Nanotechnology in Flexible Electronics: Current Trends & Future Scope

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Abstract: **Nanotechnology is one of the rapidly growing field of science and technology which focusses on nanometers scale objects. This rapidly growing technology has been widely used in almost all the recent developments in the fields of science, engineering and technology. One of the very popular application of nanotechnology is in the blossoming field of flexible electronics. In this paper, we are going to briefly discuss few of the latest inventions or research in the field of flexible electronics with a particular focus on the use of nanotechnology.**

Keywords: Nanotechnology, Nanomaterials, Flexible Electronics

I. INTRODUCTION

Nanotechnology is a technology which allows to manipulate a matter on an atomic or molecular scale. According to National Nanotechnology Initiative (NNI), nanotechnology refers to the study of particles about 100 nanometres or less in size. One of the most important advantage of these small sized particles is that they have large surface areas which lead to increase in their surface activity and produce changes in their physical properties as well as in their biological properties. Revolutionary nanotech products, materials and applications, such as nanobots, are years in the future some say only a few years, some say many years. What qualifies as "nanotechnology" today is basic research and development that is happening and explored all over the world. "Nanotech" products that are on the market today are mostly gradually improved products using evolutionary nanotechnology where some form of nano-enabled material (such as carbon nanotubes, nanocomposite structures or nanoparticles of a particular substance) or nanotech process (e.g. nanopatterning or quantum dots for medical imaging) is used in the manufacturing process. In their ongoing quest to improve existing products by creating smaller components and better performance materials, all at a lower cost. Evolutionary nanotechnology should therefore be viewed as a process that gradually will affect most companies and industries.

II. FLEXIBLE ELECTRONICS

Nanomaterials plays an important significance in the development of flexible electronics. Only by manipulating the nanoscale structure of materials we can create components with the necessary electronic properties which can also be made flexible. It is often used as connectors in various applications where flexibility, space savings, or production constraints limit the serviceability of rigid circuit boards or hand wiring are used to interconnect electronic components such as integrated circuits, resistor, and capacitors. Some of the latest inventions or research in the field of Nanotechnology in flexible Electronics are:-

- Plastic-Compatible Low Resistance Printable Gold Nanoparticle Conductors for Flexible Electronics
- All-inkjet-printed flexible electronics fabrication on a polymer substrate by low-temperature high-resolution selective laser sintering of metal nanoparticles
- Nanotubes in Electronics. A flexible approach to mobility.

A. Plastic-Compatible Low Resistance Printable Gold Nanoparticle Conductors for Flexible Electronics

Conductors with low resistance are essential for the development of low cost electronic systems such as radio frequency identification (RFID) tags. Such conductors are needed to manufacture high quality inductors, capacitors, tuned circuits, and interconnects. The assembly by printing of these circuits will result in a significant reduction in cost, by avoiding expensive processes like lithography, vacuum processing, and substrates. Solutions of organic encapsulated gold nanoparticles may be printed and subsequently normalized to form low resistance conductor patterns. We describe the process for the same and discuss the optimization of the process to exhibit plastic-compatible gold conductors. By optimizing both the size of the nanoparticle and the length of the alkanethiol encapsulant, it is possible to produce particles that normalize at low temperatures (150°C) to form continuous gold films having low resistivity

Mechanism:-

The demonstrated plastic compatible printed conductor process using gold nano-crystals.

By the reduction of the alkane chain length we can specifically decrease the processing temperature necessary to convert solution deposited nanoparticles into low resistance, continuous films. Using 4-carbon chain or 6-

carbon chain length thiols, to produce nano-crystals that normalises at plastic-compatible temperatures are achievable. The normalized conditions are independent of normalized ambient, and low resistance films are uniformly achieved. There is a trade-off between stable and normalized temperature due to the instability of thiols with short alkane chains. Therefore, optimization of the process reveals that 1.5 nm gold nanoclusters which have been encapsulated with hexanethiol have stability which is acceptable and are suitable to be used as printed conductors on plastic. Inkjet-printed conductor patterns formed on plastic using this material result in low resistance lines with conductivities as high as 70% of bulk gold, substantiating the quality of this process.

