET-ALLOIDS OR COMPOUNDS THEREOF NOT COVERED BY SUBCLASS C01C}
C01B33/00	Silicon; Compounds thereof {{C01B6/00,}C01B21/00, C01B23/00 take precedence; persilicates C01B15/14; carbides C01B32/956)
C01B33/113	. Silicon oxides; Hydrates thereof {(preparing monoxide by reduction of siliceous material C01B33/182)}
C01B33/12	.. Silica; Hydrates thereof, e.g. lepidic silicic acid
C01B33/14	... Colloidal silica, e.g. dispersions, gels, sols
C01B33/157	.... After-treatment of gels
C01B33/158	..... Purification; Drying; Dehydrating
<u>C01B33/1585</u>	..... {Dehydration into aerogels}
<u>C01B2202/00</u>	Structure or properties of carbon nanotubes
<u>C01B2204/00</u>	Structure or properties of graphene
<u>C01B2204/02</u>	. Single layer graphene
<u>C01B2204/04</u>	. Specific amount of layers or specific thickness
<u>C01B2204/06</u>	. Graphene nanoribbons
<u>C01B2204/20</u>	. Graphene characterized by its properties
C04	CEMENTS; CONCRETE; ARTIFICIAL STONE; CERAMICS; REFRACTORIES (alloys based on refractory metals C22C)
C04B	LIME, MAGNESIA; SLAG; CEMENTS; COMPOSITIONS THEREOF, e.g. MORTARS, CONCRETE OR LIKE BUILDING MATERIALS; ARTIFICIAL STONE {(roofing granules E04D7/005)}; CERAMICS (devitrified glass-ceramics C03C10/00); REFRACTORIES; TREATMENT OF NATURAL STONE
C04B14/00	Use of inorganic materials as fillers, e.g. pigments, for mortars, concrete or artificial stone; Treatment of inorganic materials specially adapted to enhance their filling properties in mortars, concrete or artificial stone (expanding or defibrillating materials C04B20/00)
C04B14/02	. Granular materials {, e.g. microballoons}
C04B14/022	.. {Carbon}
C04B14/026	... {of particular shape, e.g. nanotubes}
<u>C04B14/028</u>	.... {Carbon aerogels}
C04B14/04	.. Silica-rich materials; Silicates
C04B14/06	... Quartz; Sand
<u>C04B14/064</u>	.... {Silica aerogel}
C04B14/30	.. Oxides other than silica {(ferrites C04B14/363)}

CPC/IPC/FI Symbols	Description
C04B14/301	... {porous or hollow}
<u>C04B14/302</u>	.... {Aerogels}
C08	ORGANIC MACROMOLECULAR COMPOUNDS; THEIR PREPARATION OR CHEMICAL WORKING-UP; COMPOSITIONS BASED THEREON (manufacture or treatment of artificial threads, fibres, bristles or ribbons D01)
C08G	MACROMOLECULAR COMPOUNDS OBTAINED OTHERWISE THAN BY REACTIONS ONLY INVOLVING UNSATURATED CARBON-TO-CARBON BONDS
C08G2101/00	Foams
<u>C08G2101/0091</u>	. {Aerogels; Xerogels}
C08J	WORKING-UP; GENERAL PROCESSES OF COMPOUNDING; AFTER-TREATMENT NOT COVERED BY SUBCLASSES C08B, C08C, C08F, C08G (mechanical aspects B29; layered products, manufacture thereof B32B; treatment of macromolecular material specially adapted to enhance its filling properties in mortars, concrete or artificial stone C04B16/04, C04B18/20, C04B20/00; treatment of textiles D06)
C08J2205/00	Foams characterised by their properties
C08J2205/02	. the finished foam itself being a gel or a gel being temporarily formed when processing the foamable composition
<u>C08J2205/026</u>	.. Aerogel, i.e. a supercritically dried gel
D	TEXTILES; PAPER
D01	NATURAL OR ARTIFICIAL THREADS OR FIBRES; SPINNING (metal threads B21; fibres or filaments of softened glass, minerals, or slag C03B37/00; yarns D02)
D01F	CHEMICAL FEATURES IN THE MANUFACTURE OF ARTIFICIAL FILAMENTS, THREADS, FIBRES, BRISTLES OR RIBBONS; APPARATUS SPECIALLY ADAPTED FOR THE MANUFACTURE OF CARBON FILAMENTS
D01F9/00	Artificial filaments or the like of other substances; Manufacture thereof; Apparatus specially adapted for the manufacture of carbon filaments
D01F9/08	. of inorganic material (from softened glass, minerals or slags C03B37/00; {obtaining ceramic fibres C04B35/62227}; incandescent bodies F21H, H01K1/02, H01K3/02)
<u>D01F9/12</u>	.. Carbon filaments; Apparatus specially adapted for the manufacture thereof {(with fullerene structure, e.g. carbon nanotubes C01B32/15)}
F	MECHANICAL ENGINEERING; LIGHTING; HEATING; WEAPONS; BLASTING
F17	STORING OF DISTRIBUTING GASES OR LIQUIDS (water supply E03B)
F17C	VESSELS FOR CONTAINING OR STORING COMPRESSED, LIQUEFIED OR SOLIDIFIED GASES; FIXED-CAPACITY GAS-HOLDERS; FILLING VESSELS WITH, OR DISCHARGING FROM VESSELS, COMPRESSED, LIQUEFIED, OR SOLIDIFIED GASES (storing fluids in natural or artificial cavities or chambers in the earth B65G5/00; construction or assembling of bulk storage containers employing civil-engineering techniques E04H7/00; variable-capacity gas-holders F17B; liquefaction or refrigeration machines, plants, or systems F25)
F17C2203/00	Vessel construction, in particular walls or details thereof
F17C2203/03	. Thermal insulations
F17C2203/0304	.. by solid means
<u>F17C2203/0325</u>	... Aerogel
H	ELECTRICITY
H01	BASIC ELECTRIC ELEMENTS
H01L	SEMICONDUCTOR DEVICES; ELECTRIC SOLID STATE DE-

CPC/IPC/FI Symbols	Description
	VICES NOT OTHERWISE PROVIDED FOR (use of semiconductor devices for measuring G01; resistors in general H01C; magnets, inductors {in general} , transformers H01F; capacitors in general H01G; electrolytic devices H01G9/00; batteries, accumulators H01M; waveguides, resonators or lines of the waveguide type H01P; line connectors, current collectors H01R; stimulated emission devices H01S; electromechanical resonators H03H; loudspeakers, microphones, gramophone pick-ups or like acoustic electromechanical transducers H04R; electric light sources in general H05B; printed circuits, hybrid circuits, casings or constructional details of electric apparatus, manufacture of assemblages of electrical components H05K; use of semiconductor devices in circuits having a particular application, see the subclass for the application)
H01L41/00	Piezo-electric devices in general; Electrostrictive devices in general; Magnetostrictive devices in general; Processes or apparatus specially adapted for the manufacture or treatment thereof or of parts thereof; Details thereof (devices consisting of a plurality of solid-state components formed in or on a common substrate H01L27/00)
H01L41/16	. Selection of materials
H01L41/18	.. for piezo-electric or electrostrictive devices {, e.g. bulk piezo-electric crystals}
<u>H01L41/193</u>	... Macromolecular compositions {, e.g. piezo-electric polymers}
H01L41/22	. Processes or apparatus specially adapted for the assembly, manufacture or treatment of piezo-electric or electrostrictive devices or of parts thereof
H01L41/35	.. Forming piezo-electric or electrostrictive materials
<u>H01L41/45</u>	... Organic materials
H04	ELECTRIC COMMUNICATION TECHNIQUE
H04R	LOUDSPEAKERS, MICROPHONES, GRAMOPHONE PICK-UPS OR LIKE ACOUSTIC ELECTROMECHANICAL TRANSDUCERS; DEAF-AID SETS; PUBLIC ADDRESS SYSTEMS (generating mechanical vibrations in general B06B; transducers for measuring particular variables G01; transducers in clocks G04; producing sounds with frequency not determined by supply frequency G10K; transducers in recording or reproducing heads G11B; transducers in motors H02)
H04R17/00	Piezo-electric transducers; Electrostrictive transducers (piezo-electric or electrostrictive elements in general H01L41/00; details of piezo-electric or electrostrictive motors, generators or positioners {H01L41/00})
<u>H04R17/005</u>	. {using a piezo-electric polymer}
H04R17/02	. Microphones
<u>H04R17/025</u>	.. {using a piezo-electric polymer}
Y	GENERAL TAGGING OF NEW TECHNOLOGICAL DEVELOPMENTS; GENERAL TAGGING OF CROSS-SECTIONAL TECHNOLOGIES SPANNING OVER SEVERAL SECTIONS OF THE IPC; TECHNICAL SUBJECTS COVERED BY FORMER USPC CROSS-REFERENCE ART COLLECTIONS [XRACs] AND DIGESTS
Y10	TECHNICAL SUBJECTS COVERED BY FORMER USPC
Y10S	TECHNICAL SUBJECTS COVERED BY FORMER USPC CROSS-REFERENCE ART COLLECTIONS [XRACs] AND DIGESTS
Y10S310/00	Electrical generator or motor structure
<u>Y10S310/80</u>	. Piezoelectric polymers, e.g. PVDF
Y10S977/00	Nanotechnology
Y10S977/70	. Nanostructure
<u>Y10S977/734</u>	.. Fullerenes, i.e. graphene-based structures, such as nanohorns, nanococoons, nanoscrolls or fullerene-like structures, e.g. WS2 or

CPC/IPC/FI Symbols	Description
	MoS2 chalcogenide nanotubes, planar C3N4, etc.
<b>B82</b>	NANOTECHNOLOGY

## Nanomaterial

### International Patent Classification (IPC)

IPC Symbols	Description
B	PERFORMING OPERATIONS; TRANSPORTING
<b>B82</b>	NANOTECHNOLOGY [7]

### Cooperative Patent Classification (CPC)

CPC/IPC/FI Symbols	Description
A	HUMAN NECESSITIES
A61	MEDICAL OR VETERINARY SCIENCE; HYGIENE
A61K	PREPARATIONS FOR MEDICAL, DENTAL, OR TOILET PURPOSES (devices or methods specially adapted for bringing pharmaceutical products into particular physical or administering forms A61J3/00; chemical aspects of, or use of materials for deodorisation of air, for disinfection or sterilisation, or for bandages, dressings, absorbent pads or surgical articles A61L {; compounds per se C01, C07, C08, C12N;} soap compositions C11D {; microorganisms per se C12N})
A61K9/00	Medicinal preparations characterised by special physical form (nuclear magnetic resonance contrast preparations or magnetic resonance imaging contrast preparations A61K49/18; preparations containing radioactive substances A61K51/12)
A61K9/0087	. {Galenic forms not covered by A61K9/02 - A61K9/7023}
<u>A61K9/0092</u>	.. {Hollow drug-filled fibres, tubes of the core-shell type, coated fibres, coated rods, microtubules, nanotubes (fibres of the matrix type containing drug A61K9/70)}
<u>A61K9/14</u>	. Particulate form, e.g. powders, {Processes for size reducing of pure drugs or the resulting products, Pure drug nanoparticles (microspheres A61K9/16; microcapsules A61K9/50; nanocapsules, nanoparticles of the matrix type A61K9/51)}
B	PERFORMING OPERATIONS; TRANSPORTING
B22	CASTING; POWDER METALLURGY
B22F	WORKING METALLIC POWDER; MANUFACTURE OF ARTICLES FROM METALLIC POWDER; MAKING METALLIC POWDER (processes or devices for granulating materials in general B01J2/00; making ceramics by compacting or sintering C04B, e.g. C04B35/64; for the production of metals as such, see class C22; reduction or decomposition of metal compounds in general C22B; making alloys by powder metallurgy C22C; electrolytic production of metal powder C25C5/00)
<u>B22F1/00</u>	Special treatment of metallic powder, e.g. to facilitate working, to improve properties {(treatment of powder by mechanical means, e.g. by grinding, milling, rolling B22F9/04)}; Metallic powders per se, e.g. mixtures of particles of different composition (C04, C08 take precedence; {amorphous powder B22F9/002})
<u>B22F9/00</u>	Making metallic powder or suspensions thereof
C	CHEMISTRY; METALLURGY
<u>C01</u>	INORGANIC CHEMISTRY (processing powders of inorganic compounds preparatory to the manufacturing of ceramic products C04B35/00; fermentation or enzyme-using processes for the preparation of elements or inorganic compounds except carbon dioxide C12P3/00; obtaining metal compounds from mixtures, e.g. ores, which are intermediate compounds in a metallurgical process for obtaining a free metal C21B, C22B; production of non-metallic ele-

CPC/IPC/FI Symbols	Description
	ments or inorganic compounds by electrolysis or electrophoresis (C25B)
C01P	INDEXING SCHEME RELATING TO STRUCTURAL AND PHYSICAL ASPECTS OF SOLID INORGANIC COMPOUNDS
C01P2004/00	Particle morphology
C01P2004/60	. Particles characterised by their size
<u>C01P2004/64</u>	.. Nanometer sized, i.e. from 1-100 nanometer
Y	GENERAL TAGGING OF NEW TECHNOLOGICAL DEVELOPMENTS; GENERAL TAGGING OF CROSS-SECTIONAL TECHNOLOGIES SPANNING OVER SEVERAL SECTIONS OF THE IPC; TECHNICAL SUBJECTS COVERED BY FORMER USPC CROSS-REFERENCE ART COLLECTIONS [XRACs] AND DIGESTS
Y10	TECHNICAL SUBJECTS COVERED BY FORMER USPC
Y10S	TECHNICAL SUBJECTS COVERED BY FORMER USPC CROSS-REFERENCE ART COLLECTIONS [XRACs] AND DIGESTS
<u>Y10S977/00</u>	Nanotechnology
<u>B82</u>	NANOTECHNOLOGY
<u>C03</u>	GLASS; MINERAL OR SLAG WOOL {(organic glasses C08; metallic glasses, amorphous metals B22F, C22C)}
<u>C04B</u>	LIME, MAGNESIA; SLAG; CEMENTS; COMPOSITIONS THEREOF, e.g. MORTARS, CONCRETE OR LIKE BUILDING MATERIALS; ARTIFICIAL STONE {(roofing granules E04D7/005)}; CERAMICS (devitrified glass-ceramics C03C10/00); REFRACTORIES; TREATMENT OF NATURAL STONE
<u>C22C</u>	ALLOYS (flints C06C15/00; treatment of alloys C21D, C22F)
<u>C04</u>	CEMENTS; CONCRETE; ARTIFICIAL STONE; CERAMICS; REFRACTORIES (alloys based on refractory metals C22C)

## 4.5 Nanostructures

(( IPC (smart) = (B82B, B82Y, H01F 41/30, H01G 11/36) OR CPC (smart) = (A61F2002/3084, A61L2400/12, B01J 20/205, B22F 1/0018, B82B, B82Bmiss, B82T, B82Tmiss, B82Y, B82Ymiss, C01B 31/0206, C01P2004/24, C01P2004/64, C08K2201/011, C25D 1/006, F28F2255/20, G02B 6/0229, H01F 41/30, H01G 11/36, H01L 29/0665, H01L 51/502, H05H2245/124, Y10S 977/70, Y10S 977/762, Y10S 977/84, Y10S 977/902) ) OR Words in abstract and title = ("Nanocage\*" OR "nanochain\*" OR "Nanocomposite\*" OR "Nanofabric\*" OR "Nanofiber\*" OR "Nanoflake\*" OR "Nanoflower\*" OR "Nanofoam\*" OR "Nanohole\*" OR "Nanomesh\*" OR "Nanoparticle\*" OR "Nanopillar\*" OR "Nanopin\*" OR "Nanoplatelet\*" OR "Nanoribbon\*" OR "Nanoring\*" OR "Nanorod\*" OR "Nanosheet\*" OR "Nanoshell\*" OR "Nanotip\*" OR "Nanowire\*" OR "Nanostructured\*" OR ((NEAR(("nano", "material\*"), 5)) OR "nanomaterial\*" OR "nanostructure\*" OR "nanotube\*" OR "nanoscroll\*" OR "nanowire\*" OR "nanorod\*" OR "nanocomposite\*" OR (NEAR(("nano\*", "particle\*"), 5)) OR (NEAR(("nano\*", "composite\*"), 5)) OR (NEAR(("nano\*", "powder\*"), 5)) OR (NEAR(("nano\*", "agglomerate\*"), 5))) ) OR Tag = 18-10028\_Nanostructures\_PB\_A

PatBase Search Syntax = CL=(nanoparticle\* OR nanoparticulat\* OR nanopartikel\* OR nanorod\* OR nanowire\* OR nanocluster\* OR nanocomposite\* OR nanopowder\* OR nanoagglomerate\* OR nanocrystal\* or nanostruktur\*) and not (IPC=B82 or CPC=B82)

