CHAPTER 5

Effect of RF Plasma on Gridded Gate Pt/SiO$_2$/Si MOS Sensor on Gas Sensing Behaviour of Hydrogen

This chapter presents the effect of RF plasma on SiO$_2$ film as well as combined effect of RF plasma with gridded gate structure on C-V characteristics, sensitivity and fixed oxide charge density of MOS sensor. The goal of this study is to investigate the causes behind the high sensitivity of plasma treated gridded gate MOS sensor.

5.1 Introduction

In the recent years the several impact on the environment due to the burning of fossil fuels has attracted the modern world for clean energy source; Hydrogen is being used as a clean energy source in many industries like chemical, food, semiconductor, petroleum, research laboratory etc [Lin *et al*. (2003), Trinchi *et al*. (2008)]. It is well known fact that hydrogen is inflammable, explosive as well as hazardous gas. So due to safety reasons, its continuous monitoring is required. Hydrogen sensors form an integral part of any such systems incorporating hydrogen as a fuel [Trinchi *et al*. (2008)]. The metal-insulator-semiconductor (MIS) structure for hydrogen detection was first reported by Lundstrom *et al*. [Lundstrom *et al*. (1975)]. The MOS structure is also sensitive to hydrogen containing molecules like ethylene, ethanol and hydrogen sulphide [Lindstrom *et al*. (1989), Kumar *et al*. (2014(a))]. If the metal film is made thin and discontinuous nature, an increased response to several gases notably NH$_3$ is observed [Lundstrom *et al*. (1989)].The selectivity pattern of MOS device depends on the choice of catalytic metal gate, the structure of metal gate and operating temperature [Winquist *et al.* (1983), Huges *et al.* (1983), Lundstrom *et al*. (1989), Lundstrom *et al*. (1990) and Kumar *et al*. (2014(a))]. Surface and interface states play an important role in determining the sensing performance of the MOS capacitor sensor. It has been observed [Fogelberg *et al.* (1995), Eriksson *et al*. (1998)] that the dominating part of the response of MIS sensor is due to the charge trapping on the insulator side of the interface. Eriksson *et al*. [Eriksson *et al*. (2005)] have co-related the sensing properties (such as detection limit, sensitivity and saturation concentration level) of MIS gas sensors with the surface properties of the insulator and concluded that surface properties of the insulator have a drastic improvement on the sensing behaviour of the sensor.

Chanana *et al*. [Chanana *et al*. (1992)] has fabricated the ultra thin (6.3 nm) layer of SiO_2 using RF oxygen plasma at room temperature with in-situ dry cleaning of Si surface. They observed that electrical properties of such SiO_2 are favourable for the development of MOS based gas sensors. It was also observed that the plasma oxides usually has higher densities as compared to thermally grown oxides and same is expected about the thin plasma oxides formed at low deposition temperature. Chanana *et al*. [Chanana *et al*. (1991)] has also reported that dielectric breakdown strength of SiO_2 layer increased with plasma cleaning after conventional cleaning. Dwivedi *et al*. [Dwivedi *et al.* (2000)] has fabricated the MOS sensor for hydrogen detection by depositing 6.9 nm thick SiO_2 layer through RF anodization of dry plasma precleaned silicon surface, in oxygen plasma near room temperature and found a drastic improvement in the sensing behaviour of the sensor in terms of high sensitivity and low response time of the sensor. Surface treatment by soft plasma (O_2, He, Ar, NH_3 and H_2) is another well established technique to modify the electrical and structural properties of SiO_2 film and its interface with silicon and enhance the sensitivity of the MOS gas sensor [Kassabov *et al*. (1988(a)), Kassabov *et al*. (1988(b)), Kassabov *et al*. (1988(c)), Kassabov *et al*. (1989), Kassabov *et al*. (1992), Atanassova *et al*. (1990)].