B. *All-inkjet-printed flexible electronics fabrication on a polymer substrate by low-temperature high-resolution selective laser sintering of metal nanoparticles*

We would like to exhibit that selective laser sintering of inkjet printed metal nanoparticles enables low temperature metal deposition as well as high-resolution patterning, thus overcoming the limitation of inkjet direct writing without any lithography processes. Combined with an air-stablecarboxylate-functionalizedpolythiophene,all-inkjetprinted organic field effect transistors (OFETs) including a gate, dielectric layer and semiconductor layer with micron to submicron critical features by metal nanoparticle selective laser sintering were fabricated in a fully mask less succession , extinguishing the need for any lithographic processes. All processing and depiction of steps were carried out at plastic-compatible low temperatures and in air under closed pressure.

Mechanism:-

All-printed electronics is the one of the main technology to low cost electronics such as radiofrequency identification devices and large area displays. As a captious step in this direction, air stable OFETs were fancied using inkjet printing at low temperature selective laser sintering. OFET electrodes having high resolution and highly electrically conductive gold lines were fancied in closed pressure and without using any lithographic process at room temperature. To get the better of the defect of conventional organic semiconducting polymers and maintain the great advantage of the inkjet direct writing process, carboxylate-functionalized polythiophene with increased air stability was used as the semiconducting [1] material for OFETs fabricated by a laser sintering process and with a carrier mobility of 0.002 $cm^2 V^{-1} s^{-1}$ and a Ion/Ioff ratio ranging from 103 to 104. The OFET performance can be enhanced by further shrinking of the channel dimension and by applying other metal nanoparticles and semiconducting polymers. This mask less and directly writing process can contribute to the development of cheap and large area macro electronics such as micro contact printing (μ-CP) [1, 2, 3], nanoimprinting [4], solid state embossing [5], screen printing [6,7], drop-on-demand (DOD) inkjet printing [8,9,10,11, 12,13,14,15,16] and laser induced forward , the local material deposits of the ink-jetting process could be minimum material waste. Local thermal control of the laser sintering process could confine the heat-affected zone and help avoid thermal damage to the substrate.

C. *Nanotubes in Electronics. A flexible approach to mobility.*

In this ground breaking and ascendible scheme for making high-density arrays of aligned nanotubes could direct to the mass-production of high-performance, high-power flexible electronics. Progress in flexible technology a very large number of ground breaking products such as electronic paper, wearable displays, smart gloves and so on. Single walled carbon nanotubes have great promise for applications in flexible electronics, but it is rather difficult to prepare flexible high-performance integrated circuits based on them some of the examples which involves growing dense arrays of aligned nanotubes on a crystalline quartz substrate, and then transferring the arrays onto plastic materials to make flexible, high-performance, high-power electronic devices. A circuit which has reduced overturned the electrical industry in the 1950s, flexible electronics might also change the world's future if suitable materials are found. Most high performance electronic materials like silicon are not flexible, therefore materials that are flexible, such as conducting polymers, the electric property is very piteous. Speed of an electronic device is basically intended by the mobility of the charge carriers in the material which is used to create it. The mobility which is measured in units of $cm^2 V^{-1} s^{-1}$ — determines the speed at which charge carriers (i.e. , electrons and holes) can move in the material itself. One of the methods for making high mobility devices is to pattern a surface with catalyst nanoparticles and then grow nanotubes on this pattern .Therefore, since nanotubes incline to grow in stochastic directions, external forces (i.e. electric fields) must be applied to control the direction of growth. This method usually produces low-density arrays of nanotubes with relatively poor alignment. Furthermore, the high temperatures needed for this approach are not suitable for most flexible substrates.

III. CONCLUSION

Flexibility in electronics is one of the major factors that will revolutionize the world of electronics, which will open a whole new prospective towards now days electronics and rely on contrived and the performance of devices which electronics now days our dependent upon. Flexible devices has overtaken commercially on the industry, and in the distance future massive changes are expected by this new attribute which is now accessible for electronics manufacturers all over the world. The Future Development aspect in the distance future, if the field of flexible electronics evolves then it is most likely that graphene will be one of the most important and dominant material used in flexible electronics. Most of the other materials will be used in different combination with graphene to form different materials with lots of different qualities like superb electrical conductivity, flexibility, and physical strength etc. Research has found out that graphene can be used to build number of constituents for flexible electronic materials or devices is well evolved. It is used to build many things like transparent conductors, graphene has excellent conducting property that can also perform very well in battery electrodes, conducting interconnects, and individual transistors. As the time will pass It will be interesting to watch the success of graphene's story unfold as the commercial fabrication technologies mature and manufacturers begin to adopt the wonder material in their products and would be the start of a new era of Flexible Electronics.

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