## Cooperative Patent Classification (CPC)

CPC/IPC/FI Symbols	Description
A	HUMAN NECESSITIES
A61	MEDICAL OR VETERINARY SCIENCE; HYGIENE
A61F	FILTERS IMPLANTABLE INTO BLOOD VESSELS; PROSTHESES; DEVICES PROVIDING PATENCY TO, OR PREVENTING COLLAPSING OF, TUBULAR STRUCTURES OF THE BODY, E.G. STENTS; ORTHOPAEDIC, NURSING OR CONTRACEPTIVE DEVICES; FOMENTATION; TREATMENT OR PROTECTION OF EYES OR EARS; BANDAGES, DRESSINGS OR ABSORBENT PADS; FIRST-AID KITS (dental prosthetics A61C)
A61F2/00	Filters implantable into blood vessels; Prostheses, i.e. artificial substitutes or replacements for parts of the body; Appliances for connecting them with the body; Devices providing patency to, or preventing collapsing of, tubular structures of the body, e.g. stents (as cosmetic articles, see the relevant subclasses, e.g. wigs, hair pieces, A41G3/00, A41G5/00, artificial nails A45D31/00; dental prostheses A61C13/00; materials for prostheses A61L27/00; artificial hearts A61M1/10; artificial kidneys A61M1/14)
A61F2/02	. Prostheses implantable into the body {{closure means for urethra or rectum or for artificial body openings therefor A61F2/0004}}
A61F2/30	.. Joints
A61F2/30767	... {Special external and/or bone-contacting surfaces, e.g. coating for improving bone ingrowth (materials for coating prostheses A61L27/28)}
A61F2/30771	.... {applied in original prostheses, e.g. holes, grooves (etching the surface A61F2/30767)}
<u>A61F2002/3084</u>	..... {Nanostructures}
A61L	METHODS OR APPARATUS FOR STERILISING MATERIALS OR OBJECTS IN GENERAL; DISINFECTION, STERILISATION, OR DEODORISATION OF AIR; CHEMICAL ASPECTS OF BANDAGES, DRESSINGS, ABSORBENT PADS, OR SURGICAL ARTICLES; MATERIALS FOR BANDAGES, DRESSINGS, ABSORBENT PADS, OR SURGICAL ARTICLES (preservation of bodies or disinfecting characterised by the agent employed A01N; preserving, e.g. sterilising, food or foodstuffs A23; preparations for medical, dental or toilet purposes A61K; preparation of ozone C01B13/10)
A61L2400/00	Materials characterised by their function or physical properties
<u>A61L2400/12</u>	. Nanosized materials, e.g. nanofibres, nanoparticles, nanowires, nanotubes; Nanostructured surfaces
B	PERFORMING OPERATIONS; TRANSPORTING
B01	PHYSICAL OR CHEMICAL PROCESSES OR APPARATUS IN GENERAL (furnaces, kilns, ovens, retorts in general F27)
B01J	CHEMICAL OR PHYSICAL PROCESSES, e.g. CATALYSIS OR COLLOID CHEMISTRY; THEIR RELEVANT APPARATUS
B01J20/00	Solid sorbent compositions or filter aid compositions; Sorbents for chromatography; Processes for preparing, regenerating or reactivating thereof
B01J20/02	. comprising inorganic material
B01J20/20	.. comprising free carbon; comprising carbon obtained by carbonising processes
<u>B01J20/205</u>	... {Carbon nanostructures, e.g. nanotubes, nanohorns, nanocones, nanoballs (carbon nanotubes per se C01B32/15)}
B22	CASTING; POWDER METALLURGY
B22F	WORKING METALLIC POWDER; MANUFACTURE OF ARTICLES FROM METALLIC POWDER; MAKING METALLIC POWDER (processes or devices for granulating materials in general

CPC/IPC/FI Symbols	Description
B22F1/00	B01J2/00; making ceramics by compacting or sintering C04B, e.g. C04B35/64; for the production of metals as such, see class C22; reduction or decomposition of metal compounds in general C22B; making alloys by powder metallurgy C22C; electrolytic production of metal powder C25C5/00)
B22F1/0003	Special treatment of metallic powder, e.g. to facilitate working, to improve properties {(treatment of powder by mechanical means, e.g. by grinding, milling, rolling B22F9/04)}; Metallic powders per se, e.g. mixtures of particles of different composition (C04, C08 take precedence; {amorphous powder B22F9/002})
B22F1/0007	. {Metallic powders per se; Mixtures of metallic powders; Metallic powders mixed with a lubricating or binding agent (making ferrous alloys using a mixture of prealloyed powders C22C33/0207)}
B22F1/0011	.. {Metallic powder characterised by its shape or structure, e.g. fibre structure}
<u>B22F1/0018</u>	... {Metallic powder characterised by size or surface area only}
C	.... {Nanometer sized particles}
C01	CHEMISTRY; METALLURGY
C01P	INORGANIC CHEMISTRY (processing powders of inorganic compounds preparatory to the manufacturing of ceramic products C04B35/00; fermentation or enzyme-using processes for the preparation of elements or inorganic compounds except carbon dioxide C12P3/00; obtaining metal compounds from mixtures, e.g. ores, which are intermediate compounds in a metallurgical process for obtaining a free metal C21B, C22B; production of non-metallic elements or inorganic compounds by electrolysis or electrophoresis C25B)
C01P2004/00	INDEXING SCHEME RELATING TO STRUCTURAL AND PHYSICAL ASPECTS OF SOLID INORGANIC COMPOUNDS
C01P2004/20	Particle morphology
<u>C01P2004/24</u>	. extending in two dimensions, e.g. plate-like
C01P2004/60	.. Nanoplates, i.e. plate-like particles with a thickness from 1-100 nanometer
<u>C01P2004/64</u>	. Particles characterised by their size
C08	.. Nanometer sized, i.e. from 1-100 nanometer
C08K	ORGANIC MACROMOLECULAR COMPOUNDS; THEIR PREPARATION OR CHEMICAL WORKING-UP; COMPOSITIONS BASED THEREON (manufacture or treatment of artificial threads, fibres, bristles or ribbons D01)
C08K2201/00	USE OF INORGANIC OR NON-MACROMOLECULAR ORGANIC SUBSTANCES AS COMPOUNDING INGREDIENTS (pesticides, herbicides A01N; pharmaceuticals, cosmetics A61K; explosives C06B; paints, inks, varnishes, dyes, polishes, adhesives C09; lubricants C10M; detergents C11D; artificial filaments or fibres D01F; textile treating compositions D06)
<u>C08K2201/011</u>	Specific properties of additives
C25	. Nanostructured additives
	ELECTROLYTIC OR ELECTROPHORETIC PROCESSES; APPARATUS THEREFOR (electrodialysis, electro-osmosis, separation of liquids by electricity B01D; {separation of isotopes by electrochemical methods B01D59/38}; working of metal by the action of a high concentration of electric current B23H; treatment of water, waste water or sewage by electrochemical methods C02F1/46; surface treatment of metallic material or coating involving at least one process provided for in class C23 and at least one process covered by this class C23C28/00, C23F17/00; anodic or cathodic protection C23F; single-crystal growth C30B; metallising textiles D06M11/83; decorating textiles by locally metallising D06Q1/04; electrochemical methods of analysis G01N; electrochemical measuring, indicating or recording devices G01R; electrolytic circuit elements, e.g. capacitors, H01G; electrochemical current or voltage

CPC/IPC/FI Symbols	Description
C25D	generators H01M) PROCESSES FOR THE ELECTROLYTIC OR ELECTROPHORETIC PRODUCTION OF COATINGS; ELECTROFORMING (decorating textiles by metallising D06Q1/04; manufacturing printed circuits by metal deposition H05K3/18); APPARATUS THEREFOR
C25D1/00 <u>C25D1/006</u>	Electroforming . {Nanostructures, e.g. using aluminium anodic oxidation templates [AAO]}
F	MECHANICAL ENGINEERING; LIGHTING; HEATING; WEAPONS; BLASTING
F28	HEAT EXCHANGE IN GENERAL
F28F	DETAILS OF HEAT-EXCHANGE AND HEAT-TRANSFER APPARATUS, OF GENERAL APPLICATION (water and air traps, air venting F16)
F28F2255/00 <u>F28F2255/20</u>	Heat exchanger elements made of materials having special features or resulting from particular manufacturing processes . with nanostructures
G	PHYSICS
G02	OPTICS (making optical elements or apparatus B24B, B29D11/00, C03, or other appropriate subclasses or classes; materials per se, see the relevant places, e.g. C03B, C03C)
G02B	OPTICAL ELEMENTS, SYSTEMS, OR APPARATUS (G02F takes precedence; measuring-instruments, see the relevant subclass of G01, e.g. optical rangefinders G01C; testing of optical elements, systems, or apparatus G01M11/00; spectacles G02C; sound lenses G10K11/30; electron and ion "optics" H01J; X-ray "optics" H01J, H05G1/00; optical elements structurally combined with electric discharge tubes H01J5/16, H01J29/89, H01J37/22; microwave "optics" H01Q; combination of optical elements with television receivers H04N5/72; heating arrangements specially adapted for transparent or reflecting areas H05B3/84; {optical apparatus 42H})
G02B6/00 G02B6/02 <u>G02B6/0229</u>	Light guides . Optical fibre with cladding {with or without a coating} (mechanical structures for providing tensile strength and external protection G02B6/44) .. {characterised by nanostructures, i.e. structures of size less than 100 nm, e.g. quantum dots}
H	ELECTRICITY
H01	BASIC ELECTRIC ELEMENTS
H01F	MAGNETS; INDUCTANCES; TRANSFORMERS; SELECTION OF MATERIALS FOR THEIR MAGNETIC PROPERTIES (ceramics based on ferrites C04B35/26; alloys C22C; {construction of loading coils H01B}; thermomagnetic devices H01L37/00; loudspeakers, microphones, gramophone pick-ups or like acoustic electromechanical transducers H04R)
H01F41/00 H01F41/14 <u>H01F41/30</u>	Apparatus or processes specially adapted for manufacturing or assembling magnets, inductances or transformers; Apparatus or processes specially adapted for manufacturing materials characterised by their magnetic properties . for applying magnetic films to substrates (covering metals, or materials with metals, in general C23C; manufacturing record carriers G11B5/84) .. for applying nanostructures, e.g. by molecular beam epitaxy [MBE]
H01G	CAPACITORS; CAPACITORS, RECTIFIERS, DETECTORS, SWITCHING DEVICES OR LIGHT-SENSITIVE DEVICES, OF THE ELECTROLYTIC TYPE (selection of specified materials as dielectric H01B3/00; {ceramics C04B})
H01G11/00	Hybrid capacitors, i.e. capacitors having different positive and neg-

CPC/IPC/FI Symbols	Description
	active electrodes; Electric double-layer [EDL] capacitors [EDLCs]; Processes specially adapted for the manufacture thereof or of parts thereof
H01G11/22	. Electrodes
H01G11/30	.. characterised by their materials
H01G11/32	... Carbon-based, e.g. activated carbon materials
<u>H01G11/36</u>	.... Nanostructures, e.g. nanofibres, nanotubes or fullerenes
H01L	SEMICONDUCTOR DEVICES; ELECTRIC SOLID STATE DEVICES NOT OTHERWISE PROVIDED FOR (use of semiconductor devices for measuring G01; resistors in general H01C; magnets, inductors {in general} , transformers H01F; capacitors in general H01G; electrolytic devices H01G9/00; batteries, accumulators H01M; waveguides, resonators or lines of the waveguide type H01P; line connectors, current collectors H01R; stimulated emission devices H01S; electromechanical resonators H03H; loudspeakers, microphones, gramophone pick-ups or like acoustic electromechanical transducers H04R; electric light sources in general H05B; printed circuits, hybrid circuits, casings or constructional details of electric apparatus, manufacture of assemblages of electrical components H05K; use of semiconductor devices in circuits having a particular application, see the subclass for the application)
H01L29/00	Semiconductor devices adapted for rectifying, amplifying, oscillating or switching, or capacitors or resistors with at least one potential-jump barrier or surface barrier, e.g. PN junction depletion layer or carrier concentration layer; Details of semiconductor bodies or of electrodes thereof; {Multistep manufacturing processes therefor} (H01L31/00 - H01L47/00, H01L51/05 take precedence; processes or apparatus adapted for the manufacture or treatment thereof or of parts thereof H01L21/00; details other than of semiconductor bodies or of electrodes thereof H01L23/00; devices consisting of a plurality of solid state components formed in or on a common substrate H01L27/00; {passive two-terminal components without a potential-jump or surface barrier for integrated circuits, details thereof and multistep manufacturing processes therefor H01L28/00;} resistors in general H01C; capacitors in general H01G, {e.g. ceramic barrier-layer capacitors H01G4/1272})
H01L29/02	. Semiconductor bodies {; Multistep manufacturing processes therefor}
H01L29/06	.. characterised by their shape; characterised by the shapes, relative sizes, or dispositions of the semiconductor regions {; characterised by the concentration or distribution of impurities within semiconductor regions}
H01L29/0657	... {characterised by the shape of the body}
<u>H01L29/0665</u>	.... {the shape of the body defining a nanostructure (nanotechnology per se B82B)}
H01L51/00	Solid state devices using organic materials as the active part, or using a combination of organic materials with other materials as the active part; Processes or apparatus specially adapted for the manufacture or treatment of such devices, or of parts thereof (devices consisting of a plurality of components formed in or on a common substrate H01L27/28; thermoelectric devices using organic material H01L35/00, H01L37/00; piezoelectric, electrostrictive or magnetostrictive elements using organic material H01L41/00)
H01L51/50	. specially adapted for light emission, e.g. organic light emitting diodes [OLED] or polymer light emitting devices [PLED]; (organic semiconductor lasers H01S5/36; {circuit arrangements for OLED or PLED H05B33/0896; control arrangements for organic electroluminescent displays G09G3/3208})
H01L51/5012	.. {Electroluminescent [EL] layer}
<u>H01L51/502</u>	... {comprising active inorganic nanostructures, e.g. luminescent quantum dots}

CPC/IPC/FI Symbols	Description
H05 H05H	ELECTRIC TECHNIQUES NOT OTHERWISE PROVIDED FOR PLASMA TECHNIQUE (fusion reactors G21B; ion-beam tubes H01J27/00; magnetohydrodynamic generators H02K44/08; producing X-rays involving plasma generation H05G2/00); PRODUCTION OF ACCELERATED ELECTRICALLY-CHARGED PARTICLES OR OF NEUTRONS (obtaining neutrons from radioactive sources G21, e.g. G21B, G21C, G21G); PRODUCTION OR ACCELERATION OF NEUTRAL MOLECULAR OR ATOMIC BEAMS (atomic clocks G04F5/14; devices using stimulated emission H01S; frequency regulation by comparison with a reference frequency determined by energy levels of molecules, atoms, or subatomic particles H03L7/26)
H05H2245/00	test
H05H2245/12	. Applications
<u>H05H2245/124</u>	.. production of nanostructures
Y	GENERAL TAGGING OF NEW TECHNOLOGICAL DEVELOPMENTS; GENERAL TAGGING OF CROSS-SECTIONAL TECHNOLOGIES SPANNING OVER SEVERAL SECTIONS OF THE IPC; TECHNICAL SUBJECTS COVERED BY FORMER USPC CROSS-REFERENCE ART COLLECTIONS [XRACs] AND DIGESTS
Y10	TECHNICAL SUBJECTS COVERED BY FORMER USPC
Y10S	TECHNICAL SUBJECTS COVERED BY FORMER USPC CROSS-REFERENCE ART COLLECTIONS [XRACs] AND DIGESTS
Y10S977/00	Nanotechnology
<u>Y10S977/70</u>	. Nanostructure
<u>Y10S977/762</u>	.. Nanowire or quantum wire, i.e. axially elongated structure having two dimensions of 100 nm or less
<u>Y10S977/84</u>	. Manufacture, treatment, or detection of nanostructure
<u>Y10S977/902</u>	. Specified use of nanostructure
<u>B82B</u>	NANOSTRUCTURES FORMED BY MANIPULATION OF INDIVIDUAL ATOMS, MOLECULES, OR LIMITED COLLECTIONS OF ATOMS OR MOLECULES AS DISCRETE UNITS; MANUFACTURE OR TREATMENT THEREOF
<u>B82Y</u>	SPECIFIC USES OR APPLICATIONS OF NANOSTRUCTURES; MEASUREMENT OR ANALYSIS OF NANOSTRUCTURES; MANUFACTURE OR TREATMENT OF NANOSTRUCTURES

#### International Patent Classification (IPC)

IPC Symbols	Description
B	PERFORMING OPERATIONS; TRANSPORTING
<b>B82B</b>	NANOSTRUCTURES FORMED BY MANIPULATION OF INDIVIDUAL ATOMS, MOLECULES, OR LIMITED COLLECTIONS OF ATOMS OR MOLECULES AS DISCRETE UNITS; MANUFACTURE OR TREATMENT THEREOF [7]
<b>B82Y</b>	SPECIFIC USES OR APPLICATIONS OF NANOSTRUCTURES; MEASUREMENT OR ANALYSIS OF NANOSTRUCTURES; MANUFACTURE OR TREATMENT OF NANOSTRUCTURES [2011.01]