Pandey *et al*. [Pandey *et al.* (2009(b))] on Pd/SiO_2/Si MOS capacitor based structure observed ~73.3% sensitivity towards H_2 at room temperature. Pandey *et al.* [Pandey *et at*. (2010)] had also observed the change in sensitivity (73.3 to 74.4%) after RF and microwave oxygen plasma treatment of Pd/SiO_2/Si MOS capacitor sensor. Thus, there are several reports available on Pd based metal gate in gridded and non-gridded structures but there is a dearth of data on Pt based gridded metal gate sensors. Kumar *et al*. [Kumar *et al*. (2014(a))] has reported the enhancement in sensitivity towards hydrogen by using the gridded gate MOS structure. They had observed better sensitivity (~88%) as reported by earlier researchers [Dwivedi *et al*. (2000), Pandey *et al*. (2009(b)), Pandey *et al*. (2010)].The enhancement in sensitivity was caused by side wall diffusion, spill over of gas molecules onto oxide layer and increase in surface area of gate electrode. The sensitivity of the MOS sensor can be enhanced by changing the structure of both SiO_2 film and metal gate [Seo *et al*. (1997)]. The present chapter deals with the effect of RF plasma on SiO_2 film as well as combined effect of RF plasma with gridded gate structure on C-V characteristics, flat band sensitivity and fixed oxide charge density of MOS sensor. The goal of this experiment was to enhance the sensitivity of MOS sensor towards hydrogen. The fabricated MOS sensor S4 (treated with 40 W, 8 min., RF plasma) showed better sensitivity (91%) at 25 KHz as reported by earlier researchers [Kumar *et al.* (2014(a)), Dwivedi *et al*. (2000), Pandey *et al*. (2010), Pandey *et al*. (2009(b)].

5.2 Experimental Details

5.2.1 Device Fabrication

In the present work, 9 samples of gridded Pt/SiO_2/Si MOS capacitors were fabricated on P type <100> 3" Si substrate out of which one sample (S1) was non plasma treated and 8 samples (S2-S9) were plasma treated. The schematic diagram of plasma treated gridded Pt/SiO_2/Si MOS sensor has been illustrated in Fig. 5.1. The fabrication process of non plasma treated gridded gate Pt/SiO_2/Si MOS sensor has already been described in section 3.4 of Chapter 3. While fabrication process of plasma treated gridded gate Pt/SiO_2/Si MOS sensor has followed the following steps.

(i) Initially, all the samples were thoroughly cleaned using standard technological cleaning procedure used in silicon technology. The Details of cleaning procedure has been described in section 3.4.2 of Chapter 3.

(ii) A SiO_2 film of ~120 Å was grown by the dry thermal oxidation method by keeping all 9 samples in oxidation furnace at 850 ^{0}C for 12 minutes in O_2 and N_2 ambient atmosphere of 3:1 ratio. The thickness of the SiO_2 film was measured through ellipsometer (model no. L117, Gaertner Scientific corp., Chicago, USA). The average thickness measured by this method was calculated by Gaertner Ellipsometer Program (LGEMP).

(iii) For plasma treatment, these 8 samples (S2-S9) were divided into two sets (each set containing four samples). Each set was exposed to RF oxygen plasma with different RF power (40W and 50W, respectively) and all four samples of each set were exposed to RF plasma for different duration of time (2min., 4min., 8min., and 12min.). Oxygen plasma was generated at low pressure by using PECVD (plasma enhanced chemical vapour deposition system, made by National Physical Laboratory (NPL), New Delhi). The Schematic diagram of PECVD system has been illustrated in Fig. 3.1 of Chapter 3. The Top electrode of RF plasma system was grounded and substrates were kept on bottom electrode and they were driven by various RF power (40W and 50W) and timings (2min., 4min., 8min., and 12min). The PECVD system was operated in capacitive coupled mode at 13.56 MHz. The base pressure, working pressure and oxygen flow were kept same for all the eight samples. The details of various deposition parameters for all eight samples have been provided in table 5.1.

Table 5.1 Various RF plasma deposition parameters

Deposition Parameters/ Samples No.	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**
RF Plasma Power (watt)	40	40	40	40	50	50	50	50
Time (minutes)	2	4	8	12	2	4	8	12
Self Bias (volts)	105	105	105	105	105	105	105	105
Base Pressure (mbar)	2.5×10^{-3}							
Working Pressure (mbar)	2.5×10^{-2}							
O_2 Flow rate (sccm/min.)	99							

(iv) After RF oxygen plasma treatment of SiO_2, photolithography technique was used for retaining front side oxide and removing the oxide from the back side of all the samples.

(v) Subsequently, Pt was deposited on the front face of all nine samples (including S1) sample) of thickness ~420 Å by thermal evaporation method (model no. 12A4D, Hindhivac Co. Ltd., India, make).The required steps for metallization have been mentioned earlier in section 3.4 of Chapter 3.

(vi) For the required gridded gate structure a standard mask has been used which is shown in Fig. 3.3 of Chapter 3. The outer diameter and inner diameter of gate structure were kept 1.5 mm and 0.3 mm, respectively. The necessary photolithography technique has been performed to have proper dimensions of MOS structure. Aqua Regia ($HNO_3 + 3HCL$) was used for platinum metal etching. The detailed procedure of photolithography is mentioned in section 3.4 of Chapter 3.

