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Nano Transistor, Transition towards Quantum Computation: A Study

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Abstract— As we know that currently no transistor is being used and in place of that nano transistor been used globally. In fact this nano transistor breaks through to offer billion times faster computer. It also makes transition towards quantum computers and widely used for manipulation of individual atom with exquisite precision. It helps for making semiconductors to semiconductor to transistor to integrated circuit. Also it has been vigorously used towards bio molecular computers using reaction, diffusion dynamics in different field.

Index Terms— Accuracy, Fredkin Gate, Precision, Toffoligata

I. INTRODUCTION

First develop in 1950's transistor revolutionized in electronic industry worldwide. A "Greek" word "nano", means "dwarf", something very or extremely small when quantifiable "nano", word translates to one billionth, as in the nano-second. where as in case of transistor is a solid state active device that control current flow, comprises of semi conducting materials (silicon , germanium) in three electrodes regions with two junctions, which are alternatively doped + - + or - + - in a semi conducting sandwich . Here the outer region serves as collector and other outer region as the emitter and inner region as the base. It operates like an audio amplifier, switch or rapidly opening and closing of electronic gate. This electronic semiconductor device that amplifies, oscillates, detector or switches the flow of current between two terminals by varying the current or voltage between one of the terminals. In case of nano transistors , electronic component that acts as an electronic signal switch or amplifier , that is near the scale of a billionth of a meter show called nano meter in size.

II. NANO TRANSISTOR BREAK THROUGH TO OFFER BILLION TIMES FASTER COMPUTER

In February 20, 2012, in Sydney scientist have built the world's tiniest transistor by precisely positioning a single phosphorous atom in a silicon crystal.

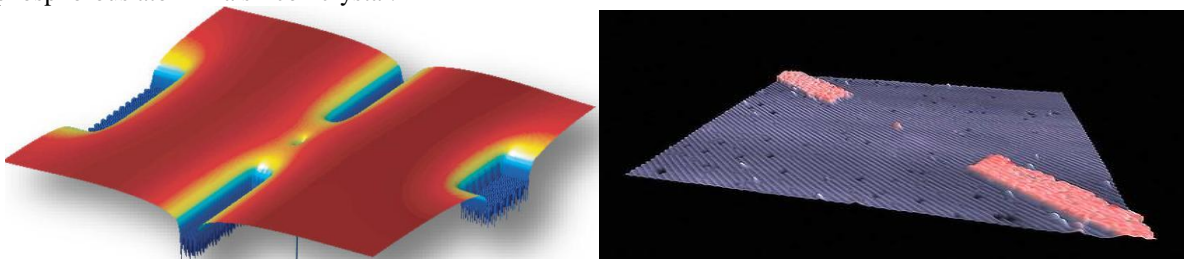


Fig. 1: A single phosphorus atom precisely positioned within a silicon crystal could become a building Block for a super-fast quantum computer."

Use :- Nano device is an important step in the development of quantum computers - super – powerful devices that will use the weird quantum properties of atoms to perform calculations billions of times faster than today's computer .

According to Michelle Simmons, et al. [6] of the University of NSW, single atom devices have made before by chance and their margin of error for placement of atom was about 10 nano meters which affected performance

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A. MANIPULATION OF INDIVIDUAL ATOMS WITH “EXQUISITE PRECISION”

This technique involves scanning, tunneling microscopes which are able to replace one silicon atom from a group of six with one phosphorous atom, achieving a placement accuracy of better than half a nano meter. This single atom sits between two pairs of electrode; one about 20 nano meters apart, the other about 100 nano meters apart. When voltages are applied to the electrodes than the nano device worked like a transistor which can amplify and switch electronic signal.

Note: - Accuracy may be defined as closer to the nominal value. for an example a resistance manufacturing drawing dimension $R = 6 \pm 0.5 \Omega$, means the variability of 5.5 to 6.5 where the specification limit is 6 is known as nominal value . It is in connection with the manufacturing of work.

Precision may be defined as repeatability or reproducibility in a measuring process under unchanged conditions show the same result. For a volt meter having list count that is minimum measuring capacity of 0.01 m volt and other having capacity of 0.02 m volt. Hence the first one is more precisions than other. Precision is connected with machine and its other related instruments and apparatus etc. More the precision higher is the accuracy.

B. APPLICATION OF NANO TRANSISTOR, TRANSITION TOWARDS QUANTUM COMPUTATION

Double – gate junction less transistor can be used as analog application

The invention has done from semi conductors to semi conductor to transistors to integrated circuit. (Semiconductors→Semiconductor→Transistors→Integrated Circuit)

Transistor acts as a switch or an amplifier or signal collector, base, and emitter. Quantum cellular automate cells composed of quantum dots, arranged next to each other on a semi conductor material in which a cell receives two electrons (that cannot escape) when created. A single is propagated down the line by a cell influencing its neighbor or neighbor’s. Beneficial, as it works on an extremely small scale (allowing dense components) and used vary little power [7].