## 4.6 Additive Manufacturing

( CPC (smart) = (A23G 3/54, B22F 3/008, B22F 3/1055, B28B 1/001, B29C 64, B29C 67/0051, B29C 67/0074, B29C 67/0077, B33Y, B33Y 10, B33Y 30, B33Y 40, B33Y 50, B33Y 70, B33Y 80, B33Y 99, G03F 7/70416, Y02P 10/29) OR IPC (smart) = (A23G 3/54,

B29C 64, B29C 67, B33Y, B33Y 10, B33Y 30, B33Y 40, B33Y 50, B33Y 70, B33Y 80, B33Y 99) )

Or

PatBase Search Syntax = TAC=(("3d" or three%dimension\* or drei%dimension\* or trois%dimension\* or ((three or drei or trois or "3")) wf2 ("D" or dimension\*)) wf3 (sinter\* or print\* or druck\* or imprim\* or plot\* or melt\* or schmelz\* or frittage or fusion or laminating or bioprint\* or ink%jet or multi%jet\* or poly%jet\*)) OR PatBase Search Syntax = TAC=(("3d" or three%dimension\* or drei%dimension\* or trois%dimension\*) wf3 ((object or objekt) w2 (building or forming or laminating or manufacturing or producing or fertigung)))

or

PatBase Search Syntax = FT=((laser\* Wf2 sinter\*) or (laser wf2 melt\*) or lasersinter\* or laserschmelz\* or ((fused or selectiv\* or selektiv\*) wf2 (filament\* or deposit\* or sinter\* or depositing or melt\* or schmelz\* )) or ((generativ\* or additiv\*) wf2 (fertigung\* or manufacturing or deposit\* or tooling)) or (rapid wf2 prototyp\*) or (stereo%lithograph\*) or (freeform w4 fabricat\*) or ((Laminated w2 Object) w4 Modell\*)) or ((direct wf2 metal) wf2 deposit\*) or ((layer\*by\*layer) wf2 printing) or ((layer wf2 laminat\*) wf2 manufacturing)

Reinigung

( Tag = AddManufact\_04\_18\_A\_0 OR Tag = AddManufact\_04\_18\_B\_0 OR Tag = AddManufact\_04\_18\_C\_0 ) AND NOT ( ( IPC (smart) = (H01L 21, H01L 29, H01L 31, H04B, H04N, H05K 1, H05K 3) OR CPC (smart) = (H01L 21, H01L 29, H01L 31, H04B, H04N, H05K 1, H05K 3) ) AND NOT ( IPC (smart) = (B22F 3, B28B 1, B29C 64, B29C 67, B33Y) OR CPC (smart) = (B22F 3, B28B 1, B29C 64, B29C 67, B33Y) ) )

### Cooperative Patent Classification (CPC)

CPC/IPC/FI Symbols	Description
A	HUMAN NECESSITIES
A23	FOODS OR FOODSTUFFS; THEIR TREATMENT, NOT COVERED BY OTHER CLASSES
A23G	COCOA; COCOA PRODUCTS, e.g. CHOCOLATE; SUBSTITUTES FOR COCOA OR COCOA PRODUCTS; CONFECTIONERY; CHEWING GUM; ICE-CREAM; PREPARATION THEREOF
A23G3/00	Sweetmeats; Confectionery; Marzipan; Coated or filled products (chewing gum A23G4/00)
A23G3/34	. Sweetmeats, confectionery or marzipan; Processes for the preparation thereof
A23G3/50	.. characterised by shape, structure or physical form, e.g. products with supported structure (composite structures including chocolate, e.g. as layer, coating or filler A23G1/54)
<u>A23G3/54</u>	... Composite products, e.g. layered, coated, filled
B	PERFORMING OPERATIONS; TRANSPORTING
B22	CASTING; POWDER METALLURGY
B22F	WORKING METALLIC POWDER; MANUFACTURE OF ARTICLES FROM METALLIC POWDER; MAKING METALLIC POWDER (processes or devices for granulating materials in general B01J2/00; making ceramics by compacting or sintering C04B, e.g. C04B35/64;

CPC/IPC/FI Symbols	Description
	for the production of metals as such, see class C22; reduction or decomposition of metal compounds in general C22B; making alloys by powder metallurgy C22C; electrolytic production of metal powder C25C5/00)
<u>B22F3/00</u>	Manufacture of workpieces or articles from metallic powder characterised by the manner of compacting or sintering; Apparatus specially adapted therefor {; Presses and furnaces}
<u>B22F3/008</u>	. {Selective deposition modelling (B22F3/1055 takes precedence)}
B22F3/10	. Sintering only
B22F3/105	.. by using electric current {other than for infra-red radiant energy}, laser radiation or plasma (B22F3/11 takes precedence){; by ultrasonic bonding (B22F3/115 takes precedence)}
<u>B22F3/1055</u>	... {Selective sintering, i.e. stereolithography (selective sintering of powdered plastics B29C64/153)}
B28	WORKING CEMENT, CLAY, OR STONE
B28B	SHAPING CLAY OR OTHER CERAMIC COMPOSITIONS, SLAG, OR MIXTURES CONTAINING CEMENTITIOUS MATERIAL, e.g. PLASTER (foundry moulding B22C; working stone or stone-like material B28D; shaping of substances in a plastic state, in general B29C; making layered products not composed wholly of these substances B32B; shaping in situ, see the relevant classes of section E)
<u>B28B1/00</u>	Producing shaped {prefabricated} articles from the material (using presses B28B3/00; shaping on moving conveyors B28B5/00; producing tubular articles B28B21/00 {; producing articles with embedded elements B28B23/00)}
<u>B28B1/001</u>	. {Rapid manufacturing of 3D objects by additive depositing, agglomerating or laminating of material (selective deposition modelling of metallic powder B22F3/008; rapid manufacturing of 3D objects in general and in particular of plastics B29C64/00)}
B29	WORKING OF PLASTICS; WORKING OF SUBSTANCES IN A PLASTIC STATE, IN GENERAL (processing doughs A21C; working chocolate A23G; casting of metals B22; working cement, clay B28; chemical aspects, see section C, particularly C08; working glass C03B; candle making C11C5/02; making soap C11D13/00; manufacture of artificial filaments, threads, fibres, bristles or ribbons D01D, D01F; manufacture of articles from cellulosic fibrous suspensions or from papier-mâché D21J)
B29C	SHAPING OR JOINING OF PLASTICS; SHAPING OF MATERIAL IN A PLASTIC STATE, NOT OTHERWISE PROVIDED FOR; AFTER-TREATMENT OF THE SHAPED PRODUCTS, e.g. REPAIRING (making preforms B29B11/00; making laminated products by combining previously unconnected layers which become one product whose layers will remain together B32B37/00 - B32B41/00)
<u>B29C64/00</u>	Additive manufacturing, i.e. manufacturing of three-dimensional [3D] objects by additive deposition, additive agglomeration or additive layering, e.g. by 3D printing, stereolithography or selective laser sintering
<u>B29C67/00</u>	Shaping techniques not covered by groups B29C39/00 - B29C65/00, B29C70/00 or B29C73/00
B33	ADDITIVE MANUFACTURING TECHNOLOGY
<u>B33Y</u>	ADDITIVE MANUFACTURING, i.e. MANUFACTURING OF THREE-DIMENSIONAL [3-D] OBJECTS BY ADDITIVE DEPOSITION, ADDITIVE AGGLOMERATION OR ADDITIVE LAYERING, e.g. BY 3-D PRINTING, STEREOLITHOGRAPHY OR SELECTIVE LASER SINTERING
<u>B33Y10/00</u>	Processes of additive manufacturing
<u>B33Y30/00</u>	Apparatus for additive manufacturing; Details thereof or accessories therefor
<u>B33Y40/00</u>	Auxiliary operations or equipment, e.g. for material handling
<u>B33Y50/00</u>	Data acquisition or data processing for additive manufacturing

CPC/IPC/FI Symbols	Description
<u>B33Y70/00</u>	Materials specially adapted for additive manufacturing
<u>B33Y80/00</u>	Products made by additive manufacturing
<u>B33Y99/00</u>	Subject matter not provided for in other groups of this subclass
G	PHYSICS
G03	PHOTOGRAPHY; CINEMATOGRAPHY; ELECTROGRAPHY; HOLOGRAPHY (reproduction of pictures or patterns by scanning and converting into electrical signals H04N)
G03F	PHOTOMECHANICAL PRODUCTION OF TEXTURED OR PATTERNED SURFACES, e.g. FOR PRINTING, FOR PROCESSING OF SEMICONDUCTOR DEVICES; MATERIALS THEREFOR; ORIGINALS THEREFOR; APPARATUS SPECIALLY ADAPTED THEREFOR; (phototypographic composing devices B41B; photosensitive materials or processes for photographic purposes G03C; electrophotography, sensitive layers or processes therefor G03G)
G03F7/00	Photomechanical, e.g. photolithographic, production of textured or patterned surfaces, e.g. printing surfaces; Materials therefor, e.g. comprising photoresists; Apparatus specially adapted therefor (using photoresist structures for special production processes, see the relevant places, e.g. B44C, H01L, e.g. H01L21/00, H05K)
G03F7/70	. {Exposure apparatus for microlithography}
G03F7/70375	.. {Imaging systems not otherwise provided for, e.g. multiphoton lithography; Imaging systems comprising means for converting one type of radiation into another type of radiation, systems comprising mask with photo-cathode}
<u>G03F7/70416</u>	... {Stereolithography, 3D printing, rapid prototyping}
Y	GENERAL TAGGING OF NEW TECHNOLOGICAL DEVELOPMENTS; GENERAL TAGGING OF CROSS-SECTIONAL TECHNOLOGIES SPANNING OVER SEVERAL SECTIONS OF THE IPC; TECHNICAL SUBJECTS COVERED BY FORMER USPC CROSS-REFERENCE ART COLLECTIONS [XRACs] AND DIGESTS
Y02	TECHNOLOGIES OR APPLICATIONS FOR MITIGATION OR ADAPTATION AGAINST CLIMATE CHANGE
Y02P	CLIMATE CHANGE MITIGATION TECHNOLOGIES IN THE PRODUCTION OR PROCESSING OF GOODS
Y02P10/00	Technologies related to metal processing
Y02P10/20	. Process efficiency
Y02P10/25	.. by increasing the energy efficiency of the process
<u>Y02P10/29</u>	... Additive manufacturing

### International Patent Classification (IPC)

IPC Symbols	Description
B	PERFORMING OPERATIONS; TRANSPORTING
<b>B33Y</b>	ADDITIVE MANUFACTURING, i.e. MANUFACTURING OF THREE-DIMENSIONAL [3D] OBJECTS BY ADDITIVE DEPOSITION, ADDITIVE AGGLOMERATION OR ADDITIVE LAYERING, e.g. BY 3D PRINTING, STEREO LITHOGRAPHY OR SELECTIVE LASER SINTERING [2015.01]

The complete description of the IPC classes can be found in the Internet at

<http://web2.wipo.int/classifications/ipc/ipcpub>

## 4.7 Mass Spectroscopy

( IPC (smart) = (G01F 1/716, G01R 33, G01V 3) OR CPC (original) = (G01F 1/716, G01R 33/20, G01R 33/44, G01R 33/4828, G01R 33/60, G01V 3, Y10T 436/24) )

MassSpectroscopy

( IPC (smart) = H01J 49 OR CPC (smart) = (G01N 33/6848, G01N 33/6851, H01J 49, H01J 49/165, H01J 49/26, Y10T 436/24) )

### Cooperative Patent Classification (CPC)

CPC/IPC/FI Symbols	Description
G	PHYSICS
G01	MEASURING (counting G06M); TESTING
G01F	MEASURING VOLUME, VOLUME FLOW, MASS FLOW OR LIQUID LEVEL; METERING BY VOLUME (milk flow sensing devices in milking machines or devices A01J5/01; measuring or recording blood flow A61B5/02, A61B8/06; metering media to the human body A61M5/168; burettes or pipettes B01L3/02; arrangements of liquid volume meters or volume-flow meters in liquid-delivering apparatus, e.g. for retail sale purposes, B67D7/16; pumps, fluid motors, details common to measuring or metering devices and pumps or fluid motors F01 - F04; {sampling G01N1/00}; locating, determining distance or velocity using reflection or reradiation of radio waves, analogous arrangements using other waves G01S; systems for ratio control G05D11/00; {coin-freed apparatus for metering flow of liquid or gas G07F15/00})
G01F1/00	Measuring the volume flow or mass flow of fluid or fluent solid material wherein the fluid passes through the meter in a continuous flow (measuring a proportion of the volume flow G01F5/00; measuring speed of flow G01P5/00; indicating presence or absence of flow G01P13/00; regulating quantity or ratio {G05D7/00, G05D11/02})
G01F1/704	. using marked regions or existing inhomogeneities within the fluid stream, e.g. statistically occurring variations in a fluid parameter (G01F1/76, G01F25/00 take precedence)
G01F1/708	.. Measuring the time taken to traverse a fixed distance
<u>G01F1/716</u>	... using electron paramagnetic resonance [EPR] or nuclear magnetic resonance [NMR]
G01N	INVESTIGATING OR ANALYSING MATERIALS BY DETERMINING THEIR CHEMICAL OR PHYSICAL PROPERTIES (separating components of materials in general B01D, B01J, B03, B07; apparatus fully provided for in a single other subclass, see the relevant subclass, e.g. B01L; measuring or testing processes other than immunoassay, involving enzymes or microorganisms C12M, C12Q; investigation of foundation soil in situ E02D1/00; sensing humidity changes for compensating measurements of other variables or for compensating readings of instruments for variations in humidity, see G01D or the relevant subclass for the variable measured; testing or determining the properties of structures G01M; measuring or investigating electric or magnetic properties of materials G01R; systems or methods in general, using reception or emission of radiowaves or other waves and based on propagation effects, e.g. Doppler effect, propagation time, direction of propagation, G01S; determining sensitivity, graininess, or density of photographic materials G03C5/02; testing component parts of nuclear reactors G21C17/00; {controlling or regulating non-electric variables G05D; measuring degree of ionisation of ionised gases, i.e. plasma H05H1/0006; testing electrographic developer properties G03G15/0848})

CPC/IPC/FI Symbols	Description
G01N33/00	Investigating or analysing materials by specific methods not covered by the preceding groups
G01N33/48	. Biological material, e.g. blood, urine (G01N33/02 - G01N33/14, G01N33/26, G01N33/44, G01N33/46 take precedence; determining the germinating capacity of seeds A01C1/02); Haemocytometers (counting blood corpuscles distributed over a surface by scanning the surface G06M11/02)
G01N33/50	.. Chemical analysis of biological material, e.g. blood, urine; Testing involving biospecific ligand binding methods; Immunological testing (measuring or testing processes involving enzymes or microorganisms, compositions or test papers therefor; processes for forming such compositions, condition responsive control in microbiological or enzymological processes C12Q)
G01N33/68	... involving proteins, peptides or amino acids {(involving lipoproteins G01N33/92)}
G01N33/6803	.... {General methods of protein analysis not limited to specific proteins or families of proteins}
<u>G01N33/6848</u>	..... {Methods of protein analysis involving mass spectrometry}
<u>G01N33/6851</u>	..... {Methods of protein analysis involving laser desorption ionisation mass spectrometry}
G01R	MEASURING ELECTRIC VARIABLES; MEASURING MAGNETIC VARIABLES (measuring physical variables of any kind by conversion into electric variables, see Note (4) following the title of class G01; measuring diffusion of ions in an electric field, e.g. electrophoresis, electro-osmosis G01N; investigating non-electric or non-magnetic properties of materials by using electric or magnetic methods G01N; indicating correct tuning of resonant circuits H03J3/12; monitoring electronic pulse counters H03K21/40; monitoring operation of communication systems H04)
<u>G01R33/00</u>	Arrangements or instruments for measuring magnetic variables
<u>G01R33/20</u>	. involving magnetic resonance (medical aspects A61B5/055; magnetic resonance gyrometers G01C19/00 {; investigating materials using NMR G01N24/00; prospecting or detecting using NMR G01V3/00})
<u>G01R33/44</u>	.. using nuclear magnetic resonance [NMR] (G01R33/24, G01R33/62 take precedence)
G01R33/48	... NMR imaging systems
<u>G01R33/4828</u>	.... {Resolving the MR signals of different chemical species, e.g. water-fat imaging}
<u>G01R33/60</u>	.. using electron paramagnetic resonance (G01R33/24, G01R33/62 take precedence)
G01V	GEOPHYSICS; GRAVITATIONAL MEASUREMENTS; DETECTING MASSES OR OBJECTS (detecting or locating foreign bodies for diagnostic, surgical or person-identification purposes A61B; means for indicating the location of accidentally buried, e.g. snow-buried persons A63B29/02; investigating or analysing earth materials by determining their chemical or physical properties G01N; measuring electric or magnetic variables in general, other than direction or magnitude of the earth's field G01R; electronic or nuclear magnetic resonance arrangements G01R33/20; radar, sonar or analogous methods in general, detecting masses or objects involving these methods G01S)
<u>G01V3/00</u>	Electric or magnetic prospecting or detecting (by optical means G01V8/00); Measuring magnetic field characteristics of the earth, e.g. declination, deviation (for navigation, for surveying G01C; {measuring direction or magnitude of magnetic fields or magnetic flux in general G01R33/02})
H	ELECTRICITY
H01	BASIC ELECTRIC ELEMENTS
H01J	ELECTRIC DISCHARGE TUBES OR DISCHARGE LAMPS (spark-gaps H01T; arc lamps with consumable electrodes H05B;

