PIR SENSOR MOTION DETECTION SYSTEM USING MEMS MOSFET ANALYSIS

Dr.C.ChandraSekhar[1] and K.Anusha[2]
[1]Professor, Head of the department of ECE, S.V.Engineering college for women, Tirupati.
[2]Mtech, Department of ECE, S.V.Engineering college for women, Tirupati
[1]hod_ece@svew.edu.in, [2]kasireddyanu1996@gmail.com

ABSTRACT:

PIR sensory system for the animal and human motion detection it detects the heat emitted by the object and it also measures the change in radiation. The measuring can be done by the radiation of a non – contacting detection at minimum distance. PIR sensor works on the principle measuring the different radiation levels emitted due to heat. PIR Sensor is great at detecting a person or animal enters into the detection range.

1. INTRODUCTION:

The term “Passive” means it doesn’t active and it doesn’t emits the heat radiation. It just measure’s the radiation emitted by the object temperature. The radiation detected by the sensor is converted into electrical charge. The electrical charge is proportional to the radiation levels emitted by the human or animal.

PIR sensor detects the IR light which is invisible to naked eye. The emitter and detector of PIR Sensor are IR LED and IR Detector Respectively. IR led emits the IR light and it strikes the object body and some of IR light absorbed by the heat body and then remaining amount gets reflected. The reflected IR light detected by the IR Detector which is sensitive to IR light. When the IR light is incident on object the change in resistance and change in output voltages leads to the output response.

2. LITERATURE SURVEY

MEMS(Micro–electro mechanical systems)

Micro-Electro-Mechanical Systems, or MEMS, it is technology to design electronic and electrical systems can be designed on a miniature board. Generally MEMS is to reduce size, cost and power consumption.

METHODOLOGY:

MEMS MOSFET ANALYSIS

The sensor design includes several phases like Model selection, Geometry creation, Physics selection, Material adding, Meshing techniques and results analysis.

In PIR sensor design first step is selected model wizard and go for 2D component. The sensor contains the 3 major parts like Transmitter, Receiver and Trapping region.

MOSFET, Metal Oxide Semiconductor Field Effect Transistor is the basic part in PIR sensor.

In geometry it looks like a rectangle but it contains 3 separate virtual regions as Drain, Gate and Source. Geometry contains both 2D and 3D components.

To draw a rectangle choose primitives, in that choose rectangle.

After finishing geometry next step is adding Physics. MOSFET is a semiconductor device so choose semiconductor physics. In physics add parameter details like Doping models, Metal contacts, insulation interfaces, recombination regions.

Next step material adding Si as a device material. In material mention basic material parameters like Relative permittivity, Electron lifetime, Hole lifetime, Band gap, Electron mobility, Hole mobility, Electron affinity, Thermal conductivity and impact ionization. After material selection MOSFET input fed as IR light. The changes in IR radiation to be detected at receiver end. The left top considered as source and right most top as drain. Source and Drain regions doped with ptype material and Gate region is with ntype material. The analytical doping model contains the impurity type as acceptor doping and donor doping.

The equilibrium electron (n_{eq}) and hole (p_{eq}) densities are given by:

$$n_{eq} = \frac{1}{2}(N_d - N_a) + \frac{1}{2}\sqrt{((N_d - N_a)^2)4n_i}$$

$$p_{eq} = -\frac{1}{2}(N_d - N_a) \pm \frac{1}{2}\sqrt{((N_d - N_a)^2)4n_i}$$

Where

N_d is the donor concentration under the gate.

In MOSFET there is 3 metal contacts to add metal contacts mention terminal name, contact type as ohmic and voltage. Also separate the gate and source with a thin insulator gate. There is default insulation between contact terminals also.

Next step is meshing the entire device separated into different parts based on shape. Based on shape meshing can be done in Edges or free triangular form and distribution should be even.

Next step is to compute the MOSFET device. First results checked in stationary study for initial values. The material sweep can be a parameter for performance difference according to material.

Finally Graphs in both 1D and 2D plots according to the values and it also shows the 3D results.

To conduct IR light through the MOSFET it should be in saturation region. Initial values of MOSFET is in off condition

when V_g=0. MOSFET is to operate in saturation region to conduct IR light. In saturation region condition is $V_{gs} > V_{th.}$.

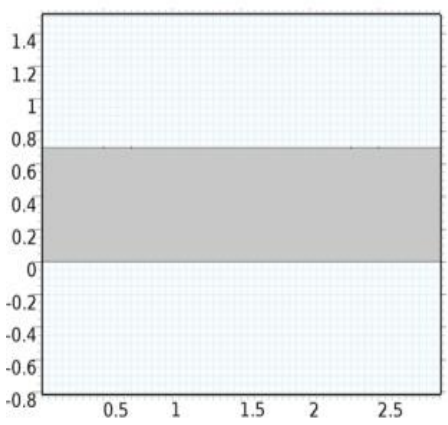

Fig1: Geometry

PIR sensor design starts with geometry it includes ptype substrate with a dopant. The substrate area, channel length and junction depth to be mentioned in geometry. The parameter description also mentioned in geometry it includes V_g,V_d and $V_{s.}$

