Modeling the Fabrication Process Flow of MOS Gas Sensor based on Surface Micro-machining Technology

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ABSTRACT : *The work on the paper has been emphasized on modelling fabrication process flow of MOS based gas sensor .Different layered with material and thickness have been structured to obtain the required characteristic of gas sensor .By using piezoresistive material on fabrication layer where micro hotplate are used, the gas sensor behave as MEMS based piezoresistive gas sensor. The cavity has made on the surface to get desired response of change a level of gas concentration with pressure for detection of various hydrocarbons gases, material of fabrication layer has been used accordingly. For all this purpose the Devedit (silvaco tool)has been used.*

Keywords - *Devedit**, Gas sensor, MEMS, Silvaco.*

I. INTRODUCTION

 MEMS (Micro-electro mechanical system) is technology that combines computers with tiny mechanical devices such as sensors ,valves ,gears,mirrors,and actuators embedded in semiconductor chips .MEMS is a innovative technology that ,in one embodiment, generates continued, sustained improvements. The future of MEMS is rich with commercial possibilities, including the trillions of MEMS sensor envisioned to be used as the eyes and the ears of internet of things
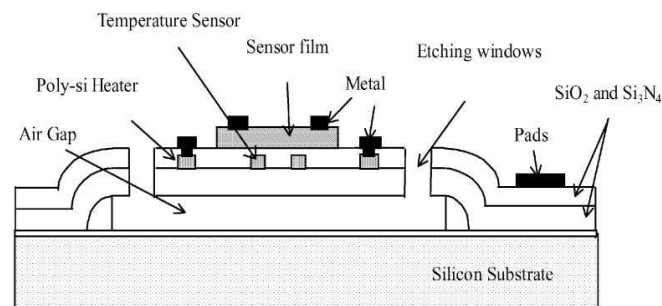

Fig1: Schematic diagram of gas sensor [1]

Fig 1 shows schematic diagram of MOS based gas Sensor in which gas concentration in air can be detected by measuring the resistance change of MOS- type gas sensors [3]. Section II defined the fabrication process flow of gas sensor in which detailed description of fabrication process shown. Section III defines the modeling steps for fabrication process through software. Section IV gives the software detailed description .section V provides the conclusion of review paper. This included the silicon anisotropic etch to create the thermally isolated micro-hotplate (MHP) and the deposition of gas-sensitive thin films using maskless r.f. SnO2 sputtering [4].SnO_2 sensing film is depositing for making monolithic SnO_2 gas sensor [5].

II. FABRICATION PROCESS

A 2mm diameter silicon wafer 100 orientation is taking as substrate on which silicon di oxide is thermally grown of 200nm thickness .The 2 mm of polysilicon was deposited on SiO2 as a sacrificial layer by   low pressure chemical vapour deposition (LPCVD).The MHP area defined the first mask. The side-wall spacer was formed after etching the poly silicon [2].

In this work RIE etching method was used instead of Tetra Methyl Ammonium Hydroxide (TMAH) etching method [6].

1. Define Si <100>
2. Deposition of SiO_2 and Si_3N_4.
3. Partially Etch Si_3N_4 and Deposition of SiO_2.
4. Partially etch SiO_2
5. Deposition of Si_3N_4
6. Partially Etch Si_3N_4
7. Deposition of SiO_2
8. Partially etch SiO_2
9. Deposition of polysilicon material for making poly silicon heaters.
10. Partially etch the polysilicon material
11. Deposition of aluminium material for metallization process.
12. Deposition of sensing layer for sensing gases like SnO_2 material sense the carbon monoxide gas in environment.
13. Again the deposition of aluminium material for making contacts.

III. THE MODELLING STEPS FOR FABRICATION PROCESS THROUGH SOFTWARE

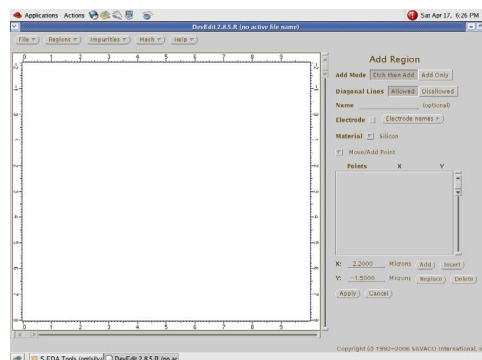Step 1. Click on Dev Edit icon in Silvaco tool, Dev Edit Window then appears as

Fig2: Dev Edit Window

Step 2. From the region menu, select the work region parameters, as shown below
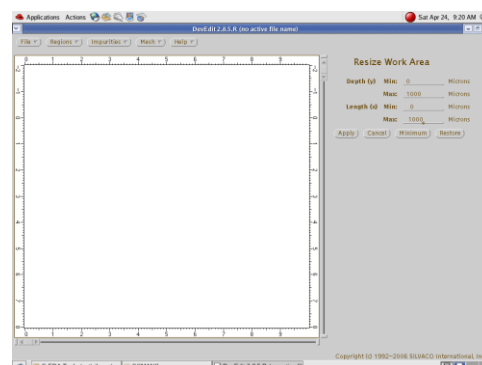

