APPLICATIONS OF NANOSENSORS IN VARIOUS FIELDS: A REVIEW

***[1]Prof.A.H.Deshpande, *[2]Prof.J.M.Weldode,*[3]Prof.J.S.Pise**

*1 Prof A.H.Deshpande, Deogiri Institute of Engineering and Management Studies, Dr.BAMU. Aurangabad, India.

*2Prof.J.M.Weldode Deogiri Institute of Engineering and Management Studies, Dr.BAMU Aurangabad, India.

*3Prof.J.S.Pise Deogiri Institute of Engineering and Management Studies, Dr.B.A.M.U. Aurangabad, India.

ABSTRACT

"The universe is incomplete without nanotechnology."As nanomaterials used in nanotechnology in various fields such as industry, medical ,energy transportation,electronics,information technology,polymers,envioronmental science and many more.The nanomaterials with their minute or extremely small size acheieves specific properties thus greatly extending the material science in various fields. The application has helped us working smoothly in tremendous field. In medicines, it helps to diagnose the patient early rather than living toxic materials in it. Inelectronics, nanotechnology helps to work in various fields and today one can see the tremendous change in it. One is the example is the smart phone which has changed the life of a common man from rural to urban. The industry surrounding sensors is no exception. Nan sensors have been under research by many institutions for as long as ten years.

A nanosensor is a sensor built on the atomic scale based in measurements of nanometers. There have been a number of advances in the research and development of nanosensors for a number of different applications. Some of the major applications are the medical field, national security, aerospace, integrated circuits, and many more. Along with many different applications for nanosensors, , there are also many different types of nanosensors, and a number of ways to manufacture them. There are a number of challenges currently with the production of these nanosensors, however, when they become perfected for regular use they will have a number of advantages over the sensors that are used in today's technology.

1. INTRODUCTION

There are many advances in nanotechnology that if perfected could help make our world a safer and ultimately a better place to call home. Our modern lives rely on sensors to allow society to run smoothly. Sensors in the road detect cars at traffic lights and adjust the flow through intersections

accordingly. Sensors at shopping malls detect your presence and open doors to allow you to enter. Sensors measure the water level in your washing machine and ensure it doesn't overflow. Nanosensors work in much the same way but they can detect either minute particles or miniscule quantities of something.Sensors operating on the scale of atoms and molecules because of their smaller size, lower weight, modest power requirements.Although sensors have a long and illustrious history, the realm of nanosensors is relatively new. A milestone chart on the development of various nanosensors within 1994 and 2005. Nanosensors are sensing devices with at least one of their sensing dimensions being not greater than 100 nm. In the field of nanotechnology, nanosensors are instrumental for (a) monitoring physical and chemical phenomena in regions difficult to reach, (b) detecting biochemicals in cellular organelles, and (c) measuring nanoscopic particles in the industry and environment. The advance in scientific understanding is naturally followed by technological development

2. DEFINITION OF NANOSENSORS

A nanosensor is a sensor that is built on the nanoscale, whose purpose is mainly to obtain data on the atomic scale and transfer it into data that can be easily analyzed. These sensors can also be defined as "A chemical or physical sensor constructed using nanoscale components, usually microscopic or submicroscopic in size." These sensors are ultra sensitive and can detect single virus particles or even ultra-low concentrations of a substance that could be potentially harmful. Since there is still so little known about this technology, it is difficult to put any single definition on what exactly a nanosensor is.

Some of the advantages that would come out of using nanosensors are because of their tiny size, the fact that they require less power to run, their greater sensitivity and that they have better specificity than today's sensors. All of these advantages will allow us to accomplish things that we could never imagine before such as atomic sized sensors flowing in our blood streams

that could predict cancer and other diseases. Between the medical advancements that could be made with the use of nanosensors and the advancements in airborne chemical detection being

There are many different types of nanosensors. A few of them are the chemical sensor, biosensors, electrometers, and deployable nanosensors

A biosensor is an analytical device which converts a biological response into an electrical signal .A chemical sensor is a device that transforms chemical information, ranging from the concentration of a specific sample component to total composition analysis, into an analytically useful signal.

Typically nanosensors work by monitoring electrical changes in the sensor materials. Carbon nanotube based sensors work in this way. For instance when a molecule of nitrogen dioxide (NO_2) is present it will strip an electron from the nanotube, which in turn causes the nanotube to be less conductive. If ammonia (NO_3) is present it reacts with water vapour and donates an electron to the

carbon nanotube, making it more conductive. By treating the nanotubes with various coating materials, they can be made sensitive to certain molecules and immune to others.

Electrometer sensor is a highly sensitive instrument used to measure the current, voltage and various parameters.