CPC/IPC/FI Symbols	Description
	particle accelerators H05H)
<u>H01J49/00</u>	Particle spectrometers or separator tubes
H01J49/02	. Details
H01J49/10	.. Ion sources; Ion guns
H01J49/16	... using surface ionisation, e.g. field-, thermionic- or photo-emission
<u>H01J49/165</u>	.... {Electrospray ionisation}
<u>H01J49/26</u>	. Mass spectrometers or separator tubes (isotope separation using these tubes B01D59/44)
Y	GENERAL TAGGING OF NEW TECHNOLOGICAL DEVELOPMENTS; GENERAL TAGGING OF CROSS-SECTIONAL TECHNOLOGIES SPANNING OVER SEVERAL SECTIONS OF THE IPC; TECHNICAL SUBJECTS COVERED BY FORMER USPC CROSS-REFERENCE ART COLLECTIONS [XRACs] AND DIGESTS
Y10	TECHNICAL SUBJECTS COVERED BY FORMER USPC
Y10T	TECHNICAL SUBJECTS COVERED BY FORMER US CLASSIFICATION
Y10T436/00	Chemistry: analytical and immunological testing
<u>Y10T436/24</u>	. Nuclear magnetic resonance, electron spin resonance or other spin effects or mass spectrometry

## 4.8 Drones

( IPC (smart) = (A01D, A63H 27, B60W 30, B63G 8/00, B64C 27, B64C 29, B64C 39, G01C 21, G05D 1) OR CPC (smart) = (A01D, A63H 27, B60W 30, B63G 8/001, B63G2008/002, B64C 27, B64C 29, B64C 39, G01C 21, G05D 1, Y02T 10) ) AND Words in abstract and title = "drone\*" OR "drohne\*" OR "uav\*" OR "agv\*" OR (("autonom\*" OR "unmanned\*" OR "automated\*" OR (NEAR(("auto\*", "guided\*"), 5))) AND ("vehicle\*" OR "mobile\*" OR "carrier\*" OR "transport\*" OR "aerial\*")) OR ("fahrerlos\*" OR "selfsteer\*" OR "selbstlenk\*" OR (NEAR(("SELF\*", "steer\*"), 5)) OR (NEAR(("SELF\*", "control\*"), 5)) OR (NEAR(("self\*", "guid\*"), 5))) AND ("vehicle\*" OR "mobile\*" OR "carrier\*" OR "transport\*" OR "aerial\*") OR CPC (smart) = (B63G2008/002, B64C2201, G05B 19/41895, G05D2201/0207, G05D2201/0212, G05D2201/0216)

Or ( IPC (smart) = (A01D, A63H 27, B60W 30, B63G 8/00, B64C 27, B64C 29, B64C 39, G01C 21, G05D 1) OR CPC (smart) = (A01D, A63H 27, B60W 30, B63G 8/001, B63G2008/002, B64C 27, B64C 29, B64C 39, G01C 21, G05D 1, Y02T 10) ) AND Pat-Base search syntax = TAC=((drone or drones or drohne\* or driverless\* or uav or agv) or ((unmanned\* or fahrerlos\* or driverless\* or (automatic\* w3 guid\*)) w4 (aerial\* or vehicle\* or transport\* or carrier\* or mobile\*)))

### Cooperative Patent Classification (CPC)

CPC/IPC/FI Symbols	Description
A	HUMAN NECESSITIES
A63	SPORTS; GAMES; AMUSEMENTS
A63H	TOYS, e.g. TOPS, DOLLS, HOOPS, BUILDING BLOCKS
<u>A63H27/00</u>	Toy aircraft; Other flying toys (toys with parachutes A63H33/20) {; Starting or launching devices therefor}
B	PERFORMING OPERATIONS; TRANSPORTING



CPC/IPC/FI Symbols	Description
G05B19/00	ate subclass, e.g. G12B, subclass of G01, H01; correcting units, see the appropriate subclass, e.g. H02K) Programme-control systems (specific applications see the relevant places, e.g. A47L15/46; clocks with attached or built-in means operating any device at a preselected time interval G04C23/00; marking or sensing record carriers with digital information G06K; information storage G11; time or time-programme switches which automatically terminate their operation after the programme is completed H01H43/00)
G05B19/02	. electric
G05B19/418	.. Total factory control, i.e. centrally controlling a plurality of machines, e.g. direct or distributed numerical control [DNC], flexible manufacturing systems [FMS], integrated manufacturing systems [IMS], computer integrated manufacturing [CIM]
G05B19/4189	... {characterised by the transport system}
<u>G05B19/41895</u>	.... {using automatic guided vehicles [AGV] (control of position or course of AGV's G05D1/00)}
G05D	SYSTEMS FOR CONTROLLING OR REGULATING NON-ELECTRIC VARIABLES (for continuous casting of metals B22D11/16; valves per se F16K; sensing non-electric variables, see the relevant subclasses of G01; for regulating electric or magnetic variables G05F)
<u>G05D1/00</u>	Control of position, course or altitude of land, water, air, or space vehicles, e.g. automatic pilot (steering applicable only to other than landborne vehicles, e.g. three-dimensional steering applicable to both aircraft and submarines B60K; construction or disposition of steering means on land vehicles B62, on waterborne vessels B63; manual or automatic control of aircraft, e.g. using automatic pilot or radiated signal B64C; radio navigation systems or analogous systems using other waves G01S)
G05D2201/00	Application
G05D2201/02	. Control of position of land vehicles
<u>G05D2201/0207</u>	.. Unmanned vehicle for inspecting or visiting an area
<u>G05D2201/0212</u>	.. Driverless passenger transport vehicle
<u>G05D2201/0216</u>	.. Vehicle for transporting goods in a warehouse, factory or similar
Y	GENERAL TAGGING OF NEW TECHNOLOGICAL DEVELOPMENTS; GENERAL TAGGING OF CROSS-SECTIONAL TECHNOLOGIES SPANNING OVER SEVERAL SECTIONS OF THE IPC; TECHNICAL SUBJECTS COVERED BY FORMER USPC CROSS-REFERENCE ART COLLECTIONS [XRACs] AND DIGESTS
Y02	TECHNOLOGIES OR APPLICATIONS FOR MITIGATION OR ADAPTATION AGAINST CLIMATE CHANGE
Y02T	CLIMATE CHANGE MITIGATION TECHNOLOGIES RELATED TO TRANSPORTATION
<u>Y02T10/00</u>	Road transport of goods or passengers
<u>A01D</u>	HARVESTING; MOWING {(parts, details or accessories of agricultural machines or implements in general A01B51/00 - A01B75/00)}

## 4.9 Radiation Detectors

CPC (smart) = (A61B 6/4233, A61B 6/4291, G01T 1/171, G01T 1/2006, G01T 1/202, G01T 1/24, G01T 1/247, G01T 1/2928, G01T 3/06, H01J 37/244, H01J2237/2445, H01J2237/24455, H01J2237/2446, H01L 27/14658, H01L 27/14676, H01L 31/115) OR  
 IPC (smart) = (G01N 23/207, G01T 1/17, G01T 1/20, G01T 1/202, H01L 31/115, H01L 31/119)

### Cooperative Patent Classification (CPC)

CPC/IPC/FI Symbols	Description
A	HUMAN NECESSITIES
A61	MEDICAL OR VETERINARY SCIENCE; HYGIENE
A61B	DIAGNOSIS; SURGERY; IDENTIFICATION (analysing biological material G01N, e.g. G01N33/48; obtaining records using waves other than optical waves, in general G03B42/00)
A61B6/00	Apparatus for radiation diagnosis, e.g. combined with radiation therapy equipment (analysis of materials using radiation G01N23/00, detecting hidden objects by radiation G01V5/0008, radiodiagnostic or X-ray contrast preparations A61K49/00; radiation therapy per se A61N5/00; instruments measuring radiation intensity for application in the field of nuclear medicine, e.g. in vivo counting G01T1/161; apparatus for taking X-ray photographs G03B42/02; X-ray photographic processes G03C5/16; irradiation devices G21K; X-ray apparatus or circuits therefor H05G1/00)
A61B6/42	. {with arrangements for detecting radiation specially adapted for radiation diagnosis (details of radiation detection G01T1/00)}
A61B6/4208	.. {characterised by using a particular type of detector}
<u>A61B6/4233</u>	... {using matrix detectors (for semiconductor radiation detectors G01T1/24, G01T1/2928)}
<u>A61B6/4291</u>	.. {the detector being combined with a grid or grating}
G	PHYSICS
G01	MEASURING (counting G06M); TESTING
G01N	INVESTIGATING OR ANALYSING MATERIALS BY DETERMINING THEIR CHEMICAL OR PHYSICAL PROPERTIES (separating components of materials in general B01D, B01J, B03, B07; apparatus fully provided for in a single other subclass, see the relevant subclass, e.g. B01L; measuring or testing processes other than immunoassay, involving enzymes or microorganisms C12M, C12Q; investigation of foundation soil in situ E02D1/00; sensing humidity changes for compensating measurements of other variables or for compensating readings of instruments for variations in humidity, see G01D or the relevant subclass for the variable measured; testing or determining the properties of structures G01M; measuring or investigating electric or magnetic properties of materials G01R; systems or methods in general, using reception or emission of radiowaves or other waves and based on propagation effects, e.g. Doppler effect, propagation time, direction of propagation, G01S; determining sensitivity, graininess, or density of photographic materials G03C5/02; testing component parts of nuclear reactors G21C17/00; {controlling or regulating non-electric variables G05D; measuring degree of ionisation of ionised gases, i.e. plasma H05H1/0006; testing electrographic developer properties G03G15/0848})
G01N23/00	Investigating or analysing materials by the use of wave or particle radiation not covered by groups G01N3/00 - G01N17/00, G01N21/00 or G01N22/00
G01N23/20	. by using diffraction of the radiation by the materials, e.g. for investigating crystal structure; by using scattering of the radiation by the materials, e.g. for investigating non-crystalline materials; by using reflection of the radiation by the materials

CPC/IPC/FI Symbols	Description
<u>G01N23/207</u>	.. Diffractometry using detectors, e.g. using a probe in a central position and one or more displaceable detectors in circumferential positions
G01T	MEASUREMENT OF NUCLEAR OR X-RADIATION (radiation analysis of materials, mass spectrometry G01N; counters per se G06M, H03K; electric discharge tubes for analysing radiation or particles H01J40/00, H01J47/00, H01J49/00)
G01T1/00	Measuring X-radiation, gamma radiation, corpuscular radiation, or cosmic radiation (G01T3/00, G01T5/00 take precedence)
G01T1/16	. Measuring radiation intensity (G01T1/29 takes precedence ; self-powered detectors G01T3/006; using an ionisation chamber filled with a liquid or solid, e.g. frozen liquid, dielectric G01T3/008)}
<u>G01T1/17</u>	.. Circuit arrangements not adapted to a particular type of detector {(pulse-selection circuits H03K, G01R)}
<u>G01T1/171</u>	... {Compensation of dead-time counting losses (see provisionally also G01T1/17)}
<u>G01T1/20</u>	.. with scintillation detectors
<u>G01T1/2006</u>	... {using a combination of a scintillator and photodetector which measures the means radiation intensity}
<u>G01T1/202</u>	... the detector being a crystal
<u>G01T1/24</u>	.. with semiconductor detectors (semiconductor devices per se H01L31/00)
<u>G01T1/247</u>	... {Detector read-out circuitry (for processing gain or off-set correction H04N)}
G01T1/29	. Measurement performed on radiation beams, e.g. position or section of the beam; Measurement of spatial distribution of radiation (scintigraphy G01T1/164; mass-spectrometers H01J49/025)
G01T1/2914	.. {Measurement of spatial distribution of radiation}
G01T1/2921	... {Static instruments for imaging the distribution of radioactivity in one or two dimensions; Radio-isotope cameras (using scintigraphy G01T1/1641)}
<u>G01T1/2928</u>	.... {using solid state detectors}
G01T3/00	Measuring neutron radiation (G01T5/00 takes precedence ; tubes therefor H01J47/12; circuits with such tubes G01T1/18; measuring short time intervals G04F10/00; measuring pulse characteristics G01R29/02; neutron choppers G21K1/04; polarimeters G01T1/32)
<u>G01T3/06</u>	. with scintillation detectors
H	ELECTRICITY
H01	BASIC ELECTRIC ELEMENTS
H01J	ELECTRIC DISCHARGE TUBES OR DISCHARGE LAMPS (spark-gaps H01T; arc lamps with consumable electrodes H05B; particle accelerators H05H)
H01J37/00	Discharge tubes with provision for introducing objects or material to be exposed to the discharge, e.g. for the purpose of examination or processing thereof (H01J33/00, H01J40/00, H01J41/00, H01J47/00, H01J49/00 take precedence; {scanning-probe techniques or apparatus G01Q}; contactless testing of electronic circuits using electron beams G01R31/305; {particle accelerators H05H})
H01J37/02	. Details
<u>H01J37/244</u>	.. Detectors; Associated components or circuits therefor (detectors per se G01T)
H01J2237/00	Discharge tubes exposing object to beam, e.g. for analysis treatment, etching, imaging
H01J2237/244	. Detection characterized by the detecting means
<u>H01J2237/2445</u>	.. Photon detectors for X-rays, light, e.g. photomultipliers
<u>H01J2237/24455</u>	.. Transmitted particle detectors
<u>H01J2237/2446</u>	.. Position sensitive detectors

CPC/IPC/FI Symbols	Description
H01L	SEMICONDUCTOR DEVICES; ELECTRIC SOLID STATE DEVICES NOT OTHERWISE PROVIDED FOR (use of semiconductor devices for measuring G01; resistors in general H01C; magnets, inductors {in general} , transformers H01F; capacitors in general H01G; electrolytic devices H01G9/00; batteries, accumulators H01M; waveguides, resonators or lines of the waveguide type H01P; line connectors, current collectors H01R; stimulated emission devices H01S; electromechanical resonators H03H; loudspeakers, microphones, gramophone pick-ups or like acoustic electromechanical transducers H04R; electric light sources in general H05B; printed circuits, hybrid circuits, casings or constructional details of electric apparatus, manufacture of assemblages of electrical components H05K; use of semiconductor devices in circuits having a particular application, see the subclass for the application)
H01L27/00	Devices consisting of a plurality of semiconductor or other solid-state components formed in or on a common substrate (details thereof H01L23/00, H01L29/00 - H01L51/00; assemblies consisting of a plurality of individual solid state devices H01L25/00)
H01L27/14	. including semiconductor components sensitive to infra-red radiation, light, electromagnetic radiation of shorter wavelength, or corpuscular radiation and specially adapted either for the conversion of the energy of such radiation into electrical energy or for the control of electrical energy by such radiation (radiation-sensitive components structurally associated with one or more electric light sources only H01L31/14; couplings of light guides with optoelectronic elements G02B6/42)
H01L27/144	.. Devices controlled by radiation
H01L27/146	... Imager structures
H01L27/14643	.... {Photodiode arrays; MOS imagers}
<u>H01L27/14658</u>	..... {X-ray, gamma-ray or corpuscular radiation imagers (measuring X-, gamma- or corpuscular radiation G01T1/00)}
H01L27/14665	.... {Imagers using a photoconductor layer}
<u>H01L27/14676</u>	..... {X-ray, gamma-ray or corpuscular radiation imagers (measuring X-, gamma- or corpuscular radiation G01T1/00)}
H01L31/00	Semiconductor devices sensitive to infra-red radiation, light, electromagnetic radiation of shorter wavelength or corpuscular radiation and adapted either for the conversion of the energy of such radiation into electrical energy or for the control of electrical energy by such radiation; Processes or apparatus peculiar to the manufacture or treatment thereof or of parts thereof; Details thereof (H01L51/42 takes precedence; devices consisting of a plurality of solid state components formed in, or on, a common substrate, other than combinations of radiation-sensitive components with one or more electric light sources, H01L27/00; measurement of X-radiation, gamma radiation, corpuscular radiation or cosmic radiation with semiconductor detectors G01T1/24, with resistance detectors G01T1/26; measurement of neutron radiation with semiconductor detectors G01T3/08; couplings of light guides with optoelectronic elements G02B6/42; obtaining energy from radioactive sources G21H)
H01L31/08	. in which radiation controls flow of current through the device, e.g. photoresistors
H01L31/10	.. characterised by at least one potential-jump barrier or surface barrier, e.g. phototransistors
<u>H01L31/115</u>	... Devices sensitive to very short wavelength, e.g. X-rays, gamma-rays or corpuscular radiation
<u>H01L31/119</u>	.... characterised by field-effect operation, e.g. MIS type detectors

