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Advancement in fabrication of sensors using nanotechnology: A bibliographic review and future research scope

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Abstract. As Sensor plays an important part in day-to-day life. Sensors are used almost in each domain wherein humans are not able to sense or measure some parameters. Say from sensing a real-time activity of a person to sensing the tiny molecules of any gas or structures. Now sensors combined with advanced fabrication techniques with nanotechnology can be said as a game-changing combination. As the modern world is evolving every minute, the size of the components, instruments, and different equipment is shrinking rapidly. For example, the sensor or any other element which was used 10 years ago is reduced up to 5 times its original size and all of this is possible because of continuous advancement done in the manufacturing and fabrication techniques that are being used nowadays. Apart from this, it is not necessary that the term nano should only justify the size of the sensor. Nanotechnologically fabricated, refers to a sensor or any other element which may be large enough as compared to the regular one but they may be structured using some nano-particles.
Keywords: fabrication; nanosensors; nanotechnology

1. Introduction

In this review paper we tried to merge the information referred from different papers, and we have tried to summarize the content and work done till now, so this will help the new researchers to get some overview of the recent trends of the fabrication of sensors with nanotechnology which is currently used. Nanotechnology is a broad field and it will change the course of different fields by affecting the workability and many more parameters in a positive way. And when it comes to the fabrication of sensors with the help of different techniques based on nanotechnology a lot of advancement is done till now. Nanowires-based sensors can be used in the biomedical field to detect the DNAs, RNAs, or viruses These types can sensors with are based on nanotechnology can also be used to detect diseases at early stages so it will be helpful for us to provide medical attention in time (Wang *et al*. 2016). Considering some different domains, nowadays ammonia sensors which are based on 1D nanostructures are preferred a lot because of the advantages they offer (Tang *et al*. 2019). Carbon nanotube field-effect transistors (CNFETs) are considered when it comes to the development of energy-efficient computing (Bishop *et al*. 2020). Through this review paper, we have discussed in brief different techniques and methods of fabrication of sensors with nanotechnology.

2. Review of papers

There are a large number of fabrication techniques mentioned. The above Fig. 1 shows the classification for a few of the fabrication methods/techniques of sensors used with nanotechnology. The below-mentioned reviews are linked to these fabrication techniques or approaches.

2.1 Nanowire based sensors for biomedical engineering

In this paper, the authors (Wang *et al*. 2016), discussed the working principle and applications of nanowire sensors which are explored for biomedical applications, like virus recognition and much more. In this paper, there are two approaches mentioned as top-down and bottom-up which are suitable for the fabrication of nanowires sensors. For the bottom-up approach, the expansion of the Si nanowires with the help of a method named chemical vapor deposition i.e. (CVD) is done at the beginning of fabrication. Silicon nanowires can be developed chemically in the chemical vapor deposition reaction with the vapor-liquid-solid mechanisms After that on the substrate of silicon a photoresist is spin-coated. At last, passivation and surface modification are performed. The downside of the bottom-up approach is that the nanowires are randomly oriented. Now, in the fabrication process, an additional alignment stage can be introduced to enhance the orientation of the nanowires. The alignment methods which can be used are Langmuir-Blodgett, blown-bubble, and contact printing. The top-down strategy is focused on the method of microfabrication over a wafer of silicon-on-insulator (SOI). Low-density boron is doped firstly at the Si layer of the wafer. Photolithographic patterning with high-density doping is then used to obtain the source and drain leads. Then reactive ion etching (RIE) is done, with the help of EBL the Si nanowire is developed, and steps similar to the bottom-up approach are carried here. We can say that nanowires are the solution to many biomedical areas because of their advantages as high sensitivity, low cost, and rapid detection.

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Table 1 Summary of acronyms

Sr No.	Acronyms	Full form of Acronyms
1	CNFET	Carbon Nanotube Field Effect Transistor
2	CVD	Chemical Vapour Deposition
3	VLS	Vapour Liquid Solid
4	SOI	Silicon on Insulator
5	RLE	Reactive ion Etching
6	CNT	Carbon Nanotube
7	ALD	Atomic Layer Deposition
8	TDMAH	Tetrakis Dimethylamino Hafnium
9	Ti	Titanium
10	TiO_2	Titanium Di-oxide
11	NWFET	Nanowire Field Effect Transistor
12	SPR	Surface Plasmon Resonance
13	MEMS	Microelectromechanical Systems
14	NEMS	Nanoelectromechanical Systems
15	LOD_{H2}	Low Limit Detection
16	NW	Nanowire
17	NT	Nanotube
18	FEBID	Focused Beam Induced Deposition
19	SWCNT	Single Walled Carbon Nanotube
20	CNS	Carbonized Nano Sponge
21	$MeCpPt (Me)_3$	trimethylmethylcyclopentadienyl platinum
22	SiC	Silicon Carbide
23	WBG	Wide Bandgap Semiconductors
26	FIB	Focused Ion Beam
27	BEOL	Back End of Line