3. APPLICATIONS OF NANOSENSORS

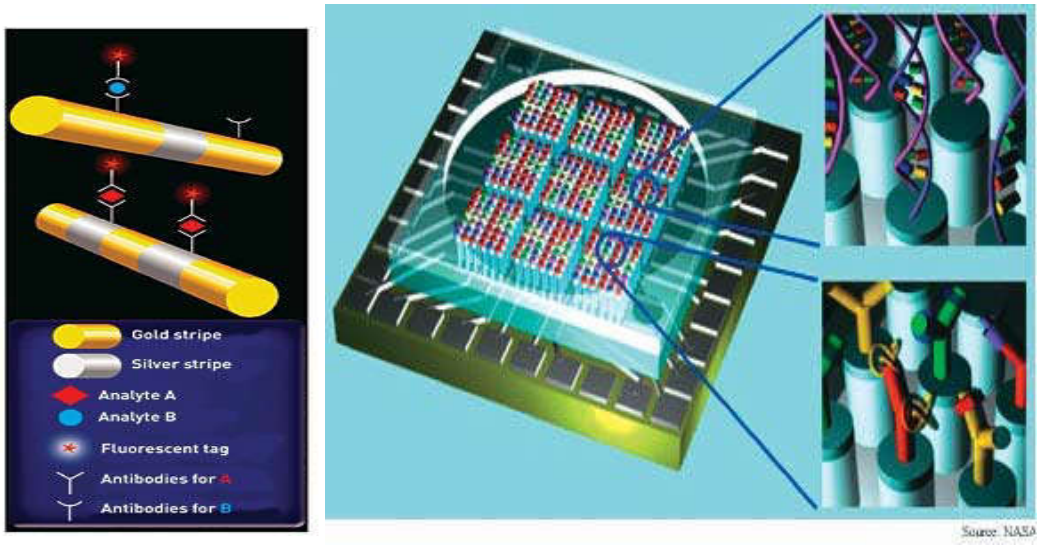
1) Another type of nanosensor is the electrometer which is a nanometer-scale mechanical electrometer that consists of atorsional mechanical resonator, a detectionelectrode, and a gate electrode which are usedto couple charge to the mechanical element. The image to the right shows the electrometerwith a schematic and micrographs of a single element and an array of elements.

2) One of the most largely funded areas of research in nanosensors is biosensors.

This is mostly due to the possibilities that this technology could lead to in early cancer detection and detection of other various diseases. The biosensors can also be used to detect specific types of DNA. The image on the left shows Nanobarcode particles. They can be used in the sensing of DNA and other biomaterials using encoded antibodies on them. The image to the right is an example of carbon nanotubes being used as a biosensor, as was described earlier. The DNA molecules attach to the ends of the vertical

carbon nanotubes that were grown on a silicon chip.

DNA detecting biosensors



Other types of biosensors can be used in more specific applications such as the detection of asthma attacks up to three weeks before it happens and assisting astronauts on space missions. These are just two major applications of nanosensors.

A nano-biosensor that can be used to detect asthma attacks up to three weeks before they happen just by using a handheld device to test the nitric oxide level in the patients breath. Testing regularly, as a diabetic patient would test their blood sugar level, could save lives. By knowing the nitric oxide level in their breath they could be alerted if the level were too high, or were increasing. This would indicate the risk of an asthma attack in the patient. The diagram below shows the most crucial pieces of the nanosensor that would accomplish this. The base of the sensor is a polymer coated nanotube field effect transistor (NTFET) containing a random network of single-walled carbon nanotubes between source and drain gold electrodes on a silicon oxide substrate.

Another biosensor is one that is being developed that could be used in the field of aeronautics. These nanosensors can pass through membranes and into the white blood cells called lymphocytes, in order to detect early radiation damage or infection in astronauts by sensing signs of biochemical changes. When on space missions, because of the amount of radiation, astronauts are at a higher risk of developing cancer due to cell damage. The sensors are created from synthetic polymers called dendrimers and are created layer-by-layer into spheres with a diameter of less than five nanometers. It is because of their small size that the goal of these sensors is to be able to administer them transdermally, through the skin. Being able to accomplish this and administer them every few weeks would avoid the need for injections or IVs during space missions. The development of these sensors would also eliminate the need to draw and test blood samples. This sensor would greatly improve conditions for astronauts going on space.

3) A different type of sensor is referred to as a deployable nanosensor. There is not a lot of research available on this type of nanosensor. These mostly refer to sensors that would be

used in the military or other forms of national security. One sensor in particular is the SnifferSTAR, which is a nano-enabled chemical sensor that can be integrated into a micro unmanned aerial vehicle. This sensor is a lightweight, portable chemical detection

system that combines a nanomaterial for sample collection and a concentration with a micro-electromechanical (MEM) based "chemical labon- a-chip" detector.