## 4.10 Biosensors, Lab On a Chip, Bioprinting

( CPC (smart) = (B01D 63/005, B01D 63/028, B01D 63/029, B01D 63/088, B01L 3/5027, B01L 9/527, B01L2200/027, C12M 23/16, C12N 5/0075, C12Q2565/629, G01N 27/327, G01N 27/3272, G01N 27/44791, G01N 33, G01N 33/543, G01N 33/54373) OR IPC (smart) = (G01N 27/327, G01N 33/543) OR Tag = Life\_Bioprinting\_01\_18 ) OR PatBase Search Syntax (with INPADOC extension) = TAC=(Bioprint\* or (bio\* w3 print\*) or Biosensor\* or (lab wf4 chip) or (microfluidi\* w3 device\*))

Bioprinting:

Tag = (spj\Bioprinting\_Auswahl) OR Words in abstract and title = "bioprinting\*" OR "bioprinter\*" OR ("print\*" OR "druck\*") AND ((NEAR(("three-dimensional\*", "tissue\*"), 3)) OR (NEAR(("three-dimensional\*", "cells\*"), 3))) OR PatBase search syntax (w/o INPADOC extension) = TAC=(((tissue\* or (living cell) or (living cells)) or liver or organ or organs or skin or bone) w3 (engineered or print or printer or printed or bioprint\*)) and SFT=(("3d" or (three\*dimension\* or drei\*dimension\* or trois\*dimension\*) or ("3d" or ((three or drei or "3") wf2 ("D" or dimension\*)))) wf3 (print\* or druck or drucken or imprim\* or bioprint\* OR (object near2 (building or forming or manufacturing or producing)))) OR ( IPC (smart) = (C12M, C12N) AND IPC (smart) = (B33Y) ) OR ( CPC (smart) = (B33Y) AND CPC (smart) = (C12M, C12N) )

### Cooperative Patent Classification (CPC)

CPC/IPC/FI Symbols	Description
B	PERFORMING OPERATIONS; TRANSPORTING
B01	PHYSICAL OR CHEMICAL PROCESSES OR APPARATUS IN GENERAL (furnaces, kilns, ovens, retorts in general F27)
B01D	SEPARATION (separating solids from solids by wet methods B03B, B03D; by pneumatic jigs or tables B03B; by other dry methods B07; magnetic or electrostatic separation of solid materials from solid materials or fluids, separation by high-voltage electric fields B03C; centrifuges, vortex apparatus B04; presses per se for squeezing-out liquid from liquid-containing material B30B9/02; treatment of water C02F, e.g. softening by ion-exchange C02F1/42; {arrangements of air intake cleaners in gas turbine plants F02C7/05};arrangements or mounting of filters in air-conditioning, air-humidification or ventilation F24F13/28)
B01D63/00	Apparatus in general for separation processes using semi-permeable membranes
<u>B01D63/005</u>	. {Microfluidic devices comprising semi-permeable hollow fibre membranes}
B01D63/02	. Hollow fibre modules
<u>B01D63/028</u>	.. {Microfluidic devices comprising semi-permeable hollow fibre membranes}
<u>B01D63/029</u>	.. {Microfluidic devices comprising semi-permeable hollow fibre membranes}
B01D63/08	. Flat membrane modules
<u>B01D63/088</u>	.. {Microfluidic devices comprising semi-permeable flat membranes}
B01L	CHEMICAL OR PHYSICAL LABORATORY APPARATUS FOR GENERAL USE (apparatus for medical or pharmaceutical purposes A61; apparatus for industrial purposes or laboratory apparatus whose construction and performance are comparable to that of similar industrial apparatus, see the relevant classes for industrial apparatus, particularly subclasses of B01 and C12; separating or distilling apparatus B01D; mixing or stirring devices B01F; atomisers B05B; {vibrating devices, e.g. shaking tables,} sieves B07B;

CPC/IPC/FI Symbols	Description
B01L3/00	corks, bungs B65D; handling liquids in general B67; vacuum pumps F04; siphons F04F10/00; taps, stop-cocks F16K; tubes, tube joints F16L; apparatus specially adapted for investigating or analysing materials G01, particularly G01N; electrical or optical apparatus, see the relevant classes in Sections G and H)
B01L3/50	Containers or dishes for laboratory use, e.g. laboratory glassware (bottles B65D; apparatus for enzymology or microbiology {specially adapted for culturing} C12M1/00); Droppers (receptacles for volumetric purposes G01F)
B01L3/502	. {Containers for the purpose of retaining a material to be analysed, e.g. test tubes (devices for taking samples of blood A61B5/14)}
<u>B01L3/5027</u>	.. {with fluid transport, e.g. in multi-compartment structures (centrifugal-type cuvettes G01N21/07; analysis by separation into components G01N30/00; automatic analysers G01N35/00)}
B01L9/00	... {by integrated microfluidic structures, i.e. dimensions of channels and chambers are such that surface tension forces are important, e.g. lab-on-a-chip (B01L3/5023 takes precedence; micromixers B01F13/0059; microreactors for synthesis B01J19/0093; microcapillary devices in general B81B1/00)}
B01L9/52	Supporting devices; Holding devices (tweezers, tongs B25B)
<u>B01L9/527</u>	. {Supports for flat sample carrier, e.g. used for plates, slides, chips}
B01L2200/00	.. {for microfluidic devices, e.g. used for lab-on-a-chip}
B01L2200/02	Solutions for specific problems relating to chemical or physical laboratory apparatus
B01L2200/026	. Adapting objects or devices to another
<u>B01L2200/027</u>	.. Fluid interfacing between devices or objects, e.g. connectors, inlet details
	... for microfluidic devices
C	CHEMISTRY; METALLURGY
C12	BIOCHEMISTRY; BEER; SPIRITS; WINE; VINEGAR; MICROBIOLOGY; ENZYMOLOGY; MUTATION OR GENETIC ENGINEERING
C12M	APPARATUS FOR ENZYMOLOGY OR MICROBIOLOGY; {APPARATUS FOR CULTURING MICROORGANISMS FOR PRODUCING BIOMASS, FOR GROWING CELLS OR FOR OBTAINING FERMENTATION OR METABOLIC PRODUCTS, i.e. BIOREACTORS OR FERMENTERS}
C12M23/00	{Constructional details, e.g. recesses, hinges (flow directing inserts in C12M27/18-C12M27/24; apparatus for chemical or physical processes in general B01J, chemical or physical laboratory apparatus in general B01L)}
C12M23/02	. {Form or structure of the vessel (large containers B65D88/00)}
<u>C12M23/16</u>	.. {Microfluidic devices; Capillary tubes (integrated microfluidic structures B01L3/5027; microreactors B01J19/0093)}
C12N	MICROORGANISMS OR ENZYMES; COMPOSITIONS THEREOF (biocides, pest repellants or attractants, or plant growth regulators, containing microorganisms, viruses, microbial fungi, enzymes, fermentates or substances produced by or extracted from microorganisms or animal material A01N63/00; food compositions A21, A23; medicinal preparations A61K; chemical aspects of, or use of materials for, bandages, dressings, absorbent pads or surgical articles A61L; fertilisers C05); PROPAGATING, PRESERVING OR MAINTAINING MICROORGANISMS (preservation of living parts of humans or animals A01N1/02); MUTATION OR GENETIC ENGINEERING; CULTURE MEDIA (microbiological testing media C12Q)
C12N5/00	Undifferentiated human, animal or plant cells, e.g. cell lines; Tissues; Cultivation or maintenance thereof; Culture media therefor;

CPC/IPC/FI Symbols	Description
C12N5/0068	(plant reproduction by tissue culture techniques A01H4/00) . {General culture methods using substrates (for specific animal cell type C12N5/06)}
<u>C12N5/0075</u>	.. {using microcarriers}
C12Q	MEASURING OR TESTING PROCESSES INVOLVING ENZYMES, NUCLEIC ACIDS OR MICROORGANISMS (immunoassay G01N33/53); COMPOSITIONS OR TEST PAPERS THEREFOR; PROCESSES OF PREPARING SUCH COMPOSITIONS; CONDITION-RESPONSIVE CONTROL IN MICROBIOLOGICAL OR ENZYMOLOGICAL PROCESSES
C12Q2565/00	Nucleic acid analysis characterised by mode or means of detection
C12Q2565/60	. Detection means characterised by use of a special device (Not used)
<u>C12Q2565/629</u>	.. being a microfluidic device
G	PHYSICS
G01	MEASURING (counting G06M); TESTING
G01N	INVESTIGATING OR ANALYSING MATERIALS BY DETERMINING THEIR CHEMICAL OR PHYSICAL PROPERTIES (separating components of materials in general B01D, B01J, B03, B07; apparatus fully provided for in a single other subclass, see the relevant subclass, e.g. B01L; measuring or testing processes other than immunoassay, involving enzymes or microorganisms C12M, C12Q; investigation of foundation soil in situ E02D1/00; sensing humidity changes for compensating measurements of other variables or for compensating readings of instruments for variations in humidity, see G01D or the relevant subclass for the variable measured; testing or determining the properties of structures G01M; measuring or investigating electric or magnetic properties of materials G01R; systems or methods in general, using reception or emission of radiowaves or other waves and based on propagation effects, e.g. Doppler effect, propagation time, direction of propagation, G01S; determining sensitivity, graininess, or density of photographic materials G03C5/02; testing component parts of nuclear reactors G21C17/00; {controlling or regulating non-electric variables G05D; measuring degree of ionisation of ionised gases, i.e. plasma H05H1/0006; testing electrographic developer properties G03G15/0848})
G01N27/00	Investigating or analysing materials by the use of electric, electrochemical, or magnetic means (G01N3/00 - G01N25/00 take precedence; measurement or testing electric or magnetic variables or of electric or magnetic properties of materials G01R)
G01N27/26	. by investigating electrochemical variables; by using electrolysis or electrophoresis (investigating resistance to corrosion G01N17/00; investigating or analysing materials by separation into components using adsorption, absorption or similar phenomena or using ion-exchange, e.g. chromatography, G01N30/00; immunoelectrophoresis G01N33/561; electrochemical processes or apparatus in general B01J; standard cells H01M6/28)
G01N27/28	.. Electrolytic cell components
G01N27/30	... Electrodes, e.g. test electrodes; Half-cells (G01N27/414 takes precedence)
<u>G01N27/327</u>	.... Biochemical electrodes {electrical and mechanical details of in vitro measurements (chemical and biological details C12Q1/00, G01N33/543; in vivo A61B5/00)}
G01N27/3271	..... {Amperometric enzyme electrodes for analytes in body fluids, e.g. glucose in blood (amperometry per se G01N27/49; aspects concerning the enzyme reagent C12Q1/001)}
<u>G01N27/3272</u>	..... {Test elements therefor, i.e. disposable laminated substrates with electrodes, reagent and channels (optical biosensors G01N33/52)}
G01N27/416	.. Systems (G01N27/27 takes precedence {; for testing batteries

CPC/IPC/FI Symbols	Description
G01N27/447	G01R31/36} ... using electrophoresis {(aspects concerning peptides or proteins C07K1/26; for non-analytical purposes B01D57/02; separating particles by dielectrophoresis B03C5/00)}
G01N27/44756	.... {Apparatus specially adapted therefor}
<u>G01N27/44791</u>	..... {Microapparatus (sample containers with integrated microfluidic structures B01L3/5027)}
<u>G01N33/00</u>	Investigating or analysing materials by specific methods not covered by the preceding groups
G01N33/48	. Biological material, e.g. blood, urine (G01N33/02 - G01N33/14, G01N33/26, G01N33/44, G01N33/46 take precedence; determining the germinating capacity of seeds A01C1/02); Haemocytometers (counting blood corpuscles distributed over a surface by scanning the surface G06M11/02)
G01N33/50	.. Chemical analysis of biological material, e.g. blood, urine; Testing involving biospecific ligand binding methods; Immunological testing (measuring or testing processes involving enzymes or microorganisms, compositions or test papers therefor; processes for forming such compositions, condition responsive control in microbiological or enzymological processes C12Q)
G01N33/53	... Immunoassay; Biospecific binding assay; Materials therefor
<u>G01N33/543</u>	.... with an insoluble carrier for immobilising immunochemicals

#### Cooperative Patent Classification (CPC)

CPC/IPC/FI Symbols	Description
B	PERFORMING OPERATIONS; TRANSPORTING
<u>B33Y</u>	ADDITIVE MANUFACTURING, i.e. MANUFACTURING OF THREE-DIMENSIONAL [3-D] OBJECTS BY ADDITIVE DEPOSITION, ADDITIVE AGGLOMERATION OR ADDITIVE LAYERING, e.g. BY 3-D PRINTING, STEREO LITHOGRAPHY OR SELECTIVE LASER SINTERING

#### International Patent Classification (IPC)

IPC Symbols	Description
B	PERFORMING OPERATIONS; TRANSPORTING
<b>B33Y</b>	ADDITIVE MANUFACTURING, i.e. MANUFACTURING OF THREE-DIMENSIONAL [3D] OBJECTS BY ADDITIVE DEPOSITION, ADDITIVE AGGLOMERATION OR ADDITIVE LAYERING, e.g. BY 3D PRINTING, STEREO LITHOGRAPHY OR SELECTIVE LASER SINTERING [2015.01]

### 4.11 Wearables, Bionics

#### Wearables

( IPC (smart) = (A61B 5, A63B 24/00, G02B 25, G02B 27, G02C 7, G06F 3/048, G06Q 50/22) OR CPC (smart) = (A61B 5, G02B 25, G02B 27, G02C 7, G06F 3/048, G06Q 50/22) ) AND ( IPC (smart) = (H04L, H04W) OR CPC (smart) = (H04L, H04W, H04W 4/008) ) AND ( Words in abstract and title = ("wearable\*" OR (NEAR(("augment\*", "reality\*"), 3)) OR NEAR(("smart", "watch\*"), 3) OR NEAR(("video\*", "goggle\*"), 3) OR "POV\*" ) )

Or

CPC (smart) = (A61B 5/6801, A61B 5/681, G02B 27/01, G02B 27/22)

or

( IPC (smart) = (A61B 5, A63B 24/00, G02B 25, G02B 27, G02C 7, G06F 3/048, G06Q 50/22) OR CPC (smart) = (A61B 5, G02B 25, G02B 27, G02C 7, G06F 3/048, G06Q 50/22) ) AND PatBase Search Syntax = FT=((wearable\* or ((augmented or augmenting) w3 reality) or (smart w2 watch\*)) and (FT=((wireless\* or transmiss\* or mobil\* or network\*) w3 communi-cat\*)))

## Bionics

(( CPC (smart) = (A61B 5/04001, A61B 5/04888, A61F 2/50, A61F 4, A61F 4/00, A61F 5/0102, A61H 1/0237, A61H 1/0274, A61H 3/008, A63B 21/00181, B25J 9/0006, G05B2219/40305, G05B2219/45109) OR IPC (smart) = (A61F 2/50, A61F 4/00) ) OR Pat-Base Search Syntax (with INPADOC extension) = TAC=(exoskelet\* or (human w3 (kinetic\* or kinematic\*)) or biomechan\* or neuroprosthes\* or neuroprothes\*) ) OR Words in abstract and title = ("neuroprosthes\*" OR "biomechanic\*")

## Cooperative Patent Classification (CPC)

CPC/IPC/FI Symbols	Description
A	HUMAN NECESSITIES
A61	MEDICAL OR VETERINARY SCIENCE; HYGIENE
A61B	DIAGNOSIS; SURGERY; IDENTIFICATION (analysing biological material G01N, e.g. G01N33/48; obtaining records using waves other than optical waves, in general G03B42/00)
<u>A61B5/00</u>	Detecting, measuring or recording for diagnostic purposes (radiation diagnosis A61B6/00; diagnosis by ultrasonic, sonic or infra-sonic waves A61B8/00); Identification of persons
A61B5/04	. Detecting, measuring or recording bioelectric signals of the body or parts thereof
<u>A61B5/04001</u>	.. {adapted to neuroelectric signals, e.g. nerve impulses}
A61B5/0488	.. Electromyography
<u>A61B5/04888</u>	... {Control of prosthetics}
A61B5/68	. {Arrangements of detecting, measuring or recording means, e.g. sensors, in relation to patient}
<u>A61B5/6801</u>	.. {specially adapted to be attached to or worn on the body surface}
A61B5/6802	... {Sensor mounted on worn items}
<u>A61B5/681</u>	.... {Wristwatch-type devices}
A61F	FILTERS IMPLANTABLE INTO BLOOD VESSELS; PROSTHESES; DEVICES PROVIDING PATENCY TO, OR PREVENTING COLLAPSING OF, TUBULAR STRUCTURES OF THE BODY, E.G. STENTS; ORTHOPAEDIC, NURSING OR CONTRACEPTIVE DEVICES; FOMENTATION; TREATMENT OR PROTECTION OF EYES OR EARS; BANDAGES, DRESSINGS OR ABSORBENT PADS; FIRST-AID KITS (dental prosthetics A61C)
A61F2/00	Filters implantable into blood vessels; Prostheses, i.e. artificial substitutes or replacements for parts of the body; Appliances for connecting them with the body; Devices providing patency to, or preventing collapsing of, tubular structures of the body, e.g. stents (as cosmetic articles, see the relevant subclasses, e.g. wigs, hair pieces, A41G3/00, A41G5/00, artificial nails A45D31/00; dental prostheses A61C13/00; materials for prostheses A61L27/00; artificial hearts A61M1/10; artificial kidneys A61M1/14)
<u>A61F2/50</u>	. Prostheses not implantable in the body {(closure means for urethra or rectum or for artificial body openings therefor A61F2/0004)}
<u>A61F4/00</u>	Methods or devices enabling invalids to operate an apparatus or a

