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Graphene Based Component Design

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ABSTRACT: Graphene is two-dimensional honeycomb lattice of carbon rings. Graphene is the emerging material in the field of electronics and nanotechnology. After studying various properties of graphene, researchers identified that this material would replace Silicon and make devices faster and easier to manufacture. Generally graphene remains highly stable and conductive even when it is cut into devices one nanometer wide. In this paper, MOSFET gets introduce in which graphene material is used. The goal behind this is to compare current-voltage characteristics of graphene MOSFET with generalized MOSFET i.e Silicon MOSFET. Also study and analysis of various parameters will be done, so that benefits of grapheme over silicon will come to know.

KEYWORDS: Graphene MOSFET, G-FET.

I. INTRODUCTION

In 1987, Graphene was introduced to world for the first time but only conceptually. After that it took nearly 23 years to see actual grapheme. In 2010, Konstantin Novoselov and Andre Geim got Nobel Price for their research. They used adhesive tape to separate out grapheme particles from graphite and they got success in it. And now Graphene is becoming emerging material in fields like Electronics, Nanotechnology, etc.Graphene has amazing properties because of it this material would replace silicon or we can use it with silicon to make devices faster and easy to manufacture. According to previous research, grapheme is 200 times stronger than steel. It is thinnest material on earth. It is good conductor of heat and electricity. Also grapheme is stretchable, transparent and flexible too.
This paper is arranged as follows.First we will look for generalized MOSFET, its working, characteristics, etc. Then next part is Graphene based MOSFET. After that Graphenevs Silicon part will come in which advantages of grapheme over silicon will be consider. Then conclusion of this paper will come.

II. LITERATURE SURVEY

Graphene based research is going on in many industries, institutes etc. So there is lot of articles and papers are available based on graphene.
Engineers at IBM Research have built the world's most advanced graphene-based chip, with performance that's 10,000 times better than previous graphene ICs. The key to the breakthrough is a new manufacturing technique that allows the graphene to be deposited on the chip without it being damaged (something that has heretofore been very hard to achieve). Perhaps more importantly, though, this new method is actually compatible with standard silicon CMOS processes. In short, we are closer than ever before to realizing a commercial graphene computer chip. [1]
Now a research partnership between theCambridge Graphene Centre, located at the University of Cambridge, and Plastic Logic have demonstrated what they claim is the first graphene-based flexible display ever produced. For years now, researchers around the world have been looking to graphene to replace the expensive and brittle indium-tin oxide (ITO) that is used as a transparent conductor to control display pixels. [1]

III. MOSFET

MOSFET is the majority charge carrier device. The device consists of active channel through which charge carrier, electron or holes flow from source to drain. Source and drain terminals conductors are connected to the semiconductor through ohmin contact. There are three terminals, Source through which carriers enters in the channel, Drain through

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which carriers leaves channel, Gate that modulates the channel conductivity by applying gate voltage. MOSFET is voltage control device with high input impedance. It generates lower noise level than BJT, MOSFET is more stable than BJT with respect to temperature parameter. The high input impedance of FET allows them to withhold loads long enough to allow its usage as storage element. Power FETs can dispute higher power and can switch very large currents.

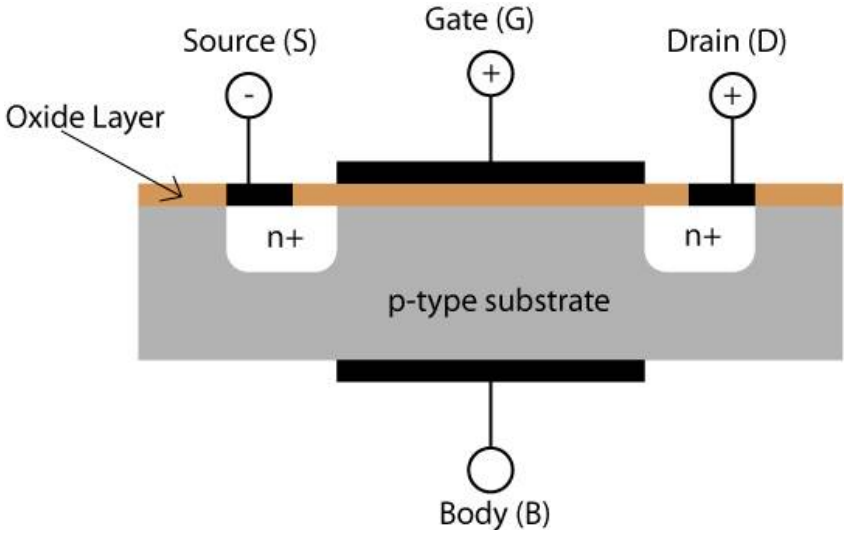

Fig.1: Generalized n-type MOSFET.