4) Blood glucose monitors measure the amount of sugar in a sample of blood using a complex chemical process. Within the test strip the blood is mixed with glucose oxidase, which reacts with the glucose in the blood sample to create gluconic acid. Another chemical within the test strip, called ferricyanide, then reacts with the gluconic acid to create ferrocyanide. The electrode within the test strip then runs a current through the blood sample and the ferrocyanide influences this current in such a way that the concentration of blood glucose within the sample can be accurately measured within a fair margin o of error. •

5) Mosquitoes have a battery of sensors in their antennas and one of them is a chemical sensor. They can sense carbon dioxide and lactic acid up to 36 meters away. Mammals and birds release these gases when they breathe. Certain chemical in sweat also seem to attract mosquitoes. This is the reason that those who sweat more easily will tend to attract more mosquitoes.

6) In transportation you can In transportation you can see nanosensors being applied on land, at sea, as well as in the air and even in space as previously discussed. Also in the field of communications, nanosensors are likely to be seen in wired and wireless technologies as well as

optical and RF technologies. They can even be seen in buildings and facilities, which consists of factories, offices, and even homes. Last but certainly not least, is perhaps the largest field aside from medical, which is robotics of all kinds. The nanosensors being applied on land, at sea, as well as in the air and even in space as previously discussed. Also in the field of communications, nanosensors are likely to be seen in wired and wireless technologies as well as optical and RF technologies. They can even be seen in buildings and facilities, which consists of factories, offices, and even homes. Last but certainly not least, is perhaps the largest field aside from medical, which is robotics of all kinds.

4 .CONCLUSION

In the future we can see many of these advances become realities. Some of them may happen within the next five to ten years and some may not happen for fifty, or even within our lifetime. With the increasing research into this technology it is hard to tell. As far as nanosensors go, we can expect to see them start to pop up within our life time, even if we cannot go out to a store as consumers and purchase them.

REFERENCES

[1] V. T. Binh, N. Garcia, and A. L. Levanuyk, Surface Sci.301, L224 (1994).
[2] D. Uttamchandany and S. McCulloch, Adv. Drug Delivery Rev. 21, 239 (1996).
[3] S. L. R. Barker, R. Kopelman, T. E. Meyer, and M. A. Cusanovich, Anal. Chem. 70, 971 (1998).
[4] Z. Rosenweig and K. P. McNamara, Abstr. Pap.Am.Chem. Soc. 216, 035-ANYL (1998).
[5] R. Meallet-Renault, P. Denjean, and R. B. Pansu, Sensors Actuators B Chem. 59, 108 (1999).
[6] X. J. Zhang, J. Wang, B. Ogorevc, and U. E. Spichiger, Electroanalysis11, 945 (1999).
[7] H. X. He, C. Z. Li, and N. J. Tao, Abstr.Pap.Am.Chem. Soc. 220, 239-COLL (2000).
[8] Y. Cui, Q. Q. Wei, H. K. Park, and C. M. Lieber, Science 293, 1289 (2001).
[9] L. Josephson, J. M. Perez, and R.W. Weissleder,Angew. Chem. Int. Ed. 40, 3204 (2001).
[10] J. P. Sumner, J.W. Aylott, E. Monson, and R. Kopelman,Analyst 127, 11 (2002)
[11] V. T. Binh, N. Garcia, and A. L. Levanuyk, Surface Sci.301, L224 (1994).
[12] D. Uttamchandany and S. McCulloch, Adv. Drug Delivery Rev. 21, 239 (1996).
[13] S. L. R. Barker, R. Kopelman, T. E. Meyer, and M. A.Cusanovich, Anal. Chem. 70, 971 (1998).
[14] Z. Rosenweig and K. P. McNamara, Abstr. Pap.Am.Chem. Soc. 216, 035-ANYL (1998).
[15] R. Meallet-Renault, P. Denjean, and R. B. Pansu, Sensors Actuators B Chem. 59, 108 (1999).
[16] X. J. Zhang, J. Wang, B. Ogorevc, and U. E. Spichiger,Electroanalysis11, 945 (1999).
[17] H. X. He, C. Z. Li, and N. J. Tao, Abstr.Pap.Am.Chem. Soc. 220, 239-COLL (2000).
[18] Y. Cui, Q. Q. Wei, H. K. Park, and C. M. Lieber, Science 293, 1289 (2001).
[19] L. Josephson, J. M. Perez, and R.W. Weissleder,Angew. Chem. Int. Ed. 40, 3204 (2001).
[20] J. P. Sumner, J.W. Aylott, E. Monson, and R. Kopelman,Analyst 127, 11 (2002)