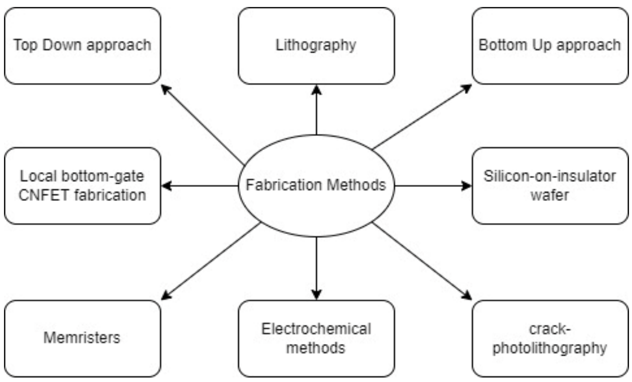

Fig. 1 Classification of fabrication methods

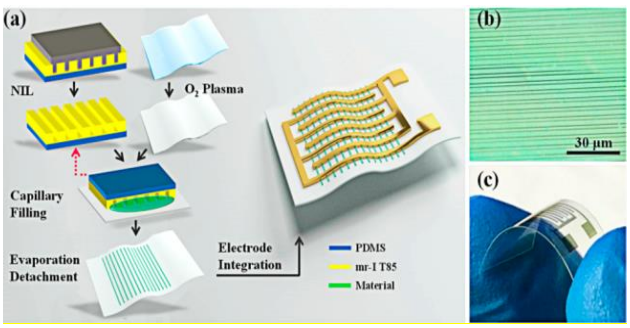

Fig. 2 The development/optical picture/flexible gadget

2.2 Using soft nano lithography fabrication of flexible wireless ammonia sensor

The authors, (Tang *et al*. 2019) described a fully-integrated device based on a nano-wire sensor with a smartphone that makes a feature that acts as a display that shows real-time ammonia (NH_3) monitoring data. Today, because of the advantages of high versatility and low power consumption, ammonia (NH_3) sensors based on 1-D nanostructure has been favoured a lot. Here, sub-100 nm nanowires were used as sensitive elements on a flexible substrate formed by low-cost soft lithography to generate impedance response.

The development of flexible nanowire sensors is depicted in Fig. 2 (a). Optical picture of nanowires that have been aligned and depicted in Fig. 2 (b). An illustration of the flexible gadget that has been incorporated in Fig. 2 (c). To summarize work done, low power consumption and the sensitive portable wireless integrated system was designed here which was based on a flexible nanowire sensor for detection of NH_3. For fabrication of the nanowire sensor, a capillary filling-based soft lithography method was used. Results suggest that the flexible devices have good durability and bendability without affecting the performance even after passing 1200 bending cycles.

2.3 Carbon nano-tube field effect transistors fabricated in commercial Si manufacturing facilities

In the production of energy-efficient computing, carbon nanotube field-effect transistors (CNFETs) are considered as the desirable technology. Still, carbon nanotube field-effect transistors (CNFETs) fabrication is done only in academic and research facilities. The reason behind this is there are a few difficulties as a suitable method of deposition of nanotubes uniformly over the standard large area substrates is not available. This deposition method should be compatible and manufacturable with modern silicon-based techniques. The authors mentioned that they have a method of deposition where the substrate is immersed in the nanotube solution that can solve these problems and thus carbon nanotube field-effect transistors (CNFETs) can be fabricated in the industries as well. By this the authors mentioned as there is improvement in the throughput, accelerating the deposition by 1100 times also considering that the cost is reduced. This allowed the authors to fabricate the carbon nanotube field-effect transistors (CNFETs) in a commercial facility. It is true that the equivalent scaling of Si field-effect transistor helped in progress till now, and all this was possible because of continuous improvement and research in commercial manufacturing. But it has its own limits. In this paper, the authors said that carbon nanotubes (CNTs) are the best possible alternative material for implementing the beyond-silicon FETs. For the carbon nanotube field-effect transistors (CNFET) to be formed many carbon nanotubes CNTs are used here which acts as the channel of the device where the gate, drain, and source regions are litho-graphically defined. In this paper, all the difficulties mentioned above are nullified by using this technique. This technique of solution-based CNT deposition is termed

