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MOLETRONICS: TOWARDS NEW ERA OF NANOTECHNOLOGY

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***Abstract*—The Molecular electronics is the fundamental building blocks of an emerging technology called 'nanoelectronics a field that holds promise for application in all kinds of electronic devices, from cell phones to sensors. Molecular devices could be built a thousand times smaller than Si based devices in use now. Computer industry execs might start breathing easier because their biggest fear - that smaller and faster devices will eventually come to an end because silicon microchips will get so small that eventually they will contain too few silicon atoms to work - might be lessened as advancements in molecular electronics come to the rescue. Molecular electronics is enabling an area of nanoscience and technology that holds promise for the next generation of electronic devices.**

***Index Terms* — Component, formatting, style, styling, insert.**

I. Introduction

Molecular electronics is, relatively called, a young Field. Moletronics technology we used molecular components instead of Si based component. In modern era there is need of miniaturization. So Molecular electronics play very important role in nanotechnology field. Single molecular diode is the major milestone in the developing of moletronics field. There is design of molecular circuit by using the concepts from chemistry and physics.

From around 100 transistors on a single chip to the very recent ULSI technique which allows over 91,000 transistor, semiconductor fabrication has come a long way. But the big question was "what after ULSI? Will Moore's cease?"The definite answer to this is moletronics.

II. Literature Survey

In 1940, Robert Muliken and Albert Szent-Gyorgy postulated the concept of charge transfer theory using molecules. In 1956, Arthur Von gave the idea about Molecular Engineering. Thus, the roots of moletronics can be traced back to the 1950s. Further, in 1974 Mark Ratner and Avi Aviram illustrated a theo-retical molecular rectifier in their paper. Also, in the 1970s, the US Government's Defence Advanced Research Projects Agency (DARPA) organized a Moletronics Research Program, which had collaborations of Hewlett-Packard scientists and UCLA researchers. In 1988 Avi Aviram proposed about a single molecule field effect transistor. In the same year Forrest Carter described further the concept about a single molecule logic gate. C. Joachim and J.K experimented the conductance of single molecule in IBM. In 1990 Mark Reed et al added few hundred molecules. In 2000 Shirakawa, Heeger and MacDiarmid won the Nobel Prize in physics for the demoletronics. The conductive polymers can be used as "molecular wires". This will altogether alter the fabrication industry because a conventional silicon chip houses over 10-50 million switches over an as large as a postage stamp. Moletronics aims at redefining this powerful integration technology to density of over one million times than today's state-of-the-art IC fabrication.

III. Future of molecular electronics

A transistor is used as a switch in any IC fabricated silicon chip. This switch is at the heart of the silicon chip and thus determines the speed of the chip and eventually the computer/processor. It goes by the principle, "Smaller the switch, faster the process". Thus, all the fabrication techniques till today have the prime purpose to accommodate as many switches and also reduce their size. This simultaneously increased their speeds too. In moletronics, the above described transistor switches are made from molecules. This has a great advantage, as using an organic molecule reduces the size of the conventional switch to one-millionth size of a grain of sand and is 10 times faster than the traditional silicon-based switch. The organic molecule used was actually a thiol molecule, which is mixture of sulphur, carbon, and hydrogen. Several such thiol molecules were sandwiched between two gold plates to act as switches. These novel channels acted either insulators or conductors, as per the electric flow through them were generated. Further investigation in this field showed bafflingly results as the molecules could even amplify signals just like their conventional counterparts. This has further pushed the application of moletronics as logic gates. Conducting polymers such as polyacetylene, polypyrrole, and polyaniline have a linear-backbone and are the main classes of conducting polymers. These form the molecular building blocks in the field of moletronics. Poly (3-alkylthiophenes) is the archetypical materials for transistors. Along with these, the naturally available graphite too forms the raw material for moletronics. The Buckminster Fullerene or C-60 nanotubes are the final produce of graphite as an application in moletronics. While most of the conductive polymers have longed to find any large scale application, the nanostructured forms of these have provided.

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IV. Working Principle

The basic working principle of moletronics is the same as the conventional silicon fabricated chips. The main difference is in the workability of the two. While the conventional silicon chips have shown tremendous advancement throughout their development from the SSI to the latest ULSI, moletronics seems to the best bet when it comes to performance. Thus, moletronics uses molecular blocks as a substitute to the traditional silicon. Everything else remains more and the same in the integrated circuits. Also, to use them as a switch only one electron is sufficient to either turn ON or OFF these molecular transistors.