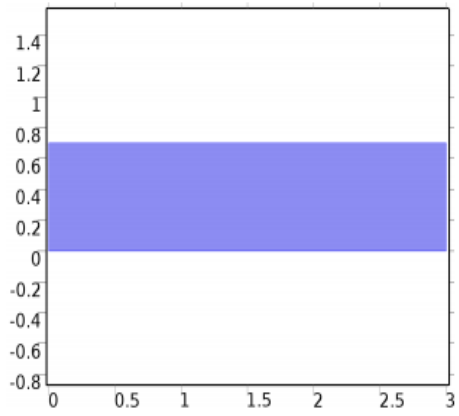

Fig2: Material adding

After completing the geometry material adding was done according to requirement. The substrate material is Silicon and also specifies the carrier concentration, doping levels of the material. To measure the better performance material sweep property was used.

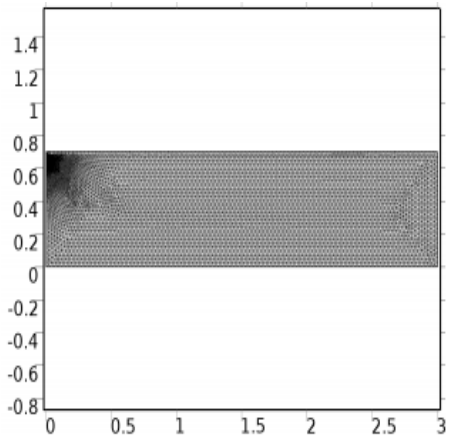

Fig3: Meshing

Next step is Meshing. It is to divide the domains into finite blocks to represent the element.

3. RESULTS ANALYSIS:

Once meshing was finished next step is model simulation.

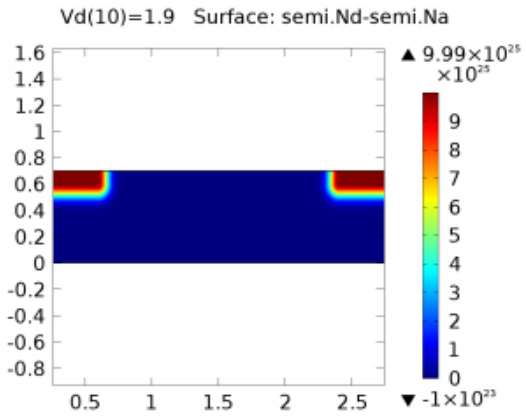

Fig4: Signed dopant concentration

The simulation shows the results with different colours and the colour of scale mentions the deformation rate. According to scale device is safe to operate in Blue, green, orange. The device deforms when the scale colour reaches to Red.

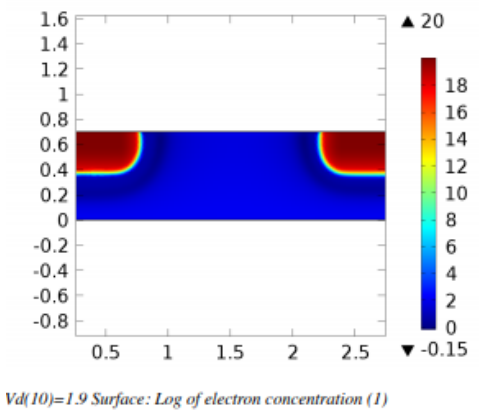

Fig5: Electron concentration

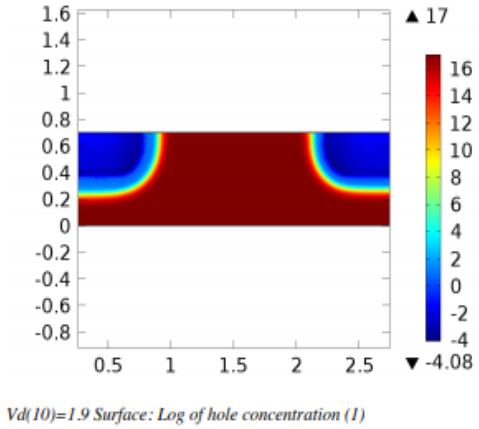

Fig6: Hole concentration

The following 1D plot is related to electron concentration.

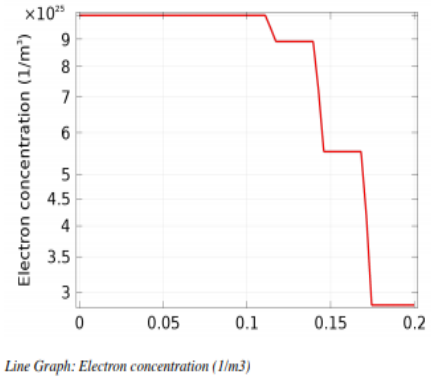

Fig7: Electron concentration

4. CONCLUSION

PIR sensor is already exists in our daily life. It includes door closing and opening systems, surveillance cameras, indoor and outdoor motion detection systems. But to reduce size and cost MEMS based PIR sensor was designed. It also gives the complete device details and results before device fabrication.

5. REFERENCES

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