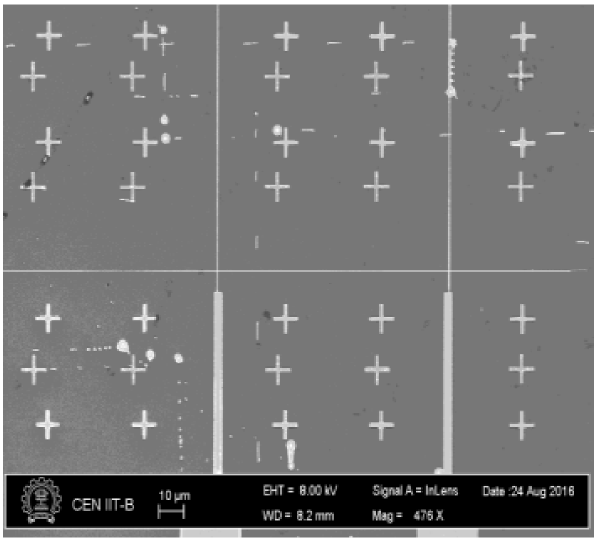

Fig. 3 Memristor array (Raith 150)

'incubation', it also offers several advantages. The authors also introduced improved deposition methods wherein they achieved improved throughput and reduction in cost as well, these advancements allowed the authors to fabricate the CNFETs in two different facilities. Fabrication methods like local bottom-gate fabrication here. The wafer substrate was planarized, and metal gates were designed and defined using a tungsten plug damascene method to create the layer of CNFETs in the BEOL.

2.4 MIS type RRAM based on HfO_2 as an electronic synapse

In this paper, the authors S. Tapar, P. Kumbhare, and U. Belorkar discussed the stack of n+ -Silicon/Hafnium dioxide/Titanium/Aluminium was developed whereas for bottom-electrode low resistivity n-type Silicon was cleaned with the help of RCA cleaning method. With the help of atomic layer deposition (ALD) at 200°, C with precursors such as Tetrakis Dimethylamino Hafnium (TDMAH) and H_2O, a 4 nm layer of HfO_2 was deposited. With the help of UV photolithography devices of size 50 µm x 50 µm were patterned, with the help of RF magnetron sputter, Aluminium of 100 nm thick and with a 2 nm Titanium interlayer was sputtered. The authors attempted to clarify the rupture mechanism and the filament formation, considering oxygen vacancy density and band diagram.

2.5 Fabrication of Si based memory using 6×6 array of memristers

When it comes to fabrication on a nano-scale it becomes a tedious job. A Silicon (Si) based memory is fabricated using a 6x6 array of memristors based on titanium (Ti), and these memristors can also be used or say implemented as CPU's because they are able to reprogram themselves with help of other memristers. Now, a memristor is nothing but a two-terminal device that has a variable resistor, so it can be used as a memory. Basically, memristors use high and low resistance states, these memristors can be formed over a silicon substrate, on which a thin titanium oxide layer is sandwiched between two Ti gold plates which acts as the electrodes. This memristor technology assures dense and compact memory packaging. The TiO_2 has a wide energy band gap of 3.2eV, TiO_2 is preferred because of its high stability, low cost, and low toxicity in comparison with other semiconductor materials used. HP Labs has implemented circuits that mimic or copy the aspects of the brain. Wherein the transistors are used as the neurons, nano-wires in a crossbar network act as the axons, and the memristors act like the synapses. The scaling rate of devices is slowing down nowadays because each parameter is already at its maximum limit. These issues can be solved by using new semiconductor devices such as memristors which can be used as memory cells and also as switching circuits.

The design for the 6 x 6 memristor array is shown in Fig. 3. The whole target is cleaned with acetone, dried, and subjected to characterization.

2.6 Programmable nanowire circuits for nano-processors

The authors first synthesized the Germanium/Silicon Core nano-wires with nano-cluster catalyzed technique in this paper. In the vacuum at 200 ° C and using trimethyl-aluminium, tetrakis zikronium, and water as precursors, the development of the charge trapping gate di-electric shells was achieved by ALD. The focused ion beam technique was for the formation of a cross-sectional sample of the nanowire field-effect transistor (NWFET) device. To pattern the nanowires, electron beam lithography, and inductively coupled plasma reactive ion etching were used.

2.7 Nano/microbots meet electrochemistry

And one of the best examples of nanosensors/ nanotechnology is the Nano-bots also called nano-motors or nano-submarines. These bots are quite different from the normal one's not only because of the size factor but these nano-bots are able to generate the power by themselves using the chemical energy available in the nearby environment and converting that into kinetic motion. Thus, these nano-bots can perform certain tasks by providing some RNA for treatment and much more. The function of electrochemistry in the motion of self-electrophoretically powered micromotors as well as the general fluid flow caused by electrochemical reactions have been studied by the authors. Electrochemistry has a considerable influence on nano/microrobot design and usefulness. Combining this knowledge with the use of these self-propelled vehicles will help to improve the ability to use them to complete challenging missions. The review's structure is based on a bottom-up approach. Several fabrication processes are described, including electrochemical methods, self-electro-phoresis, electrochemistry, and electric fields.