CPC/IPC/FI Symbols	Description
A61F5/00	device not forming part of the body (operating or control means for prostheses A61F2/68; {serving devices for one-handed persons A47G21/08}) Orthopaedic methods or devices for non-surgical treatment of bones or joints (surgical instruments or methods for treatment of bones or joints, devices specially adapted therefor A61B17/56); Nursing devices; {Anti-rape devices} (bandages, dressings or absorbent pads A61F13/00)
A61F5/01 <u>A61F5/0102</u>	. Orthopaedic devices, e.g. splints, casts or braces .. {specially adapted for correcting deformities of the limbs or for supporting them; Ortheses, e.g. with articulations}
A61H	PHYSICAL THERAPY APPARATUS, e.g. DEVICES FOR LOCATING OR STIMULATING REFLEX POINTS IN THE BODY; ARTIFICIAL RESPIRATION; MASSAGE; BATHING DEVICES FOR SPECIAL THERAPEUTIC OR HYGIENIC PURPOSES OR SPECIFIC PARTS OF THE BODY (electrotherapy, magnetotherapy, radiation therapy, ultrasound therapy A61N)
A61H1/00	Apparatus for passive exercising (A61H5/00 takes precedence); Vibrating apparatus {(driving means for vibrating A61H23/00)}; Chiropractic devices, e.g. body impacting devices, external devices for briefly extending or aligning unbroken bones
A61H1/02 <u>A61H1/0237</u> <u>A61H1/0274</u>	. Stretching or bending {or torsioning} apparatus for exercising .. {for the lower limbs} .. {for the upper limbs}
A61H3/00  <u>A61H3/008</u>	Appliances for aiding patients or disabled persons to walk about (apparatus for helping babies to walk A47D13/04; {orthopaedic devices for correcting deformities of, or supporting, limbs A61F5/0102}; exercising apparatus for the feet or toes A63B23/10; {stairways or ramps E04F11/00}) . {Using suspension devices for supporting the body in an upright walking or standing position, e.g. harnesses (drawing-out devices A61H1/0218)}
A63 A63B	SPORTS; GAMES; AMUSEMENTS APPARATUS FOR PHYSICAL TRAINING, GYMNASTICS, SWIMMING, CLIMBING, OR FENCING; BALL GAMES; TRAINING EQUIPMENT (apparatus for passive exercising, massage A61H)
A63B21/00  <u>A63B21/00181</u> <u>A63B24/00</u>	Exercising apparatus for developing or strengthening the muscles or joints of the body by working against a counterforce, with or without measuring devices (electric or electronic controls therefor A63B24/00; measuring muscular strength A61B5/22) . {comprising additional means assisting the user to overcome part of the resisting force, i.e. assisted-active exercising} Electric or electronic controls for exercising apparatus of preceding groups; {Controlling or monitoring of exercises, sportive games, training or athletic performances}
B B25  B25J	PERFORMING OPERATIONS; TRANSPORTING HAND TOOLS; PORTABLE POWER-DRIVEN TOOLS; MANIPULATORS MANIPULATORS; CHAMBERS PROVIDED WITH MANIPULATION DEVICES ({manipulators specially adapted for use in surgery A61B34/70; manipulators used in cleaning hollow articles B08B9/04}; manipulators associated with rolling mills B21B39/20; manipulators associated with forging machines B21J13/10; {manipulators associated with picking-up and placing mechanisms B23P19/007}; means for holding wheels or parts thereof B60B30/00; {vehicles with ground-engaging propulsion means, e.g. walking members B62D57/02, B62D57/032; devices for picking-up and depositing articles or materials between conveyors B65G47/90, B65G47/91; manipulators with gripping or holding means for transferring packages B65H67/065}; cranes B66C;

CPC/IPC/FI Symbols	Description
B25J9/00 <u>B25J9/0006</u>	{manipulators used in the protection or supervision of pipe-line installations F17D5/00; walking equipment adapted for nuclear steam-generators F22B37/006}; manipulators specially adapted for, or associated with, nuclear reactors G21C; {apparatus used for handling wafers during manufacture or treatment of semiconductor H01L21/68} Programme-controlled manipulators . {Exoskeletons, i.e. resembling a human figure}
G	PHYSICS
G02	OPTICS (making optical elements or apparatus B24B, B29D11/00, C03, or other appropriate subclasses or classes; materials per se, see the relevant places, e.g. C03B, C03C)
G02B	OPTICAL ELEMENTS, SYSTEMS, OR APPARATUS (G02F takes precedence; measuring-instruments, see the relevant subclass of G01, e.g. optical rangefinders G01C; testing of optical elements, systems, or apparatus G01M11/00; spectacles G02C; sound lenses G10K11/30; electron and ion "optics" H01J; X-ray "optics" H01J, H05G1/00; optical elements structurally combined with electric discharge tubes H01J5/16, H01J29/89, H01J37/22; microwave "optics" H01Q; combination of optical elements with television receivers H04N5/72; heating arrangements specially adapted for transparent or reflecting areas H05B3/84; {optical apparatus 42H})
<u>G02B25/00</u>	Eyepieces; Magnifying glasses (simple lenses G02B3/00)
<u>G02B27/00</u>	Other optical systems; Other optical apparatus (means for bringing about special optical effects in shop-windows, showcases A47F, e.g. A47F11/06; optical toys A63H33/22; designs or pictures characterised by special light effects B44F1/00)
<u>G02B27/01</u>	. Head-up displays
<u>G02B27/22</u>	. for producing stereoscopic or other three dimensional effects (in microscopes G02B21/22; viewing apparatus G02B27/02; stereoscopic television H04N13/00)
G02C	SPECTACLES; SUNGLASSES OR GOGGLES INsofar AS THEY HAVE THE SAME FEATURES AS SPECTACLES; CONTACT LENSES (trial frames for testing the eyes A61B3/04; goggles or eyeshields not having the same features as spectacles A61F9/00)
<u>G02C7/00</u>	Optical parts (characterised by the material G02B1/00)
G05	CONTROLLING; REGULATING (specially adapted to a particular field of use, see the relevant place for that field, e.g. A62C37/00, B03B13/00, B23Q)
G05B	CONTROL OR REGULATING SYSTEMS IN GENERAL; FUNCTIONAL ELEMENTS OF SUCH SYSTEMS; MONITORING OR TESTING ARRANGEMENTS FOR SUCH SYSTEMS OR ELEMENTS (fluid-pressure actuators or systems acting by means of fluids in general F15B; valves per se F16K; characterised by mechanical features only G05G; sensitive elements, see the appropriate subclass, e.g. G12B, subclass of G01, H01; correcting units, see the appropriate subclass, e.g. H02K)
G05B2219/00	Program-control systems
G05B2219/30	. Nc systems
G05B2219/40	.. Robotics, robotics mapping to robotics vision
<u>G05B2219/40305</u>	... Exoskeleton, human robot interaction, extenders
G05B2219/45	.. Nc applications
<u>G05B2219/45109</u>	... Exercise, coordination, therapy, rehabilitation robot for disabled patients
G06	COMPUTING; CALCULATING; COUNTING (score computers for games A63B71/06, A63D15/20, A63F1/18; combinations of writing implements with computing devices B43K29/08)
G06F	ELECTRIC DIGITAL DATA PROCESSING (computer systems

CPC/IPC/FI Symbols	Description
G06F3/00	based on specific computational models G06N) Input arrangements for transferring data to be processed into a form capable of being handled by the computer; Output arrangements for transferring data from processing unit to output unit, e.g. interface arrangements (typewriters B41J; conversion of physical variables F15B5/00, G01; image acquisition G06T1/00, G06F9/00; coding, decoding or code conversion in general H03M; transmission of digital information H04L; {in regulating or control systems G05B})
G06F3/01	. Input arrangements or combined input and output arrangements for interaction between user and computer (G06F3/16 takes precedence)
<u>G06F3/048</u>	.. Interaction techniques based on graphical user interfaces [GUI]
G06Q	DATA PROCESSING SYSTEMS OR METHODS, SPECIALLY ADAPTED FOR ADMINISTRATIVE, COMMERCIAL, FINANCIAL, MANAGERIAL, SUPERVISORY OR FORECASTING PURPOSES; SYSTEMS OR METHODS SPECIALLY ADAPTED FOR ADMINISTRATIVE, COMMERCIAL, FINANCIAL, MANAGERIAL, SUPERVISORY OR FORECASTING PURPOSES, NOT OTHERWISE PROVIDED FOR
G06Q50/00	Systems or methods specially adapted for specific business sectors, e.g. utilities or tourism (healthcare informatics G16H)
G06Q50/10	. Services
<u>G06Q50/22</u>	.. Social work
H	ELECTRICITY
<u>H04L</u>	TRANSMISSION OF DIGITAL INFORMATION, e.g. TELEGRAPHIC COMMUNICATION (typewriters B41J; order telegraphs, fire or police telegraphs G08B; visual telegraphy G08B, G08C; teleautographic systems G08C; ciphering or deciphering apparatus per se G09C; coding, decoding or code conversion, in general H03M; arrangements common to telegraphic and telephonic communication H04M; selecting H04Q)
<u>H04W</u>	WIRELESS COMMUNICATIONS NETWORKS (radio transmission systems H04B7/00; transmission systems using electromagnetic waves other than radio waves, e.g. light, infrared H04B10/00; communication systems using wireless extensions, i.e. wireless links without selective communication, e.g. cordless telephones H04M1/72; broadcast communication H04H)

### International Patent Classification (IPC)

IPC Symbols	Description
H	ELECTRICITY
H04	ELECTRIC COMMUNICATION TECHNIQUE
<b>H04W</b>	WIRELESS COMMUNICATION NETWORKS [2009.01]
<b>H04W48/00</b>	Access restriction; Network selection; Access point selection [2009.01]
<b>H04L</b>	TRANSMISSION OF DIGITAL INFORMATION, e.g. TELEGRAPHIC COMMUNICATION (arrangements common to telegraphic and telephonic communication H04M) [4]

## 4.12 Radiation Diagnosis and Therapy

Bioimaging, Radio Diagnosis

( CPC (smart) = (A61B 6, A61B 6/037, A61B 6/06, A61B 6/40, A61B 6/4092, A61B 6/4233, A61B 6/4291, A61B 6/484, A61N 5/1049, A61N 5/1064, A61N 5/1067, A61N2005/1061, A61N2005/1087) OR IPC (smart) = (A61B 5/055, A61B 6/00) )

Radio Therapy

( CPC (smart) = (A61K 51, A61N 5/10, A61N2005/1061, A61N2005/1087) OR IPC (smart) = (A61K 51, A61N 5/10) )

### Cooperative Patent Classification (CPC)

CPC/IPC/FI Symbols	Description
A	HUMAN NECESSITIES
A61	MEDICAL OR VETERINARY SCIENCE; HYGIENE
A61B	DIAGNOSIS; SURGERY; IDENTIFICATION (analysing biological material G01N, e.g. G01N33/48; obtaining records using waves other than optical waves, in general G03B42/00)
A61B5/00	Detecting, measuring or recording for diagnostic purposes (radiation diagnosis A61B6/00; diagnosis by ultrasonic, sonic or infrasonic waves A61B8/00); Identification of persons
A61B5/05	. Detecting, measuring or recording for diagnosis by means of electric currents or magnetic fields; {Measuring using microwaves or radiowaves} (A61B5/02, A61B5/04, A61B5/11 take precedence)
<u>A61B5/055</u>	.. involving electronic or nuclear magnetic resonance, e.g. magnetic resonance imaging (arrangements or instruments for measuring magnetic variables involving electronic or nuclear magnetic resonance, in general G01R33/20)
<u>A61B6/00</u>	Apparatus for radiation diagnosis, e.g. combined with radiation therapy equipment (analysis of materials using radiation G01N23/00, detecting hidden objects by radiation G01V5/0008, radiodiagnostic or X-ray contrast preparations A61K49/00; radiation therapy per se A61N5/00; instruments measuring radiation intensity for application in the field of nuclear medicine, e.g. in vivo counting G01T1/161; apparatus for taking X-ray photographs G03B42/02; X-ray photographic processes G03C5/16; irradiation devices G21K; X-ray apparatus or circuits therefor H05G1/00)
A61B6/02	. Devices for diagnosis sequentially in different planes; Stereoscopic radiation diagnosis
A61B6/03	.. Computerised tomographs ({diagnosis by magnetic resonance imaging A61B5/055;} echo-tomography A61B8/14)
<u>A61B6/037</u>	... {Emission tomography (detector details for PET G01T1/2985, detector details for SPECT G01T1/1644)}
<u>A61B6/06</u>	. Diaphragms {for particular diagnostic applications, e.g. tomography, i.e. not of general applicability (diaphragms, e.g. variable, or collimators in general G21K1/02)}
<u>A61B6/40</u>	. {with arrangements for generating radiation specially adapted for radiation diagnosis (X-ray tubes or details thereof H01J35/00)}
A61B6/4064	.. {adapted for producing a particular type of beam}
<u>A61B6/4092</u>	... {for producing synchrotron radiation}
A61B6/42	. {with arrangements for detecting radiation specially adapted for radiation diagnosis (details of radiation detection G01T1/00)}
A61B6/4208	.. {characterised by using a particular type of detector}

CPC/IPC/FI Symbols	Description
<u>A61B6/4233</u>	... {using matrix detectors (for semiconductor radiation detectors G01T1/24, G01T1/2928)}
<u>A61B6/4291</u>	.. {the detector being combined with a grid or grating}
A61B6/48	. {Diagnostic techniques (A61B6/022, A61B6/032, A61B6/037 take precedence)}
<u>A61B6/484</u>	.. {involving phase contrast X-ray imaging}
A61K	PREPARATIONS FOR MEDICAL, DENTAL, OR TOILET PURPOSES (devices or methods specially adapted for bringing pharmaceutical products into particular physical or administering forms A61J3/00; chemical aspects of, or use of materials for deodorisation of air, for disinfection or sterilisation, or for bandages, dressings, absorbent pads or surgical articles A61L {; compounds per se C01, C07, C08, C12N; } soap compositions C11D {; microorganisms per se C12N})
<u>A61K51/00</u>	Preparations containing radioactive substances for use in therapy or testing in vivo
A61N	ELECTROTHERAPY; MAGNETOTHERAPY; RADIATION THERAPY; ULTRASOUND THERAPY (measurement of bioelectric currents A61B; surgical instruments, devices or methods for transferring non-mechanical forms of energy to or from the body A61B18/00; anaesthetic apparatus in general A61M; incandescent lamps H01K; infra-red radiators for heating H05B)
A61N5/00	Radiation therapy (ultrasound therapy A61N7/00; devices or apparatus applicable to both therapy and diagnosis A61B6/00)
<u>A61N5/10</u>	. X-ray therapy; Gamma-ray therapy; Particle-irradiation therapy (A61N5/01 takes precedence {; radiation diagnosis, e.g. combined with radiation therapy A61B6/00; irradiation devices in general G21K1/00; X-ray tubes, Lenard tubes H01J35/00; X-ray techniques, in particular circuits for feeding or controlling X-ray tubes, H05G})
A61N5/1048	.. {Monitoring, verifying, controlling systems and methods}
<u>A61N5/1049</u>	... {for verifying the position of the patient with respect to the radiation beam}
<u>A61N2005/1061</u>	.... {using an x-ray imaging system having a separate imaging source}
<u>A61N5/1064</u>	... {for adjusting radiation treatment in response to monitoring}
A61N5/1065	.... {Beam adjustment}
<u>A61N5/1067</u>	..... {in real time, i.e. during treatment}
A61N2005/1085	.. {characterised by the type of particles applied to the patient}
<u>A61N2005/1087</u>	... {Ions; Protons}

## 4.13 Protein Engineering

( IPC (smart) = (C07K, C07K 1, C07K 2, C07K 4, C07K 5, C07K 7, C07K 9, C07K 11, C07K 14, C07K 16, C07K 17, C07K 19, C07Kmiss, C12N) OR CPC (smart) = (C07K, C07K 1, C07K 2, C07K 4, C07K 5, C07K 7, C07K 9, C07K 11, C07K 14, C07K 16, C07K 17, C07K 19, C07K2299, C07K2316, C07K2317, C07K2318, C07K2319, C12N, C12Nmiss) )