Fig3: Resize Work Area Window

Step 3. For <100> boron doped silicon wafer, select ADD region from Region menu, then from right side window select silicon from material tab and from move/add point select Set Base Impurity, the corresponding structure looks like as follows:
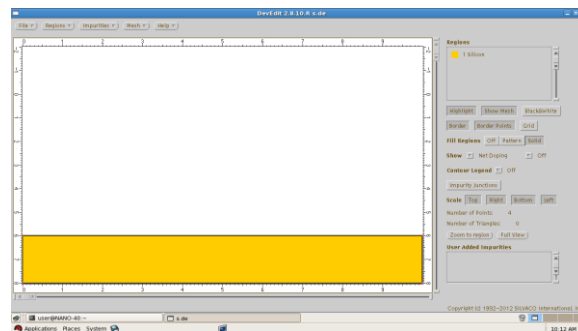
Fig4: Boron Doped Silicon Wafer

Step 4. For thermally grown SiO2, from region menu select add region, then from right window from material tab select SiO2 and from Add/Point select preferences color as shown below:
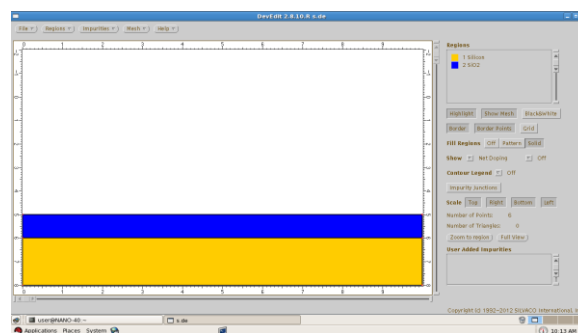

Fig5: Thermally grown SiO2

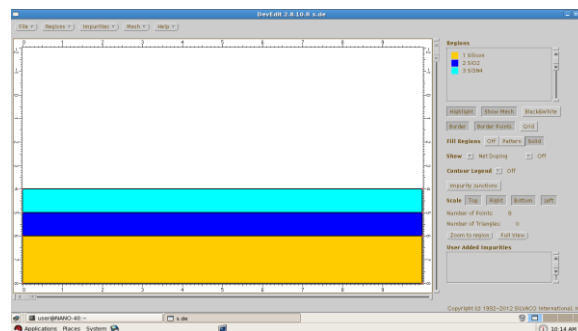Step 5. For Si3N4 layer, again repeat the same process, and thus we deposit Si3N4, as shown below:

Fig6: Deposit Si3N4 layer

Step 6. For window opening use the RIE of Si3N4 and wet etching of SiO2, for this select Add Region from Region menu and select the particular part which you have to etch then from right window click on Apply button. Another window is appeared in which click a right button on that particular layer from region then a window pop-up from that will select a delete region. Finally, that layer will be deleted, and structure looks like as:
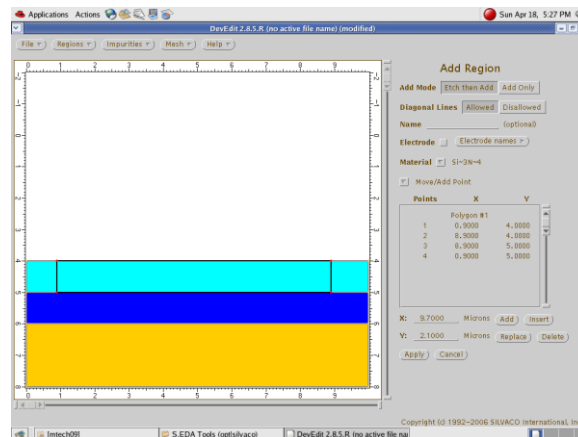
Fig7: Wet Etching Of Sio2

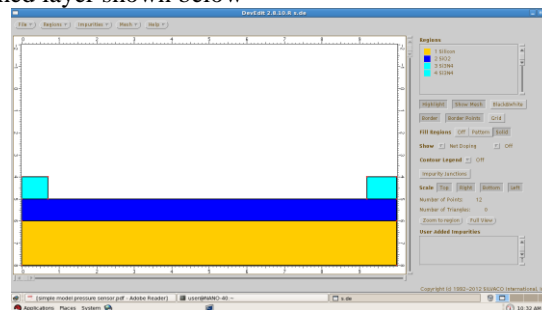Step 7. Finally we get the etched layer shown below

Fig8: Etched Layer

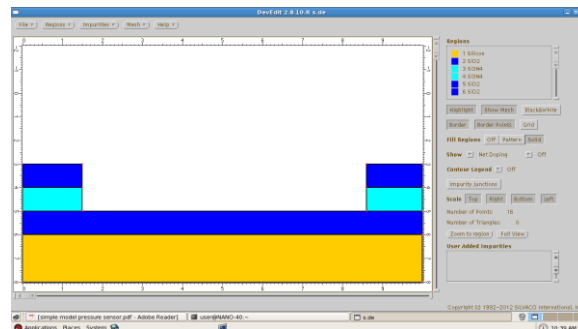Step 8. Similarly we can etch the SiO2 layer shown below:

Fig9: Etch SiO2 layer

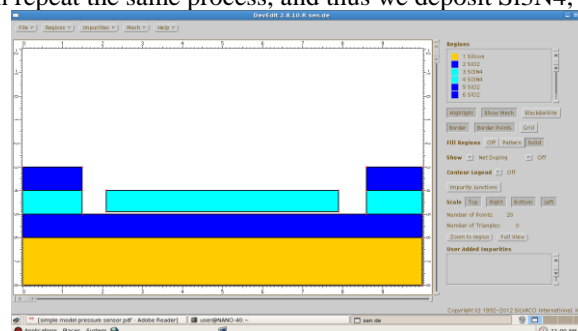Step9 For Si3N4 layer, again repeat the same process, and thus we deposit Si3N4, as shown below:

Fig10: Deposit Si3N4 layer

Step10 For thermally grown SiO2, from region menu select add region, then from right window from material tab select SiO2 and from Add/Point select preferences color as shown below:
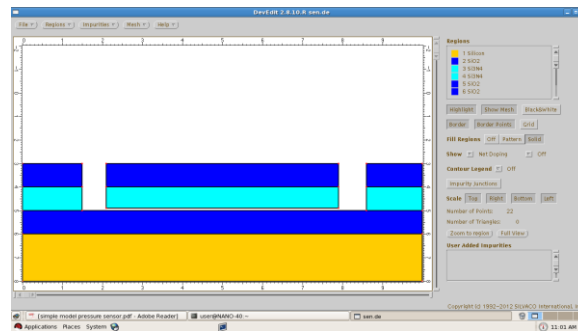

Fig11:Thermally grown SiO2 layer

Step11 For making polysilicon heater ,we take polysilicon material in proper dimensions.
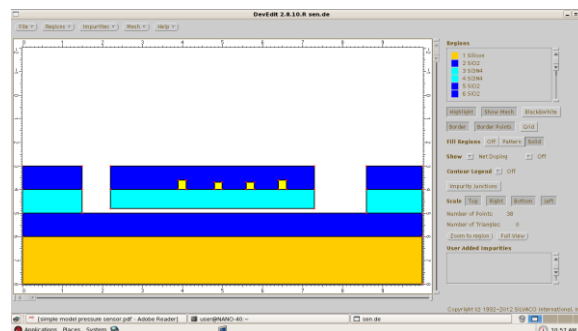

Fig12:Making polysilicon heater

Step12 For sensor metal interconnection aluminium Al for temperature sensor, heater and gas sensor   were deposited.
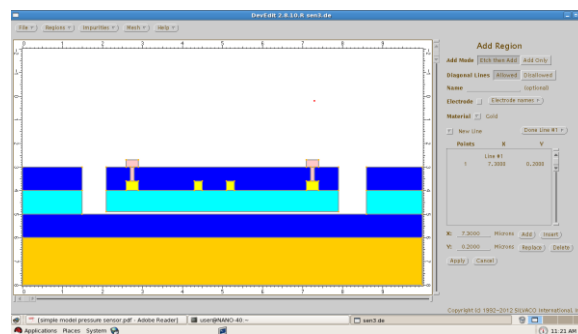

Fig13: Metallalization

Step13 Sensing layer is made up of SnO_2 material but in devedit environment there is no SnO_2 material so we take gold (Au) material as a substitute material for this.
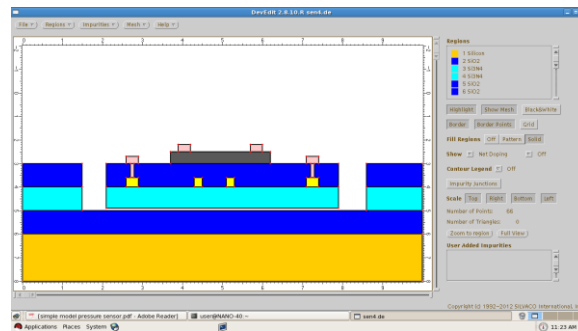
Fig14: Sensing layer

IV.   SOFTWARE DETAILS

Dr. Ivan Pesic was founded Silvaco in 1984. Silvaco provides the interactive tool.This interactive tool has different parts such as Deck build, Tony Plot, Mask view, and Optimizer ATHENA is Silvaco, Inc's. Version of SUPREM. ATHENA is normally used in conjunction with VWF Interactive tools. Among these interactive tools, we have worked on DevEdit, it can be used to either create a device by   remeshing or edit an existing device. It creates standard Silvaco structures which are easily integrated into 2D or 3D simulators of silvaco tool.

V.   CONCLUSION

In this paper , we have been presented the fabrication process flow of MEMS based gas sensor .The Devedit tool (Silvaco) has been utilized to describe the fabrication steps; and gas sensor has been modelled the dimension and layered diagram which are in micron range has taken from literature.

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