2.8 Design, characterization and fabrication of graphene sensors inspired by inter sheet effect

In this paper, the authors (Rao *et al*. 2012) discussed as, with the help of edge-tailoring, controlled layer engineering, and selective-electrode fabrication on different atomic layers, the authors tried to resolve the challenges of batch fabrication of the inter-sheet graphene sensors. The method of oxygen plasma etching is used to eliminate the graphene layer-by-layer, allowing FLGs to be fabricated in a controllable way due to the fast speed as well as the readiness of pattering of this process as compared with traditional mechanical exfoliation. In the methodology section, there are three parts sample preparation, Device fabrication, and vapor sensing testing. Inter-layer sensors were created using high-quality mono-/bi-layer graphene's in this study. Mechanical exfoliation was used to produce the graphene samples. Traditional planar micro/ nano-machining techniques were used to make the devices. The constructed graphene-based sensors were used to detect ethanol and water vapour molecules to show the sensing capability of the inter-sheet transduction idea.

2.9 2-D and 3-D plasmonic nanostructure array patterns review: Light management, fabrication and sensing applications

The improvement regarding Surface Plasmon Resonance (SPR) of both the 2-dimensional and 3-dimensional chip-based nanoarray patterns is discussed by the authors (Kasani *et al.* 2019). in this paper. Traditional photolithography is widely used for fabrication in semiconductors as well as in microfabrication facilities but the diffraction limit of light restricts its spatial resolution. Thus, the traditional photolithography failed to provide good quality nano characteristics, specifically 2D and 3D hierarchical nanostructures. To address these disadvantages, modern nano-fabrication methods can be used. Nanoarrays have attracted researchers' interest because of a few reasons. Many different techniques have been introduced in the past two decades to solve the problems with traditional photolithography. The huge manufacturing of nanoarrays at nanoscale resolution also poses challenges. In several cases, the simulation shows that exceptional optical properties can be seen in hierarchical structures. However, in the creation of nanoarray patterns, technological obstacles are present.

2.10 Integrated H_2 nano-sensor array on GaN honeycomb nanonetwork fabricated by MEMS-based technology

In this paper, the author has described a monolithically integrated H_2 nanosensor array on the GaN honeycomb nano-network (Ga-HN). Now, a few elements are mounted on a single chip for each H_2 sensing unit. According to the author, quick response and low limit detection nano-structured based sensors are preferred. The author mentioned that the semiconductor type H_2 has certain advantages such as small size, long life, and mass productiveness. The H_2 sensors on GaN film exhibit high-temperature tolerance of about 400° C, High selectivity, and much more still, the response time is large as well as the low limit detection (LOD_{H2}) is more, considering in the presence of oxygen about 1000 ppm. Researchers worked on GaN nano-wire and nano-tube to solve this problem. Change in low limit detection (LOD_{H2}) was observed as it came down to 25 ppm from 1000ppm for the GaN nano-tube with quick response, electron beam lithography and guiding force assisted alignment is designed to specifically produce and assemble the nanowires and the nanotubes directly, at the required position as to fabricate the nanodevices. For the H_2 sensing element, in order to accelerate some chemical reactions, more temperature is needed, resulting to the high energy consumption of about 900 mW. In order to minimize power consumption, micro-heaters were used. A reference sensor is needed to avoid environmental effects such as temperature fluctuation over gas sensing. With the help of MEMS-based fabrication method, monolithic integration is done wherein multiple elements are combined on a single chip to satisfy all the requirements mentioned. A major increase in sensing performance compared to the GaN film was observed using the GaN honeycomb nano network (GaN-HN). With this work, by just combining the GaN-HN MBE growth with standard photolithography, an integrated H_2 nanosensor was implemented.

2.11 Highly stretchable, rapid-response strain sensor based on SWCNTs/CB nanocomposites coated on rubber/latex polymer for human motion tracking

A flexible and versatile strain sensor with a low-cost manufacturing method with good dynamic characteristics that will be appropriate for monitoring the motions of humans is described here. The strain sensor is fabricated with the help of a rubber polymer as an elastic carrier and single-walled carbon nanotubes synergistic conductive network. In naphtha, the rubber or latex polymer was first processed and then immersed in the SWCNTs rubber-composite solution. Then, strain sensing and a few more performances of the sensor were determined as well as human motion monitoring applications were attempted. In this paper, a flexible, as well as stretchable strain sensor, was implemented where fabrication is low as well as dynamic characteristics are good. The stretchability of the sensor is 500 % more as compared with the conventional sensors.

2.12 Cracking-assisted nano/nanofluidic fabrication platform for silver nanobelt arrays and nanosensors

Nanowire (NW) manufacturing platform based on crack photolithography to produce a micro/nanofluidic channel network is shown in this paper. For the fabrication of silver nanobelts (AgNBs), chemical synthesis was done in the nano slit-like nano-channels. Moreover, the Nanowire/ Nanobelt platform also made it possible to simultaneously synthesize and align AgNBs on a chip, thereby reducing processing time, cost and labor. Current nanowire fabrication can be classified as a bottom-up and top-down approach.