(vii) The ohmic contact to the back side of Si substrate was made by evaporating Al metal.

(viii) Annealing at 450 ^{o}C in N_2 ambient atmosphere for 7 minutes was performed to have proper ohmic contacts.

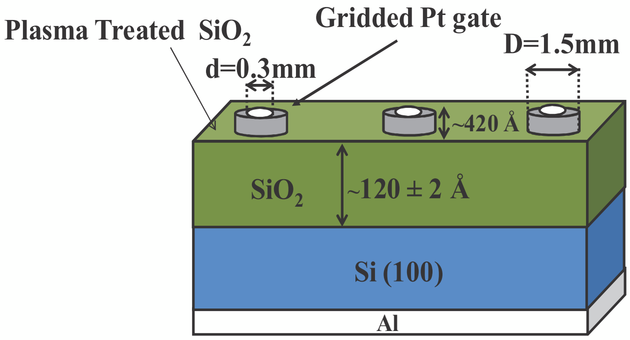

Fig. 5.1 3-D structure of plasma treated gridded gate Pt/SiO_2/Si MOS sensor

5.2.2 Surface Characterization of Device

The microstructure analysis of SiO_2 surfaces of all nine sensors was carried out by AFM in contact mode (model no.-NSE, Nanoscope E Digital Instrument Inc., U.S.A) which is illustrated in Fig 5.2a to Fig. 5.2f. AFM study reveals the microporous and granular nature of the SiO_2 film. The surface roughness and grain size of SiO_2 film of all nine sensors have been evaluated from AFM micrograph and shown in Table 5.2. The details of AFM instrument has been described in section 3.2.6 of chapter 3.

5.2.3 Electrical Characterization of Device

The C-V measurements of fabricated gridded Pt/SiO$_2$/Si MOS capacitor sensors (all nine samples) have been carried out in air, in a closed chamber towards hydrogen (250-3500 ppm) at 25 KHz at room temperature. The experimental set-up used to study the C-V response of the fabricated device with exposure to hydrogen in air is same as described in section 3.3.1, Fig. 3.2 of Chapter 3.

5.3 **Results and Discussion**

The surface morphology of SiO$_2$ films of all nine samples has been investigated through AFM study (shown in Fig. 5.2a to Fig. 5.2f). Moreover, the film surface of all plasma treated samples (S2-S9) comprising of granular and microporous structures which may lead to improved sensing behaviour of the device which is shown in Fig. 5.2b-5.2f. It has been observed that there was less porosity found in non plasma treated SiO$_2$ film of S1 sample which is shown in Fig.5.2a. Fig. 5.3 shows the C-V characteristics of S1 sensor and Fig. 5.4 to Fig. 5.11 show the C-V characteristics of all eight MOS sensors (S2-S9) treated at 40 W and 50 W RF oxygen plasma power for different durations (2 min., 4 min., 8 min. and 12 min.) upon exposure to various concentrations of hydrogen (250 ppm-3000 ppm) at 25 KHz. It has been observed that with increase in the hydrogen concentration the entire C-V curve shifts towards the negative side of the voltage axis [Snow *et al*. (1965), Yadava *et al*. (1990), Pandey *et al*. (2009(b),]. The change in capacitance with H$_2$ concentration is converted into percentage sensitivity (%) through the formula [Yadava *et al*. (1990)],

$$S\% = ((C_{\text{air}} - C_{\text{gas}})/C_{\text{air}}) \text{ X } 100. \qquad (5.1)$$

Where, C_{air} and C_{gas} are the capacitances in air and H$_2$ gas, respectively.

Fig. 5.12 to Fig. 5.14 show sensitivity vs concentration curves of all nine gridded gate MOS sensors (S1-S9). From Fig. 5.13, it has been observed that at 40 W RF plasma power as the plasma exposure time increases (2 min. to 8 min.) the sensitivity of the sensor also increases. The maximum sensitivity i.e. ~91% has been observed in case of S4 sensor (40W, 8 min.) as compared to other sensors. However, in case of 50 W, for plasma exposure of 2 min. and 4 min. duration, the sensitivity of the sensors increases initially and is found to be decrease for the samples with exposure time of 8 min. and 12 min. duration shown in Fig. 5.14 and shows a saturating trend at higher concentration of H_2. The reason for high gas sensitivity of MOS structures is higher density of surface states in oxide layer and at the interface of insulator/silicon. The main reasons of higher gas sensitivity are large grain boundaries, high value of surface roughness, large porosity found in the oxide film. Higher density of surface states in oxide film and at the interface of insulator/silicon is also responsible for high gas sensitivity [Snow *et al*. (1965), Yadava *et al.* (1990), Pandey *et al*. (2009(b)]. In the present work, AFM analysis of RF oxygen plasma treated SiO_2 surfaces consists certain porosities as shown in Fig. 5.2b-5.2f. The porosity in the SiO_2 film is found to increase with plasma exposure time and power both. Fig.5.2b to 5.2f illustrates the AFM images of RF oxygen plasma treated SiO_2 surfaces.