### Cooperative Patent Classification (CPC)

CPC/IPC/FI Symbols	Description
C	CHEMISTRY; METALLURGY
C07	ORGANIC CHEMISTRY (such compounds as the oxides, sulfides, or oxysulfides of carbon, cyanogen, phosgene, hydrocyanic acid or salts thereof C01; products obtained from layered base-exchange silicates by ion-exchange with organic compounds such as ammonium, phosphonium or sulfonium compounds or by intercalation of organic compounds C01B33/44; macromolecular compounds C08; dyes C09; fermentation products C12; fermentation or enzyme-using processes to synthesise a desired chemical compound or composition or to separate optical isomers from a racemic mixture C12P; production of organic compounds by electrolysis or electrophoresis C25B3/00, C25B7/00)
<u>C07K</u>	PEPTIDES (peptides in foodstuffs A23; obtaining protein compositions for foodstuffs, working-up proteins for foodstuffs A23J; preparations for medicinal purposes A61K; peptides containing beta-lactam rings C07D; cyclic dipeptides not having in their molecule any other peptide link than those which form their ring, e.g. piperazine-2,5-diones, C07D; ergot alkaloids of the cyclic peptide type C07D519/02; macromolecular compounds having statistically distributed amino acid units in their molecules, i.e. when the preparation does not provide for a specific; but for a random sequence of the amino acid units, homopolyamides and block copolyamides derived from amino acids C08G69/00; macromolecular products derived from proteins C08H1/00; preparation of glue or gelatine C09H; single cell proteins, enzymes C12N; genetic engineering processes for obtaining peptides C12N15/00; compositions for measuring or testing processes involving enzymes C12Q; investigation or analysis of biological material G01N33/00)
<u>C07K1/00</u>	General methods for the preparation of peptides {, i.e. processes for the organic chemical preparation of peptides or proteins of any length}
<u>C07K2/00</u>	Peptides of undefined number of amino acids; Derivatives thereof
<u>C07K4/00</u>	Peptides having up to 20 amino acids in an undefined or only partially defined sequence; Derivatives thereof
<u>C07K5/00</u>	Peptides containing up to four amino acids in a fully defined sequence; Derivatives thereof
<u>C07K7/00</u>	Peptides having 5 to 20 amino acids in a fully defined sequence; Derivatives thereof
<u>C07K9/00</u>	Peptides having up to 20 amino acids, containing saccharide radicals and having a fully defined sequence; Derivatives thereof
<u>C07K11/00</u>	Depsipeptides having up to 20 amino acids in a fully defined sequence; Derivatives thereof
<u>C07K14/00</u>	Peptides having more than 20 amino acids; Gastrins; Somatostatins; Melanotropins; Derivatives thereof
<u>C07K16/00</u>	Immunoglobulins [IGs], e.g. monoclonal or polyclonal antibodies {(antibodies with enzymatic activity, e.g. abzymes C12N9/0002)}
<u>C07K17/00</u>	Carrier-bound or immobilised peptides (carrier-bound or immobilised enzymes C12N11/00); Preparation thereof
<u>C07K19/00</u>	Hybrid peptides
<u>C07K2299/00</u>	Coordinates from 3D structures of peptides, e.g. proteins or enzymes

CPC/IPC/FI Symbols	Description
<u>C07K2317/00</u>	Immunoglobulins specific features
<u>C07K2318/00</u>	Antibody mimetics or scaffolds
<u>C07K2319/00</u>	Fusion polypeptide
<u>C12N</u>	MICROORGANISMS OR ENZYMES; COMPOSITIONS THEREOF (biocides, pest repellants or attractants, or plant growth regulators, containing microorganisms, viruses, microbial fungi, enzymes, fermentates or substances produced by or extracted from microorganisms or animal material A01N63/00; food compositions A21, A23; medicinal preparations A61K; chemical aspects of, or use of materials for, bandages, dressings, absorbent pads or surgical articles A61L; fertilisers C05); PROPAGATING, PRESERVING OR MAINTAINING MICROORGANISMS (preservation of living parts of humans or animals A01N1/02); MUTATION OR GENETIC ENGINEERING; CULTURE MEDIA (microbiological testing media C12Q)

#### International Patent Classification (IPC)

IPC Symbols	Description
C	CHEMISTRY; METALLURGY
<b>C07K</b>	PEPTIDES (peptides containing $\beta$ -lactam rings C07D; cyclic dipeptides not having in their molecule any other peptide link than those which form their ring, e.g. piperazine-2,5-diones, C07D; ergot alkaloids of the cyclic peptide type C07D519/02; single cell proteins, enzymes C12N; genetic engineering processes for obtaining peptides C12N15/00) [4]
<b>C12N</b>	MICROORGANISMS OR ENZYMES; COMPOSITIONS THEREOF (biocides, pest repellants or attractants, or plant growth regulators containing microorganisms, viruses, microbial fungi, enzymes, fermentates, or substances produced by, or extracted from, microorganisms or animal material A01N63/00; medicinal preparations A61K; fertilisers C05F); PROPAGATING, PRESERVING, OR MAINTAINING MICROORGANISMS; MUTATION OR GENETIC ENGINEERING; CULTURE MEDIA (microbiological testing media C12Q1/00) [3]

### 4.14 Drug Discovery Systems Biology

#### Systems Biology

(( CPC (smart) = (G06F 17/10, G06F 19, G06F 19/28) OR IPC (smart) = (G06F 17/10, G06F 19/00, G06F 19/28) ) AND Tag = Life\_Biotech\_Extended\_12\_17 OR CPC (smart) = (C07K2299, C12N 15/1037, C12N 15/1093, G06F 19/10, G06F 19/16, G06F 19/18, G06F 19/22, G06F 19/706, Y10S 977/808) OR IPC (smart) = (G06F 19/16, G06F 19/18, G06F 19/22) ) OR PatBase Search Syntax = FT=((Drug\* w3 targeting\*) or (systems\* w2 biology\*) or pharmacophor\*) and SC=(G06F or C40)

#### Rational Drug Discovery

( CPC (smart) = (G06F 17/10, G06F 19) OR IPC (smart) = (G06F 17/10, G06F 19/00) ) AND Tag = Life\_Pharma\_01\_18 OR CPC (smart) = (C40B 30/02, C40B 30/04, C40B 50/02, G06F 19/16, G06F 19/24, G06F 19/706, Y10S 977/808) OR IPC (smart) = (C40B 20/04, C40B 30/02, C40B 30/04, C40B 50/02, G06F 19/16) OR PatBase Search Syntax = FT=((virtual\* or ((target\* or structure) w2 based)) w5 ((lead optimizati\*) or (drug design\*)) or (silico\* w drug w screen\*) or (predictiv\* w systems w modelli\*) or (drug w target\* w discover\*) or (rational w target w develo\*)) OR PatBase Search Syntax = TAC= ((algorithm\*) and SC=(A61K31))

## Cooperative Patent Classification (CPC)

CPC/IPC/FI Symbols	Description
C	CHEMISTRY; METALLURGY
C07	ORGANIC CHEMISTRY (such compounds as the oxides, sulfides, or oxysulfides of carbon, cyanogen, phosgene, hydrocyanic acid or salts thereof C01; products obtained from layered base-exchange silicates by ion-exchange with organic compounds such as ammonium, phosphonium or sulfonium compounds or by intercalation of organic compounds C01B33/44; macromolecular compounds C08; dyes C09; fermentation products C12; fermentation or enzyme-using processes to synthesise a desired chemical compound or composition or to separate optical isomers from a racemic mixture C12P; production of organic compounds by electrolysis or electrophoresis C25B3/00, C25B7/00)
C07K	PEPTIDES (peptides in foodstuffs A23; obtaining protein compositions for foodstuffs, working-up proteins for foodstuffs A23J; preparations for medicinal purposes A61K; peptides containing beta-lactam rings C07D; cyclic dipeptides not having in their molecule any other peptide link than those which form their ring, e.g. piperazine-2,5-diones, C07D; ergot alkaloids of the cyclic peptide type C07D519/02; macromolecular compounds having statistically distributed amino acid units in their molecules, i.e. when the preparation does not provide for a specific; but for a random sequence of the amino acid units, homopolyamides and block copolyamides derived from amino acids C08G69/00; macromolecular products derived from proteins C08H1/00; preparation of glue or gelatine C09H; single cell proteins, enzymes C12N; genetic engineering processes for obtaining peptides C12N15/00; compositions for measuring or testing processes involving enzymes C12Q; investigation or analysis of biological material G01N33/00)
<u>C07K2299/00</u>	Coordinates from 3D structures of peptides, e.g. proteins or enzymes
C12	BIOCHEMISTRY; BEER; SPIRITS; WINE; VINEGAR; MICROBIOLOGY; ENZYMOLOGY; MUTATION OR GENETIC ENGINEERING
C12N	MICROORGANISMS OR ENZYMES; COMPOSITIONS THEREOF (biocides, pest repellants or attractants, or plant growth regulators, containing microorganisms, viruses, microbial fungi, enzymes, fermentates or substances produced by or extracted from microorganisms or animal material A01N63/00; food compositions A21, A23; medicinal preparations A61K; chemical aspects of, or use of materials for, bandages, dressings, absorbent pads or surgical articles A61L; fertilisers C05); PROPAGATING, PRESERVING OR MAINTAINING MICROORGANISMS (preservation of living parts of humans or animals A01N1/02); MUTATION OR GENETIC ENGINEERING; CULTURE MEDIA (microbiological testing media C12Q)
C12N15/00	Mutation or genetic engineering; DNA or RNA concerning genetic engineering, vectors, e.g. plasmids, or their isolation, preparation or purification; Use of hosts therefor (mutants or genetically engineered microorganisms, per se C12N1/00, C12N5/00, C12N7/00; new plants per se A01H; plant reproduction by tissue culture techniques A01H4/00; new animals per se A01K67/00; use of medicinal preparations containing genetic material which is inserted into cells of the living body to treat genetic diseases, gene therapy A61K48/00)
C12N15/09	. Recombinant DNA-technology
C12N15/10	.. Processes for the isolation, preparation or purification of DNA or RNA (chemical preparation of DNA or RNA C07H21/00; preparation of non-structural polynucleotides from microorganisms or with enzymes C12P19/34)
C12N15/1034	... {Isolating an individual clone by screening libraries}
<u>C12N15/1037</u>	.... {Screening libraries presented on the surface of microorganisms,

CPC/IPC/FI Symbols	Description
	e.g. phage display, E. coli display}
<u>C12N15/1093</u>	.... {General methods of preparing gene libraries, not provided for in other subgroups}
C40	COMBINATORIAL CHEMISTRY
C40B	COMBINATORIAL CHEMISTRY; LIBRARIES, e.g. CHEMICAL LIBRARIES, IN SILICO LIBRARIES
C40B20/00	Methods specially adapted for identifying library members
<u>C40B20/04</u>	. Identifying library members by means of a tag, label, or other readable or detectable entity associated with the library members, e.g. decoding processes
C40B30/00	Methods of screening libraries
<u>C40B30/02</u>	. In silico screening
<u>C40B30/04</u>	. by measuring the ability to specifically bind a target molecule, e.g. antibody-antigen binding, receptor-ligand binding
C40B50/00	Methods of creating libraries, e.g. combinatorial synthesis
<u>C40B50/02</u>	. In silico or mathematical conception of libraries
G	PHYSICS
G06	COMPUTING; CALCULATING; COUNTING (score computers for games A63B71/06, A63D15/20, A63F1/18; combinations of writing implements with computing devices B43K29/08)
G06F	ELECTRIC DIGITAL DATA PROCESSING (computer systems based on specific computational models G06N)
G06F17/00	Digital computing or data processing equipment or methods, specially adapted for specific functions
<u>G06F17/10</u>	. Complex mathematical operations {(function generation by table look-up G06F1/03; evaluation of elementary functions by calculation G06F7/544)}
<u>G06F19/00</u>	Digital computing or data processing equipment or methods, specially adapted for specific applications (specially adapted for specific functions G06F17/00; data processing systems or methods specially adapted for administrative, commercial, financial, managerial, supervisory or forecasting purposes G06Q; healthcare informatics G16H)
<u>G06F19/10</u>	. Bioinformatics, i.e. methods or systems for genetic or protein-related data processing in computational molecular biology (in silico methods of screening virtual chemical libraries C40B30/02; in silico or mathematical methods of creating virtual chemical libraries C40B50/02)
<u>G06F19/16</u>	.. for molecular structure, e.g. structure alignment, structural or functional relations, protein folding, domain topologies, drug targeting using structure data, involving two-dimensional or three-dimensional structures
<u>G06F19/18</u>	.. for functional genomics or proteomics, e.g. genotype-phenotype associations, linkage disequilibrium, population genetics, binding site identification, mutagenesis, genotyping or genome annotation, protein-protein interactions or protein-nucleic acid interactions
<u>G06F19/22</u>	.. for sequence comparison involving nucleotides or amino acids, e.g. homology search, motif or Single-Nucleotide Polymorphism [SNP] discovery or sequence alignment
<u>G06F19/24</u>	.. for machine learning, data mining or biostatistics, e.g. pattern finding, knowledge discovery, rule extraction, correlation, clustering or classification
<u>G06F19/28</u>	.. for programming tools or database systems, e.g. ontologies, heterogeneous data integration, data warehousing or computing architectures
G06F19/70	. {Chemoinformatics, i.e. data processing methods or systems for the retrieval, analysis, visualisation, or storage of physicochemical or structural data of chemical compounds (in silico methods of screening virtual chemical libraries C40B30/02; in silico or mathematical methods of creating virtual chemical libraries C40B50/02;

CPC/IPC/FI Symbols	Description
<u>G06F19/706</u>	computer-aided design per se G06F17/50; bioinformatics G06F19/10; processing of 2D or 3D images G06T} .. {for drug design with the emphasis on a therapeutic agent, e.g. ligand-biological target interactions, pharmacophore generation (drug targeting using protein structure data G06F19/16; binding site identification G06F19/18)}
Y	GENERAL TAGGING OF NEW TECHNOLOGICAL DEVELOPMENTS; GENERAL TAGGING OF CROSS-SECTIONAL TECHNOLOGIES SPANNING OVER SEVERAL SECTIONS OF THE IPC; TECHNICAL SUBJECTS COVERED BY FORMER USPC CROSS-REFERENCE ART COLLECTIONS [XRACs] AND DIGESTS
Y10	TECHNICAL SUBJECTS COVERED BY FORMER USPC
Y10S	TECHNICAL SUBJECTS COVERED BY FORMER USPC CROSS-REFERENCE ART COLLECTIONS [XRACs] AND DIGESTS
Y10S977/00	Nanotechnology
Y10S977/70	. Nanostructure
Y10S977/788	.. Of specified organic or carbon-based composition
Y10S977/802	... Virus-based particle
Y10S977/806	.... with exterior chemical attachment
<u>Y10S977/808</u>	..... Exterior attachment for targeting, e.g. drug targeting

## 4.15 Classical Organic Pharmaceutical Active Substances

( IPC (smart) = A61K 31 OR CPC (smart) = A61K 31 ) AND ( IPC (smart) = (C07C, C07D, C07F, C07G, C07H) OR CPC (smart) = (C07C, C07Cmiss, C07D, C07Dmiss, C07F, C07Fmiss, C07G, C07Gmiss, C07H, C07Hmiss) ) AND NOT Tag = Life\_ProteinEngineering\_03\_18

### Cooperative Patent Classification (CPC)

CPC/IPC/FI Symbols	Description
A	HUMAN NECESSITIES
A61	MEDICAL OR VETERINARY SCIENCE; HYGIENE
A61K	PREPARATIONS FOR MEDICAL, DENTAL, OR TOILET PURPOSES (devices or methods specially adapted for bringing pharmaceutical products into particular physical or administering forms A61J3/00; chemical aspects of, or use of materials for deodorisation of air, for disinfection or sterilisation, or for bandages, dressings, absorbent pads or surgical articles A61L {; compounds per se C01, C07, C08, C12N;} soap compositions C11D {; microorganisms per se C12N})
<u>A61K31/00</u>	Medicinal preparations containing organic active ingredients
C	CHEMISTRY; METALLURGY
<u>C07C</u>	ACYCLIC OR CARBOCYCLIC COMPOUNDS
<u>C07D</u>	HETEROCYCLIC COMPOUNDS
<u>C07F</u>	ACYCLIC, CARBOCYCLIC OR HETEROCYCLIC COMPOUNDS CONTAINING ELEMENTS OTHER THAN CARBON, HYDROGEN, HALOGEN, OXYGEN, NITROGEN, SULFUR, SELENIUM OR TELLURIUM (metal-containing porphyrins C07D487/22)
<u>C07G</u>	COMPOUNDS OF UNKNOWN CONSTITUTION
<u>C07H</u>	SUGARS; DERIVATIVES THEREOF; NUCLEOSIDES; NUCLEOTIDES; NUCLEIC ACIDS (derivatives of aldonic or saccharic acids C07C, C07D; aldonic acids, saccharic acids C07C59/105, C07C59/285; cyanohydrins C07C255/16; glycals C07D; compounds of unknown constitution C07G; polysaccharides, derivatives thereof C08B; DNA or RNA concerning genetic engineering, vectors, e.g. plasmids, or their isolation, preparation or purification C12N15/00; sugar industry C13)

## 4.16 Organic & Perovskite Photovoltaics

( CPC (smart) = (H01G 9/2059, H01L2031/0344, Y02E 10/542, Y02E 10/549) OR Words in abstract and title = (NEAR(("dye\*", "sensitiz\*"), 5) OR NEAR(("perovskit\*", "solar\*"), 5) OR NEAR(("perovskit\*", "photovolt\*"), 5) )

or Patbase: FT=((perovskit\* or (dye w3 sensitiz\*)) w5 (solar or photovolt\*))