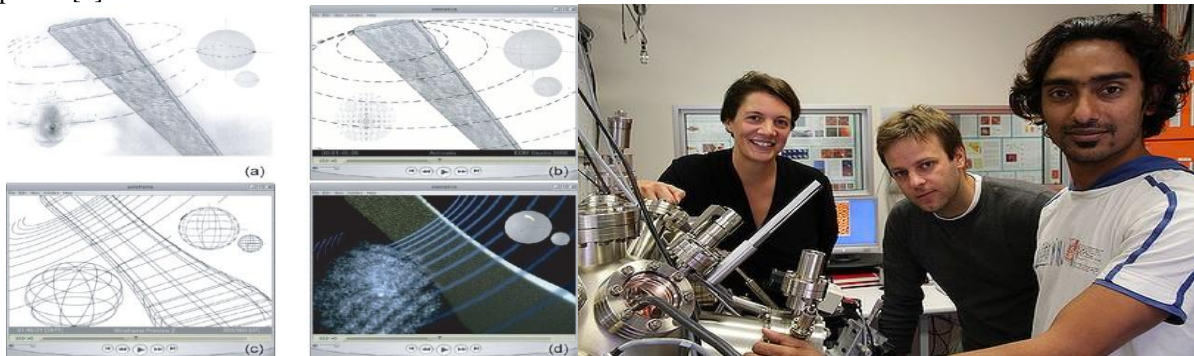


Fig. 2: Single atom sits between two pairs of electrodes, one about 20 nanometres apart, the other About 100 nanometres apart.

For an example:-

- Use of basic propagation quantum dot electron cell.
- Use of majority gate.
- Common logical gates AND OR XY XY X AND YX OR Y

Towards a quantum computer, one dot at a time

In January 20, 2006 at university of Pittsburgh [9] have develop a way to create semi conductor islands then smaller than 10 nano meters in scale, known as quantum dot. The island made from germanium and placed on the surface of silicon with two nano meters precision, are capable of confining single electrons.

Thereby

- Each quantum dots ships of as single photon emitters.
- Single quantum dots nano wire photo detectors were active element is a single quantum dot.
- Smallest quantum dots ever created and make possible a new level of control over individual electrons.
- Electrons traps that compute where semi conductor material to create super imposed quantum dots that “trap “single electron.

Two dimensional cavity grids for scalable quantum computation with super conductivity circuit which is used for quantum information processing.



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C. Quantum Coherence and De-coherence:

→Engineering entanglement [8] between atoms and three or four photons in a cavity correlations and entanglement quantum teleportation and beyond being done in Quantum Coherence and decoherence. Quantum manipulations of small Josephson junctions and the measurement process performed with a single – electron transistor. Smallest transistor [4] ever built in fact that smallest transistor that can be built – has been created using a single phosphorous atom. Hence a single phosphorous atom precisely positioned with in silicon, could become a building block for a super fast quantum computer.

→ By making of single – atom transistor by using single phosphorous atom which has developed a wire of phosphorous and silicon – just one atom tall and four atoms wide – that behaves like copper wire. It behave like metal in silicon

Design of reversible sequential elements [1] with fusibility of transistor implementation: →Reversible latches and flip flops are designed from reversible Fredkin, Feynman and Toffoligates. Two reversible gates are so called modified fredkin gate (MFG) and modified toffoligate (MTG) are also proposed to design the optimized implementations.

Silicon – based Quantum computers, a breakthrough for modern electronics device [2]:

→Quantum computers are the development of a “silicon based “can be solved some problem much more efficiently than the conventional computer and crack quickly existing codes and create Un-crack able codes Towards bio molecular computers using reaction – diffusion dynamics [3]:

→ It investigates a possibility of constructing massively parallel computing system using molecular electronics technology. By using” Enzymes “ new integrated circuit (I C) architectures that are free from inter connection problems could be constructed and it develop artificial catalyst devices as basic building blocks for molecular computing integrated circuits, and explore the possibility of a new computing paradigm using reaction – diffusion dynamic induced through collective behavior of artificial catalyst devices. Apart from the application of computer science use of nano technology involves work of scientist in chemistry, physics, biology, engineering and numerous related field, area ranging from computing and medicine to stain resistant textiles and suntan lotions [5]. The nano scale is also about new materials that may serves for medical treatments.

III. CONCLUSION

Single – atom transistor is the end of Moore’s law; may be beginning of nano transistor transition towards quantum computing. One potential benefit of more powerful computers would be to get rid of the keyboard and to be able to hold intelligent conversations with a computer. If more powerful computers are not built then the potential will never be explored or discovered.

IV. FUTURE APPLICATIONS

Number of transistor squeezed onto a circuit double about every two years – a trend known as Moore’s law and this lead to the prediction that transistors would need to reach the single atom level by 2020 through nano transistor, transition towards quantum computation, as per the professor Simmon view. Scientists decided 10 years ago to start this program to try and make single atom devices as fast as we could try and beat the law. This had now been achieved gent to ten years ahead of the industry’s schedule. Molecular electronics is based on building computers out of molecular switches and wires. A combination of molecular electronics and conventional complementary metal oxide semiconductor (CMOS) seems to have the potential to extend the exponential growth in computer power for another 50 years.

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