2.13 A tunable strain sensor using nanogranular metals

A modern technique for manufacturing strain sensor elements for microelectromechanical systems /nanoelectronmechanical systems (MEMS/NEMS) applications which is based on the tunneling effect of nano-granular metals has been implemented in this paper. With the help of the maskless lithography method of focused electron beam induced deposition using the precursor trimethylmethyl-cyclopentadienyl platinum the strain elements were prepared. The sensitivity of the strain sensor can be tuned by varying the conductivity of the deposit leading to a maximum in the gauge factor. In addition to this, the high resolution of the FEBID method makes it possible for downscaling of the sensor elements below 100 nm.

2.14 Wearable strain sensor based on Carbonized NanoSponge/Silicone composite for human motion detection

In the last decade, smart wearable and flexible devices are boosted enough when it comes to usage, applications, and demand. These smart wearable devices are used in different areas such as monitoring, healthcare, sports, and much more. But the user should not feel the weight of the wearable device. This gives rise to the need for a compact fabrication process that will not only reduce the size of the wearable device but also make it flexible enough so it can be used in smart and effective ways. It can be said that, due to their low sensing range, rigidity and fragile nature, traditional strain sensors/wearable devices based on metals or semiconductors cannot fulfill the wearable device requirements. Now, for the user, it should be easy enough to wear the devices. Thus, various flexible strain sensors that may be based on piezo-resistive, capacitors or field-effect transistors have been successfully demonstrated to increase wearability. All this was possible because of rigorous research for the compactness and to increase in the workability of the devices. For this Carbonized Nano Sponge (CNS) is used, when it comes to sensing strain or stress CNS is the key sensing material for wearable sensing elements, using Carbonized Nano Sponge (CNS) has certain advantages.

2.15 Embedded capacitive displacement sensor for nano-positioning applications

This paper throws some light over the research and testing process of capacitive-based displacement sensor, non-invasive technique and low voltage needed for signal conditioning are the advantages of the sensor. To provide structural stability for easy integration into the nano positioner gap, sensor was formed using an silicon on insulator (SOI) wafer. As for the development, the wafer was cleaned in a wet chemical cleaning bay in the NIST NanoFab cleanroom initially prior to the deposition of the silicon dioxide coating. And, using some low-pressure chemical vapor deposition, a silicon dioxide coating of 0.1 µm was deposited, then the top surface of the wafer was deposited with chromium and gold with the help of an e-beam evaporator, where chromium was deposited to strengthen gold and silver oxide bonding. The top surface of the wafer was then coated with a photoresist. The sensor electrode pattern is created by the photoresist mask. The gold and chromium etchants were used to remove the chromium segments. The silicon-dioxide layer was eliminated because it was responsible for the high dissipation factor. The sensor was static during the tests, and the nano positioner platform adjusted the needle above it.

2.16 Nanoscale build-up sensors for diabetes monitoring in real time

The nano, biosensor design engineering rationales utilized to investigate a wide variety of glucose levels and transduce them into readable output signals for dead-end and fast-response investigations are highlighted by the authors El-Safty S.A., Shenashen M.A. Traditional evaluation and analytical procedures can be replaced with powerful nanoscale chemical sensor technologies. This review looks at mature and dependable technology for next-generation, well-designed integration, and full-control evaluation of wearable, touchscreen nano biomedical sensor engineering designs in one smart device. Continuous glucose monitoring via an implant would allow for full control of regular insulin or therapeutic medication administration dosages and procedures, but this remains a challenge.

2.17 Nanoarchitectonics for wide bandgap bemi-conductor nanowires: Toward the next generation of environmental monitoring nanoelectromechanical systems

This article provides a detailed summary of recent advances in the development, characteristics, and uses of silicon carbide (SiC), group III-nitrides, and diamond nanowires as preferred materials for nanoelectromechanical systems (NEMS). The fundamental physics of wide bandgap semiconductors (WBG) nanowires, as well as their potential for nanoelectromechanical systems (NEMS), are detailed in a review of their mechanical, electrical, optical, and thermal characteristics. A variety of sensing and electrical gadgets, mostly for environmental monitoring, are examined, extending the capacity in industrial applications even further. The paper finishes with a discussion of the benefits and drawbacks of environmental monitoring applications based on these types of nanowires, as well as a roadmap for future study in this rapidly developing subject. The authors also suggest that in the future years, gaining a better understanding of the different intrinsic and extrinsic parameters that influence the output voltage of nanogenerators should be at the forefront of research efforts.