V. Components

The main electronic component here is the molecular wire. This different concept than the use of conductive polymers. Molecular wires can be infused as conductive polymers, thereby enhancing their various mechano-electric properties. Molecular wires have a repeating structure which can be either organic or inorganic in nature. Their structure can be familiarized well with the study of the Human DNA. These can conduct electricity. These typically have non-linear current-voltage characteristics and do not behave like ohmic conductors. Their conductance follows the typical power law as a function of temperature or electric field, whichever is the greater, arising from their strong one-dimensional character. These are also called as "nanowires" which should be able to self-assemble to be used in moletronics. They should have the ability to connect to diverse metal surfaces such as gold which is extensively used in semiconductor fabrication industries to form the connection with the outside world. In addition to this, the connectors should have the recognitive ability. The next important component involves the concept of molecular logic gates. To start off with, molecular logic gate is a molecule that is capable of doing the logical operations as its bulk elec-tronic counterpart. Its operations are based on one or more physical or chemical inputsand a single output. These molecular logic devices are also termed as "moleculators". These have advanced so far that now these are capable of computing combinational and sequential logical operations. One break-through in this technology is the use of these components as memory storage devices. Molecular logic gates work with in-put signals based on chemical processes and with output sig-nals based on spectroscopy. Compound A is a push-pull olefin with the top receptor containing four carboxylic acid anion groups (and non-disclosed counter cations) capable of binding to calcium. The bottom part is a quinolone molecule which is a receptor for hydrogen ions. The logic gate operates as follows. Without any chemical input of Ca2+ or H+, the chromophore shows a maximum absorbance in UV/VIS spectroscopy at 390 nm. When calcium is introduced a blue shift takes place and the absorbance at 390 nm decreases.

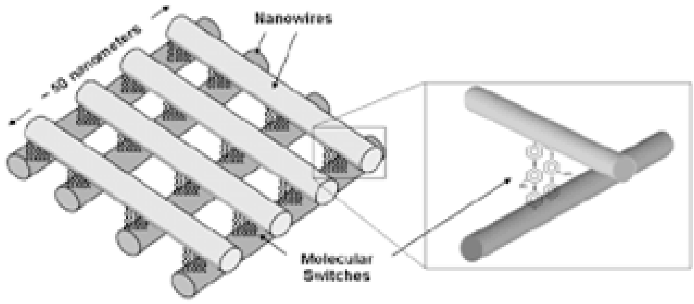

Fig.1 molecular scale crossbar ckt architecture

This system represents a XNOR logic gate in absorption and a XOR logic gate in transmittance.

Molecular sequential logic is exemplified by D. Margulies et al., were they demonstrate a molecular keypad lock resembling the processing capabilities of an electronic security device which is equivalent to incorporates several interconnected AND logic gates in parallel. The moleculemimics an electronic keypad of an automated teller machine (ATM). The output signals are de-pendent not only on the combination of inputs but also on the correct order of inputs: in other words the correct password must be entered. The molecule was designed using pyrene and fluorescein fluorophores connected by a siderophore, which binds to Fe (III), and the acidic of the solution changes the fluo-rescence properties of the fluorescein fluorophore.

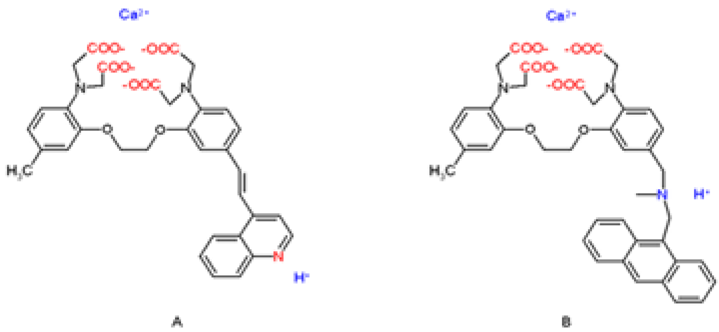

Fig. 2 Molecular logic gates

CONCLUSION

Moletronics is nowadays seen as the next step in the world of microelectronics. It can assuredly change the way chip-fabrication works in this present era. With a vision to go be-yond the scope of Moore's law, moletronics has paved a way for the future of the microelectronics industry. But there are still some issues that need to be taken into consideration so as to practically implement this technology. Mass production of moletronic chips is only possible after we have sorted these issues. It has tremendous potential to rightly achieve another milestone in the fabrication industry. Use of organic polymers also ensures lesser generation of carbon emissions. With this technology, Nano-robotics & DNA Computing can be easily materialized. With this view, we can conclude that moletronics is a safe and efficient future technology in chip-fabrication after ULSI.

Acknowledgement
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