Generally MOSFET is used for Switching, Voltage Regulator, Chopper and Amplifier. MOSFET don't require any input current to control the load current. In enhancement mode MOSFET gate voltage helps to increase the conductivity of the device. In depletion mode, gate voltage reduces the conductivity.

To understand the working of MOSFET we have to go for its Voltage Current Characteristics.

Transfer characteristics of MOSFET depend on Drain Current (Id) and input gate-source driving voltage (V_{GS}). Transfer characteristic graph can locate the gate voltage at which the transistor passes current and leaves the OFF-state. This is nothing but device threshold voltage. Drain current gets elevates as as the V_{GS} increases.

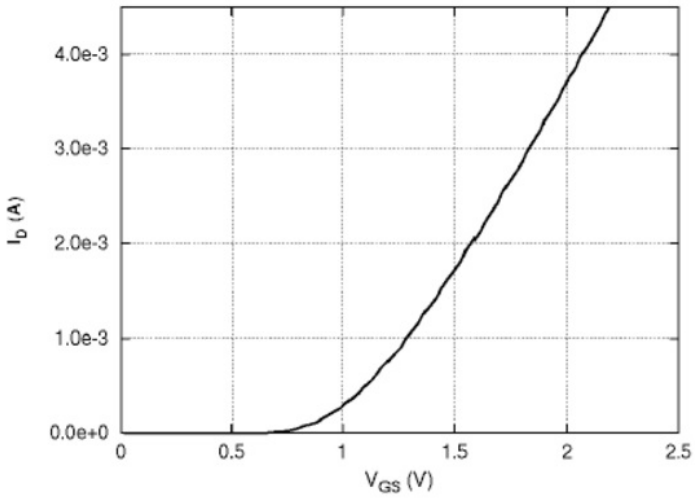

Fig.2 MOSFET Transfer Characteristics

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For Vgs, 0V to 0.7V Id remains 0A. Once Vgs becomes 0.7V current increases.Therefore, the threshold voltage of the given nMOS transistor is about 0.7V.

IV. GRAPHENE MOSFET

As we have already seen that grapheme is the amazing material which can be help to make device faster than regular devices.

Graphene MOSFET structure is consist of graphene layer in between Silicon and Substrate. This Silicon – Graphene combination will make device faster also it will change the voltage- current characteristics of device.

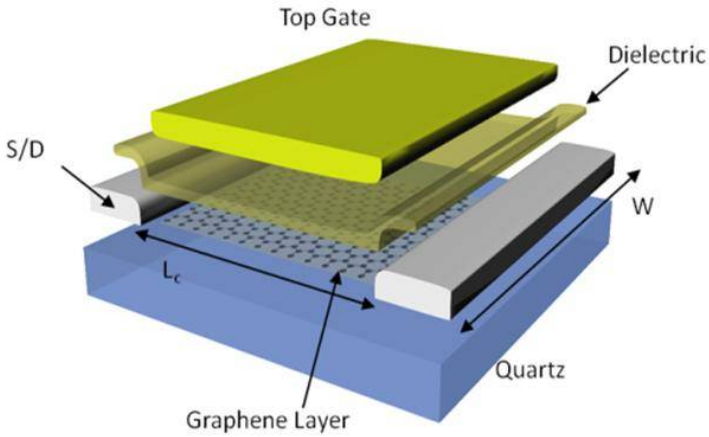

Fig.3 Graphene MOSFET

Consider fig 2 it shows the generalized MOSFET transfer characteristics. In which, once Vgs reaches to 0.7V drain current starts to increase rapidly. Now in graphene based MOSFET, it is expected that because of free electron property energy consumption will be done. So that the drain current increases as Vgs gets increase but faster than generalized MOSFET. So that at minimum Vgs, Id will reach at higher level. This will be beneficiary thing of GFET. This is what a exact change we need if we add Graphene to MOSFET device.

V. GRAPHENE VS SILICON

If we compare Graphene and Silicon we will come to know that in various aspectgraphene is richer than silicon. Silicon has break down voltage 0.3V where graphene has breakdown voltage less than 0.3V. Electron transfer is 200 times faster in graphene than silicon. Band gap energy of silicon is 1.1V, where graphene is zero band gap energy element. Graphene have high flexibility than silicon also it is unbreakable.

VI. CONSLUSION

Graphene-based nano electronics is still in its infancy to make any valid conclusions. But still there are many researches which can say that graphene will be definitely helpful in electronics. Nonetheless, the latest ITRS roadmap strongly recommends intensified research into graphene, and even envisions a research and development schedule for carbon-based nano electronics. The work in this field is only beginning. And the expectations are high.

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