3. Bibliometric analysis of advancement in fabrication of sensors using nanotechnology

This section explains different analyses done in advancement in the fabrication of sensors using nano-technology. The data is collected from Scopus and the duration is from 2010 to 23 January 2021. Now, the motive for this study is to understand the work done in sensor

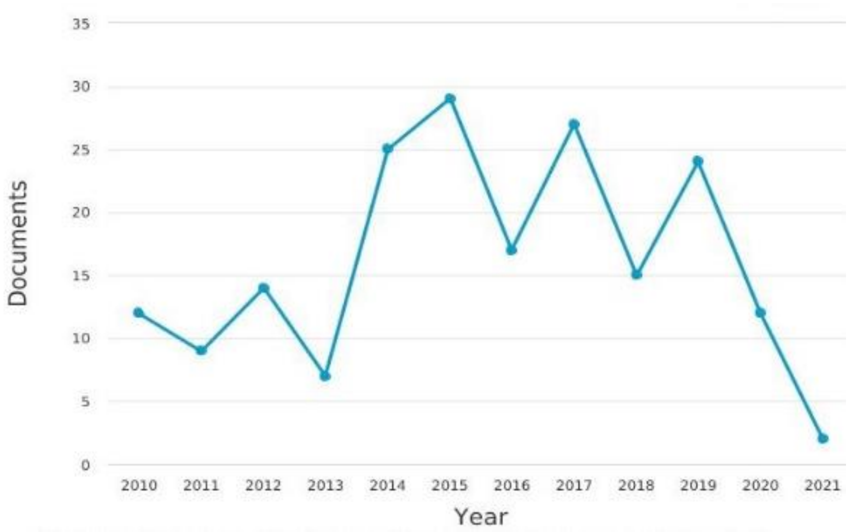

Fig. 4 Number of documents published per year

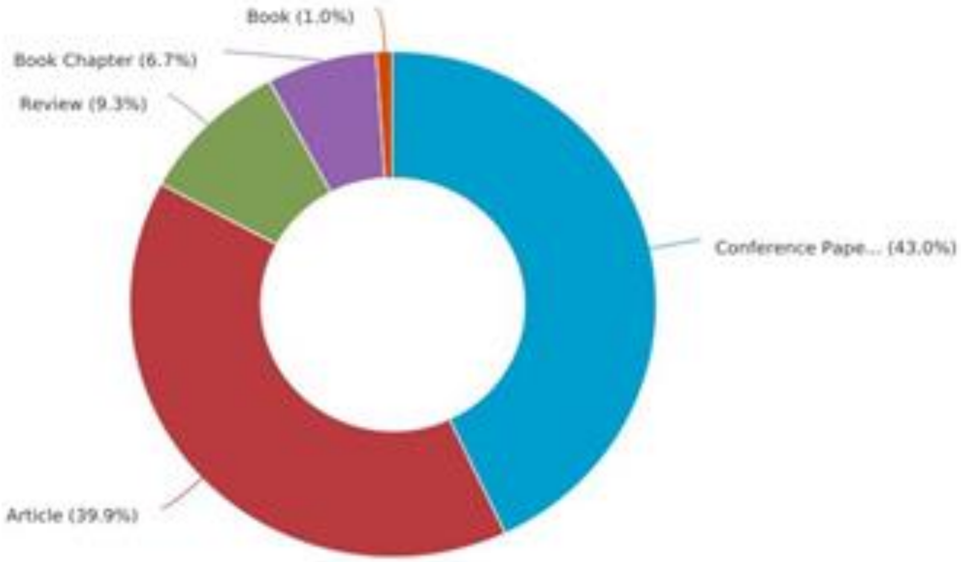

Fig. 5 Distribution of documents by its type

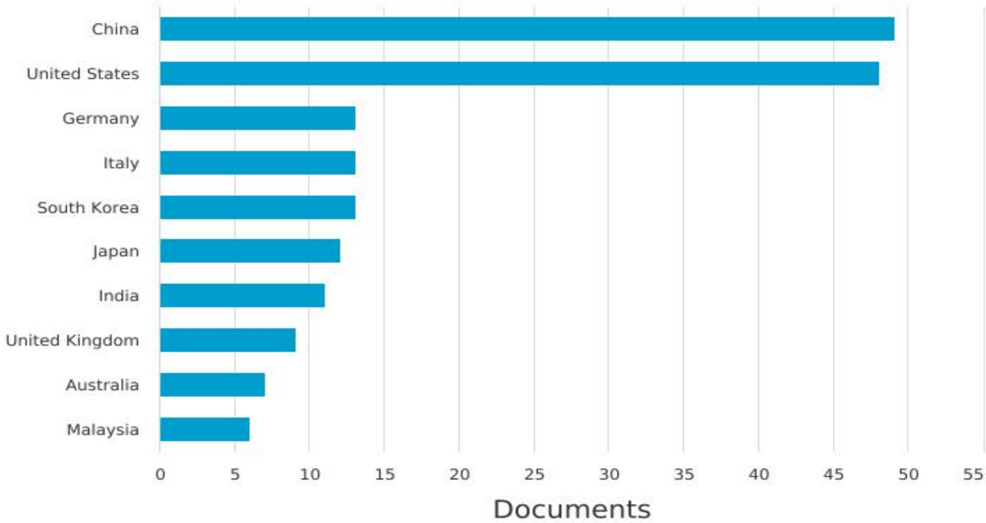

Fig. 6 Bar chart of country-wise documents published till now

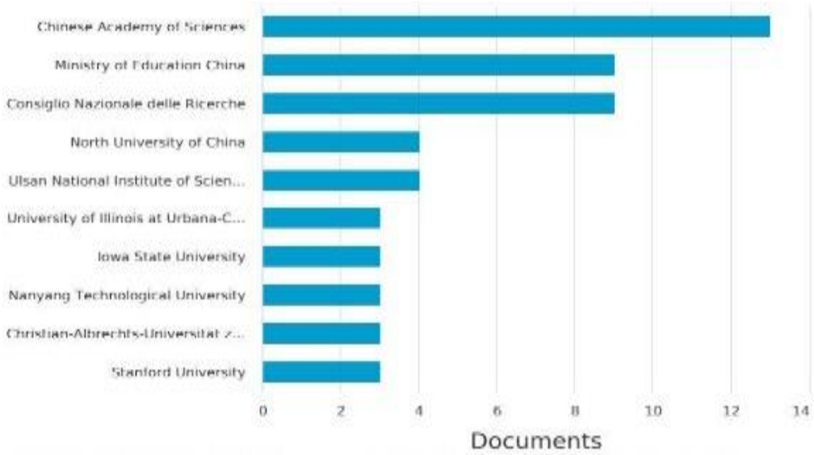

Fig. 7 Bar chart of number of documents published by top ten universities

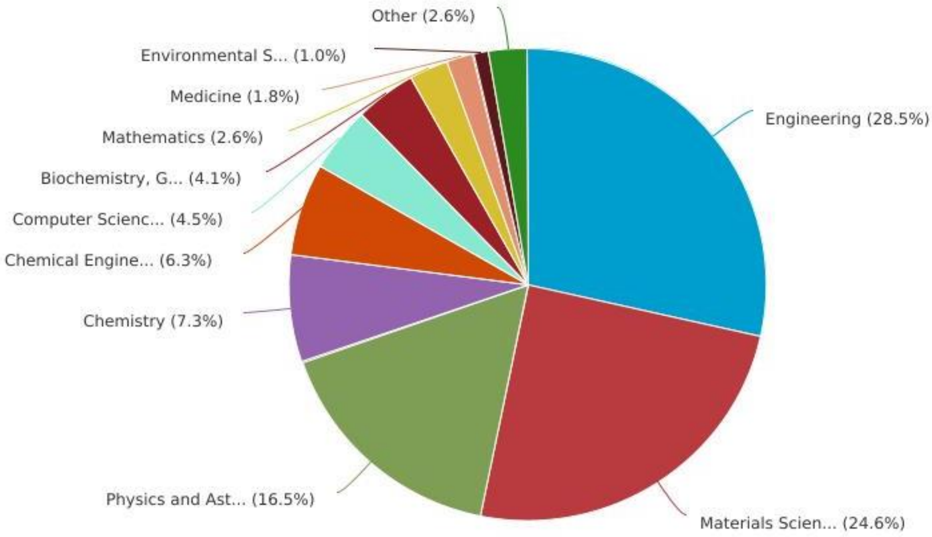

Fig. 8 Distribution of documents by subject area

fabrication with nanotechnology and also to go through some amazing applications of nanosensors/nanotechnology which is been used in different fields for various applications.

As you can see, the above Fig. 4 shows us how the papers/articles are published year wise throughout the time span of 10 years. If you observe clearly in 2010 total 12 papers/articles or say books where published and till 2013 the graph is repetitive, as in the number of documents published is below 20. After that it got a sudden jump in count of the papers/articles published in the year 2014, and increase in year 2015. After which the condition was good. But again, in the year 2020 it dropped below 20 and that is because the research laboratories were not available for the researchers to complete their research work because of the pandemic situation faced by the world. So, we have done the bibliographic analysis of the data in the period of 2010 to 23 January 2021 and it is found that 193 documents are published in Scopus. The highest number of documents with a count of 29 were published in the year 2015.

The above Fig. 5 shows us how the research documents are distributed. Now, out of this 43% are conference papers whereas articles are 39.9% which are published over the period 2010 to 23 January 2020, as there is an ample number of articles and conference papers available but when it comes to reviewing papers, it's not that much, so in our review paper we have tried to combine articles/ papers from different domains so it will be convenient enough for the reader to get an overview of different topics and research work done till now and by this the new researchers can get an idea about the researches which can be done in coming time.