### Cooperative Patent Classification (CPC)

CPC/IPC/FI Symbols	Description
H	ELECTRICITY
H01	BASIC ELECTRIC ELEMENTS
H01G	CAPACITORS; CAPACITORS, RECTIFIERS, DETECTORS, SWITCHING DEVICES OR LIGHT-SENSITIVE DEVICES, OF THE ELECTROLYTIC TYPE (selection of specified materials as dielectric H01B3/00; {ceramics C04B})
H01G9/00	Electrolytic capacitors, rectifiers, detectors, switching devices, light-sensitive or temperature-sensitive devices; Processes of their

CPC/IPC/FI Symbols	Description
H01G9/20 <u>H01G9/2059</u>	manufacture . Light-sensitive devices .. {comprising an organic dye as the active light absorbing material, e.g. adsorbed on an electrode or dissolved in solution}
H01L	SEMICONDUCTOR DEVICES; ELECTRIC SOLID STATE DEVICES NOT OTHERWISE PROVIDED FOR (use of semiconductor devices for measuring G01; resistors in general H01C; magnets, inductors {in general} , transformers H01F; capacitors in general H01G; electrolytic devices H01G9/00; batteries, accumulators H01M; waveguides, resonators or lines of the waveguide type H01P; line connectors, current collectors H01R; stimulated emission devices H01S; electromechanical resonators H03H; loudspeakers, microphones, gramophone pick-ups or like acoustic electromechanical transducers H04R; electric light sources in general H05B; printed circuits, hybrid circuits, casings or constructional details of electric apparatus, manufacture of assemblages of electrical components H05K; use of semiconductor devices in circuits having a particular application, see the subclass for the application)
H01L31/00	Semiconductor devices sensitive to infra-red radiation, light, electromagnetic radiation of shorter wavelength or corpuscular radiation and adapted either for the conversion of the energy of such radiation into electrical energy or for the control of electrical energy by such radiation; Processes or apparatus peculiar to the manufacture or treatment thereof or of parts thereof; Details thereof (H01L51/42 takes precedence; devices consisting of a plurality of solid state components formed in, or on, a common substrate, other than combinations of radiation-sensitive components with one or more electric light sources, H01L27/00; measurement of X-radiation, gamma radiation, corpuscular radiation or cosmic radiation with semiconductor detectors G01T1/24, with resistance detectors G01T1/26; measurement of neutron radiation with semiconductor detectors G01T3/08; couplings of light guides with optoelectronic elements G02B6/42; obtaining energy from radioactive sources G21H)
H01L31/0248	. characterised by their semiconductor bodies
H01L31/0256	.. characterised by the material
<u>H01L2031/0344</u>	... {Organic materials}
Y	GENERAL TAGGING OF NEW TECHNOLOGICAL DEVELOPMENTS; GENERAL TAGGING OF CROSS-SECTIONAL TECHNOLOGIES SPANNING OVER SEVERAL SECTIONS OF THE IPC; TECHNICAL SUBJECTS COVERED BY FORMER USPC CROSS-REFERENCE ART COLLECTIONS [XRACS] AND DIGESTS
Y02	TECHNOLOGIES OR APPLICATIONS FOR MITIGATION OR ADAPTATION AGAINST CLIMATE CHANGE
Y02E	REDUCTION OF GREENHOUSE GAS [GHG] EMISSIONS, RELATED TO ENERGY GENERATION, TRANSMISSION OR DISTRIBUTION
Y02E10/00	Energy generation through renewable energy sources
Y02E10/50	. Photovoltaic [PV] energy
Y02E10/54	.. Material technologies
<u>Y02E10/542</u>	... Dye sensitized solar cells
<u>Y02E10/549</u>	... organic PV cells

## 4.17 Waste Water, Biomass, Carbon Capture

### Biomass\_Fermentation

( CPC (smart) = (C02F 11/04, C02F2203, C10J2300/0916, C12P2203/00, F26B2200/02, Y02E 50/14, Y02E 50/30, Y02E 50/343, Y02P 20/136, Y02P 20/145, Y02W 30/47, Y02W 90/20) OR IPC (original) = C02F 11/04 )

### Wastewater

( CPC (smart) = (C02F 1, C02F 1/30, C02F 3, C02F 9, C02F 11/04, C02F2203, C02F2209, Y02W 10/00, Y02W 10/10, Y02W 10/20, Y02W 10/30, Y02W 10/40) OR IPC (original) = (C02F 1, C02F 3, C02F 9, C02F 11/04) )

### CarbonCapture

(( CPC (smart) = (B01D 53/04, B01D 53/047, B01D 53/14, B01D 53/1475, B01D 53/22, B01D 53/62, B01D2257/50, B01D2257/504, C01B 31/20, C01B2203/0283, C01B2203/0475, Y02C 10, Y02C 10/00, Y02C 10/02, Y02P 20/152) OR IPC (original) = (B01D 53/04, B01D 53/047, B01D 53/14, B01D 53/22, B01D 53/62, C01B 31/20) ) AND PatBase search syntax = FT=((footprint\* or captur\* or (carbon w2 capture\*) or (reduc\* w3 emissions\*) or environment\* or green or umwelt\*) and (co2 or carbondiox\* or kohlen-diox\* or (carbon w2 diox\*))) and SC=(b01d53 or y02c\* or y02w30\*) not FT=((combustion\* w3 gas\*) or flue or (process w2 stream\*) or crude or sulphur\* or So2) OR ( Owner of cited patents (incl. inactive) = (Calera, CARBON ENGINEERING PARTNERSHIP, CARBON SINK, CCM RES, CCM RESEARCH, CCM RESEARCH, CHICHILNISKY, CHICHILNISKY GRACIELA, CLIMEWORKS, EISENBERGER PETER) OR Original Inventor = (JAMES WEIFU LEE) )) OR F-term (smart) = (4D006/PB64, 4H006/BE41)

### Cooperative Patent Classification (CPC)

CPC/IPC/FI Symbols	Description
B	PERFORMING OPERATIONS; TRANSPORTING
B01	PHYSICAL OR CHEMICAL PROCESSES OR APPARATUS IN GENERAL (furnaces, kilns, ovens, retorts in general F27)
B01D	SEPARATION (separating solids from solids by wet methods B03B, B03D; by pneumatic jigs or tables B03B; by other dry methods B07; magnetic or electrostatic separation of solid materials from solid materials or fluids, separation by high-voltage electric fields B03C; centrifuges, vortex apparatus B04; presses per se for squeezing-out liquid from liquid-containing material B30B9/02; treatment of water C02F, e.g. softening by ion-exchange C02F1/42; {arrangements of air intake cleaners in gas turbine plants F02C7/05};arrangements or mounting of filters in air-conditioning, air-humidification or ventilation F24F13/28)
B01D53/00	Separation of gases or vapours; Recovering vapours of volatile solvents from gases; Chemical or biological purification of waste gases, e.g. engine exhaust gases, smoke, fumes, flue gases, aerosols, (recovery of volatile solvents by condensation B01D5/00; sublimation B01D7/00; cold traps, cold baffles B01D8/00; working-up undefined gaseous mixtures obtained by cracking hydrocarbon oils C10G70/00; cleaning coal gas C10K; working-up of natural gas, or synthetic natural gas, C10L3/10; separation of difficult-to-condense gases or air by liquefaction F25J; for investigating mate-

CPC/IPC/FI Symbols	Description
B01D53/02	rials G01N30/00) . by adsorption, e.g. preparative gas chromatography {(solid sorbent compositions B01J20/00, preparation of inorganic compounds or elements C01)}
<u>B01D53/04</u>	.. with stationary adsorbents {(B01D53/025 takes precedence)}
<u>B01D53/047</u>	... Pressure swing adsorption
<u>B01D53/14</u>	. by absorption
B01D53/1456	.. {Removing acid components}
<u>B01D53/1475</u>	... {Removing carbon dioxide}
<u>B01D53/22</u>	. by diffusion (manufacturing semi-permeable membranes B01D67/00; form, structure or properties of semi-permeable membranes B01D69/00; material for semi-permeable membranes B01D71/00)
B01D53/34	. Chemical or biological purification of waste gases
B01D53/46	.. Removing components of defined structure
<u>B01D53/62</u>	... Carbon oxides
B01D2257/00	Components to be removed
<u>B01D2257/50</u>	. Carbon oxides
<u>B01D2257/504</u>	.. Carbon dioxide
C	CHEMISTRY; METALLURGY
C01	INORGANIC CHEMISTRY (processing powders of inorganic compounds preparatory to the manufacturing of ceramic products C04B35/00; fermentation or enzyme-using processes for the preparation of elements or inorganic compounds except carbon dioxide C12P3/00; obtaining metal compounds from mixtures, e.g. ores, which are intermediate compounds in a metallurgical process for obtaining a free metal C21B, C22B; production of non-metallic elements or inorganic compounds by electrolysis or electrophoresis C25B)
C01B	NON-METALLIC ELEMENTS; COMPOUNDS THEREOF; {MET-ALLOIDS OR COMPOUNDS THEREOF NOT COVERED BY SUBCLASS C01C}
C01B2203/00	Integrated processes for the production of hydrogen or synthesis gas (reactors or details thereof B01J2208/00 - B01J2219/00)
C01B2203/02	. Processes for making hydrogen or synthesis gas
<u>C01B2203/0283</u>	.. containing a CO-shift step, i.e. a water gas shift step
C01B2203/04	. containing a purification step for the hydrogen or the synthesis gas
C01B2203/0465	.. Composition of the impurity
<u>C01B2203/0475</u>	... the impurity being carbon dioxide
C02	TREATMENT OF WATER, WASTE WATER, SEWAGE, OR SLUDGE (settling tanks, filtering, e.g. sand filters or screening devices, B01D)
C02F	TREATMENT OF WATER, WASTE WATER, SEWAGE, OR SLUDGE (separation in general B01D; special arrangements on waterborne vessels of installations for treating water, waste water or sewage, e.g. for producing fresh water, B63J; adding materials to water to prevent corrosion C23F; treating radioactively-contaminated liquids G21F9/04; regeneration of reactants for recirculation into processes, see the relevant places for the processes)
<u>C02F1/00</u>	Treatment of water, waste water, or sewage (C02F3/00 - C02F9/00 take precedence)
<u>C02F1/30</u>	. by irradiation
<u>C02F3/00</u>	Biological treatment of water, waste water, or sewage {(C02F1/006 takes precedence)}
<u>C02F9/00</u>	Multistage treatment of water, waste water, or sewage
C02F11/00	Treatment of sludge; Devices therefor
C02F11/02	. Biological treatment

CPC/IPC/FI Symbols	Description
<u>C02F11/04</u>	.. Anaerobic treatment; Production of methane by such processes
<u>C02F2203/00</u>	Apparatus and plants for the biological treatment of water, waste water or sewage
<u>C02F2209/00</u>	Controlling or monitoring parameters in water treatment
C10	PETROLEUM, GAS OR COKE INDUSTRIES; TECHNICAL GASES CONTAINING CARBON MONOXIDE; FUELS; LUBRICANTS; PEAT
C10J	PRODUCTION OF PRODUCER GAS, WATER-GAS, SYNTHESIS GAS FROM SOLID CARBONACEOUS MATERIAL, OR MIXTURES CONTAINING THESE GASES (synthesis gas from liquid or gaseous hydrocarbons C01B; underground gasification of minerals E21B43/295); CARBURETTING AIR OR OTHER GASES
C10J2300/00	Details of gasification processes
C10J2300/09	. Details of the feed, e.g. feeding of spent catalyst, inert gas or halogens
C10J2300/0913	.. Carbonaceous raw material
<u>C10J2300/0916</u>	... Biomass
C12	BIOCHEMISTRY; BEER; SPIRITS; WINE; VINEGAR; MICROBIOLOGY; ENZYMOLOGY; MUTATION OR GENETIC ENGINEERING
C12P	FERMENTATION OR ENZYME-USING PROCESSES TO SYNTHESISE A DESIRED CHEMICAL COMPOUND OR COMPOSITION OR TO SEPARATE OPTICAL ISOMERS FROM A RACEMIC MIXTURE {(brewing of beer C12C; producing vinegar C12J; producing specific peptides or proteins C07K; producing enzymes C12N9/00; DNA or RNA concerning genetic engineering, vectors, e.g. plasmids, or their isolation, preparation or purification C12N15/00; measuring or testing processes involving enzymes or microorganisms C12Q; measuring or testing processes involving nucleic acid amplification reactions C12Q1/6844; fermentation processes to form a food composition, A21 or A23; compounds in general, see the relevant compound class, e.g. C01, C07)}
<u>C12P2203/00</u>	Fermentation products obtained from optionally pretreated or hydrolyzed cellulosic or lignocellulosic material as the carbon source (ethanol C12P7/10)
F	MECHANICAL ENGINEERING; LIGHTING; HEATING; WEAPONS; BLASTING
F26	DRYING
F26B	DRYING SOLID MATERIALS OR OBJECTS BY REMOVING LIQUID THEREFROM (racks for drying fruit and vegetables A01F25/12; drying foodstuffs A23; drying hair A45D20/00; body-drying implements A47K10/00; drying household articles A47L, {e.g. drying footwear A47L23/20;} drying gases and vapours B01D; chemical and physical processes for dewatering or like separating liquids from solids B01D43/00; centrifugal apparatus B04; drying ceramics C04B33/30; drying yarns and fabrics in association with some other form of treatment D06C; drying frames for laundry without heating or positive air circulation, domestic and like spin-dryers, wringing and hot pressing laundry D06F; furnaces, kilns, ovens F27; {treatment including a drying step of semiconductor substrates, e.g. wafers, H01L21/67028})
F26B2200/00	Drying processes and machines for solid materials characterised by the specific requirements of the drying good
<u>F26B2200/02</u>	. Biomass, e.g. waste vegetative matter, straw
Y	GENERAL TAGGING OF NEW TECHNOLOGICAL DEVELOPMENTS; GENERAL TAGGING OF CROSS-SECTIONAL TECHNOLOGIES SPANNING OVER SEVERAL SECTIONS OF THE IPC; TECHNICAL SUBJECTS COVERED BY FORMER USPC CROSS-REFERENCE ART COLLECTIONS [XRACs] AND DIGESTS

CPC/IPC/FI Symbols	Description
Y02	TECHNOLOGIES OR APPLICATIONS FOR MITIGATION OR ADAPTATION AGAINST CLIMATE CHANGE
Y02C	CAPTURE, STORAGE, SEQUESTRATION OR DISPOSAL OF GREENHOUSE GASES [GHG]
<u>Y02C10/00</u>	CO2 capture or storage (not used, see subgroups)
<u>Y02C10/02</u>	. Capture by biological separation
Y02E	REDUCTION OF GREENHOUSE GAS [GHG] EMISSIONS, RELATED TO ENERGY GENERATION, TRANSMISSION OR DISTRIBUTION
Y02E50/00	Technologies for the production of fuel of non-fossil origin
Y02E50/10	. Biofuels
<u>Y02E50/14</u>	.. Bio-pyrolysis
<u>Y02E50/30</u>	. Fuel from waste
Y02E50/34	.. Methane
<u>Y02E50/343</u>	... production by fermentation of organic by-products, e.g. sludge
Y02P	CLIMATE CHANGE MITIGATION TECHNOLOGIES IN THE PRODUCTION OR PROCESSING OF GOODS
Y02P20/00	Technologies relating to chemical industry
Y02P20/10	. General improvement of production processes causing greenhouse gases [GHG] emissions
Y02P20/12	.. Energy input
Y02P20/133	... Renewable energy sources
<u>Y02P20/136</u>	.... of biological origin, e.g. biomass, biofuels, biogas
Y02P20/14	.. Reagents; Educts; Products
Y02P20/141	... Feedstock
<u>Y02P20/145</u>	.... the feedstock being materials of biological origin
Y02P20/151	... Reduction of greenhouse gas [GHG] emissions
<u>Y02P20/152</u>	.... CO2
Y02W	CLIMATE CHANGE MITIGATION TECHNOLOGIES RELATED TO WASTEWATER TREATMENT OR WASTE MANAGEMENT
<u>Y02W10/00</u>	Technologies for wastewater treatment (fuel from waste Y02E50/30; methane from waste for energy generation Y02E50/34)
<u>Y02W10/10</u>	. Biological treatment of water, waste water, or sewage
<u>Y02W10/20</u>	. Sludge processing
<u>Y02W10/30</u>	. Wastewater or sewage treatment systems with climate change mitigation effect characterised by the origin of the energy
<u>Y02W10/40</u>	. Valorisation of by-products of wastewater, sewage or sludge processing
Y02W30/00	Technologies for solid waste management (heat utilisation in combustion or incineration of waste Y02E20/12; fuel from waste Y02E50/30; methane from waste for energy generation Y02E50/34)
Y02W30/40	. Bio-organic fraction processing; Production of fertilisers from the organic fraction of waste or refuse
<u>Y02W30/47</u>	.. Anaerobic fermentation, e.g. methanation combined with capture, recycling or flaring
Y02W90/00	Enabling technologies or technologies with a potential or indirect contribution to greenhouse gas [GHG] emissions mitigation
<u>Y02W90/20</u>	. Computer systems or methods specially adapted for waste reduction or recycling of materials or goods