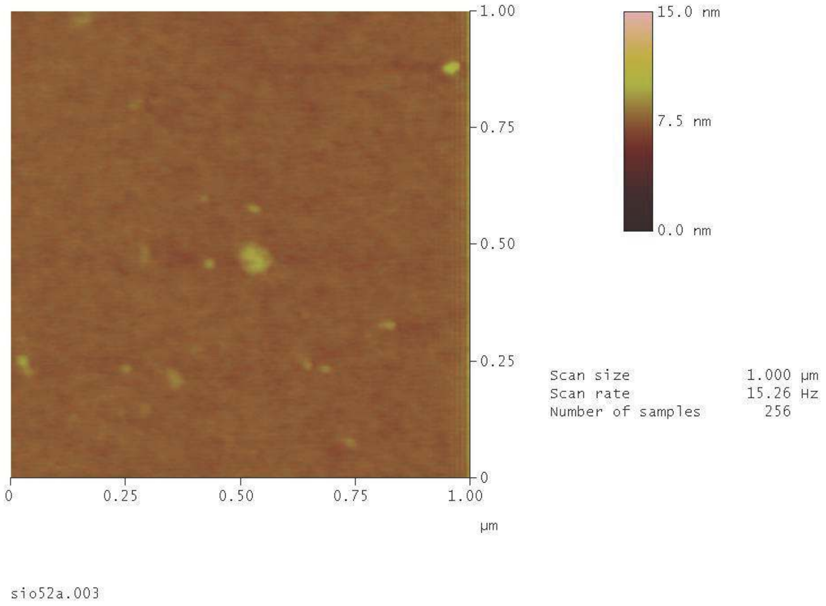

Fig. 5.2 (a) AFM images of Non plasma treated SiO_2 film (S1)