As you can see in Fig. 6 the number of documents published country-wise in that China and the United States are leading with 49 and 48 respectively whereas other countries mentioned in the chart are lagging in the publishing part for nanosensors/nanotechnology.

The above Fig. 7 is the bar chart of documents published by the top 10 universities in the field of nanotechnology and various techniques of fabrication of sensors using nano-

Table 2 Number of documents published by top ten universities

Sr. No.	University Name	No. of Papers Published
1	Chinese Academy of Sciences	13
2	Ministry of Education China	9
3	Consiglio Nazionale delle Ricerche	9
4	North University of China	4
5	Ulsan National Institute of Science and Technology	4
6	University of Illinois at Urbana-Champaign	3
7	Iowa State University	3
8	Nanyang Technological University	3
9	Christian-Albrechts-Universität zu Kiel	3
10	Stanford University	3

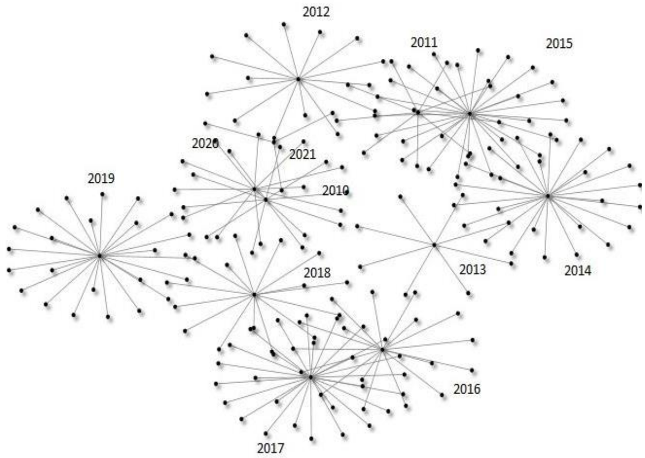

Fig. 9 Cluster of document title and publication year

technology. The bar chart shows that the Chinese Academy of Sciences is the leading university for publishing documents related to the fabrication of sensors with nanotechnology. Table 2 shows the exact number of documents published university-wise. According to the database of Scopus, 168 universities have given their valuable contribution in this research field.

The percentage-wise data distribution is shown in above Fig. 8, like nanotechnology or says nanosensors are part of engineering and material science subject areas as they cover 28.55 and 24.6% compared with all other subjects. Other than that physics and astronomy subject also contributes 16.5% whereas chemistry and chemical engineering both includes 7.35 and 6.3% respectively.

The above Fig. 9 shows a cluster of document titles with the year of publication. The above Figure is generated with the help of NodeXL software wherein the document titles and year of publications are shown in the form of nodes. As you can see that a greater number of documents are published in 2014 as compared with 2013. In a similar way, it is represented for each year.

4. Future breakthroughs

As the demand for new sensors or say instruments is increasing day-by-day so it becomes very crucial for the designer to integrate multiple elements on a single chip, for example, a sensor with signal conditioning elements. So, in this case, fabrication with the help of nanotechnology will definitely change everything in a positive manner. It will be possible in the future to design and develop such sensors which can be used in different domains according to the applications. Though a lot of advancement has been achieved with the help of nanotechnology, there remain a few challenges, for example, to deposit carbon nanotubes (CNTs) evenly over industry-standard substrate diameters (wafers with a diameter of 200 mm and higher). Providing a solution for a practical and portable energy generator is very demanding and remains a problem, despite recent developments in fuel cells. But, micromotors were shown to be capable of efficiently generating H2 on-site and overcoming the obstacles of H2 transit and storage. Despite the greater resolution, commercial manufacturing employing focused ion beam (FIB) lithography still faces challenges in terms of throughput and large-area fabrication. As, in this review paper few application-based sensors are also mentioned in which the researchers tried to minimize the problems with the fabrication of sensors by introducing nanotechnology with the traditional methods, likewise in future it is possible for the new researchers to achieve more advanced devices with the help of nanotechnology.

5. Conclusions

This bibliometric study helped us to understand the work done in nanotechnology with respect to the fabrication of sensors using some techniques. As the demand for denser workable and complex circuitry is increasing day-by-day which also includes the sensors, so fabrication of sensors with a blend in nanotechnology is increasing the boundaries of the tasks which the sensor could perform. This review paper will help any person who wants to do some study/research in sensor fabrication and nanotechnology. With this review paper, we studied how nanotechnology is changing the world by eliminating the limitations of conventional techniques which are used for the fabrication of sensors. A lot of advancement is done in various domains for example biomedical applications, real-time monitoring, and much more.

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