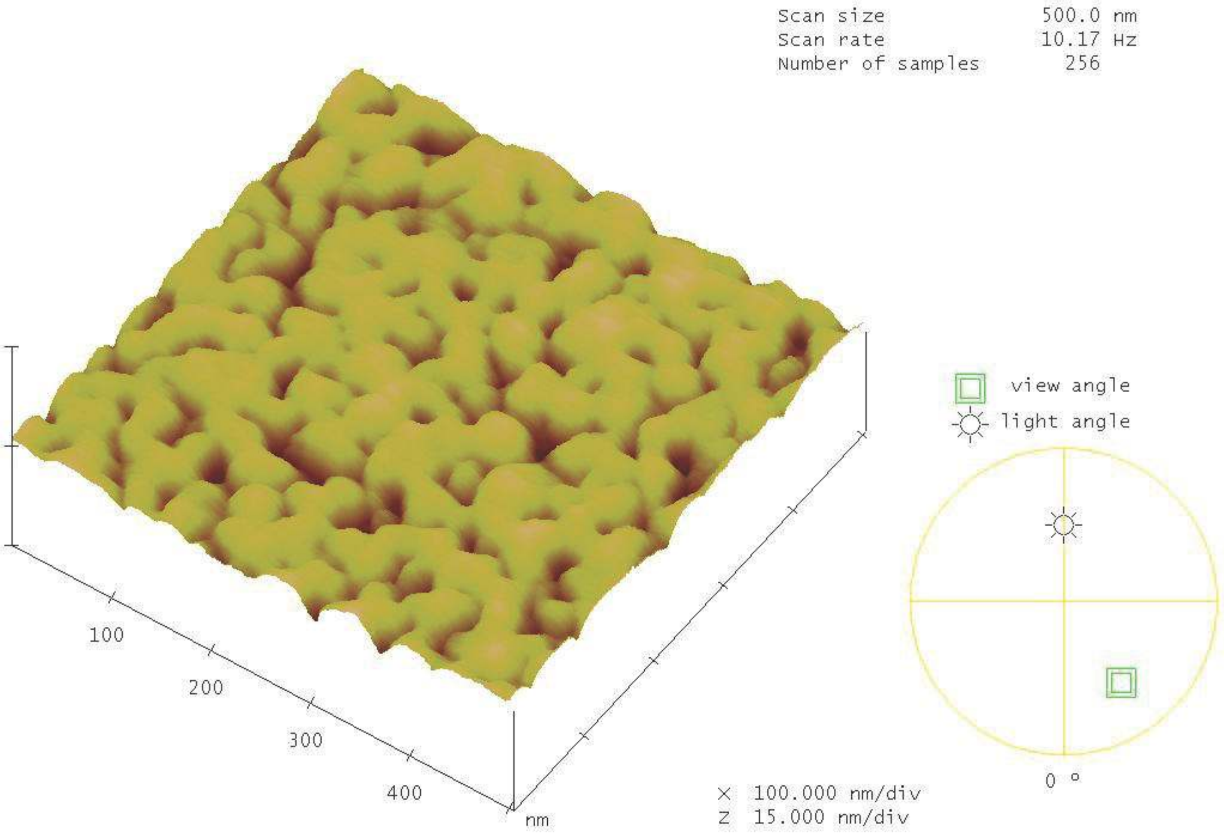

Fig. 5.2b AFM image of SiO$_2$ surfaces treated with O$_2$ plasma at 40W RF power for 4 minutes (S3)

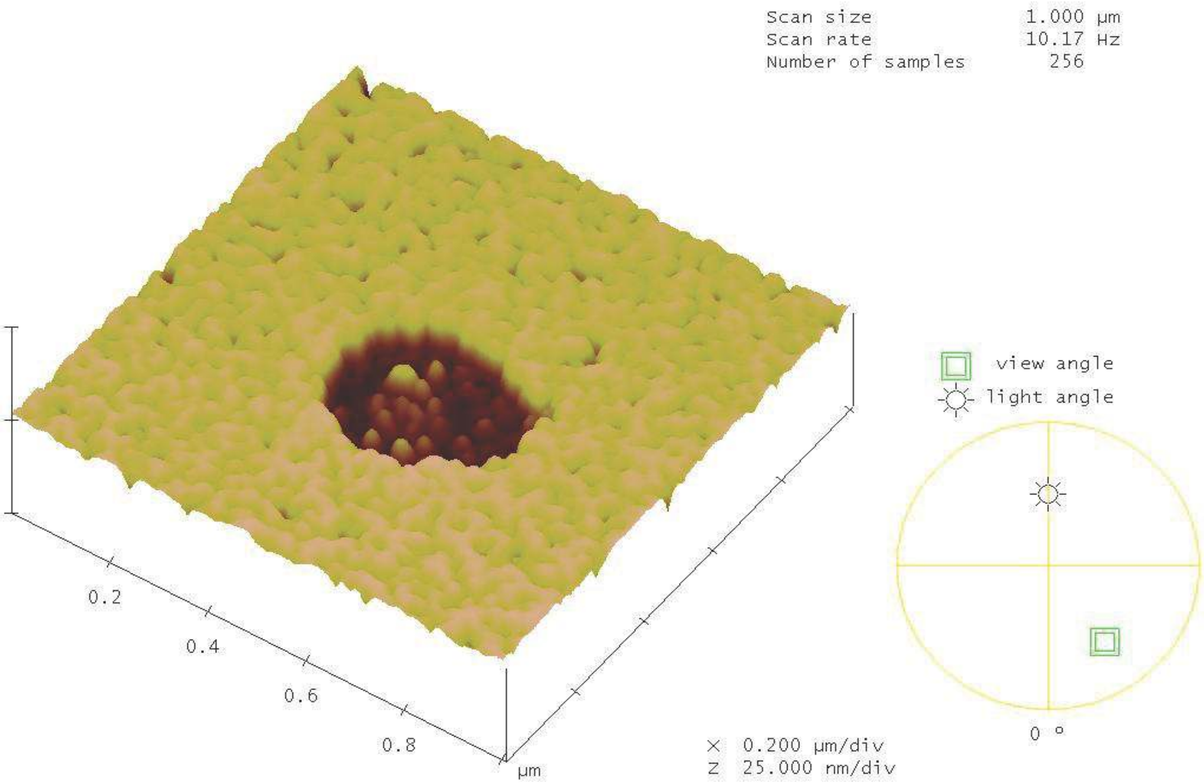

Fig. 5.2c AFM image of SiO$_2$ surfaces treated with O$_2$ plasma at 40W RF power for 8 minutes (S4)

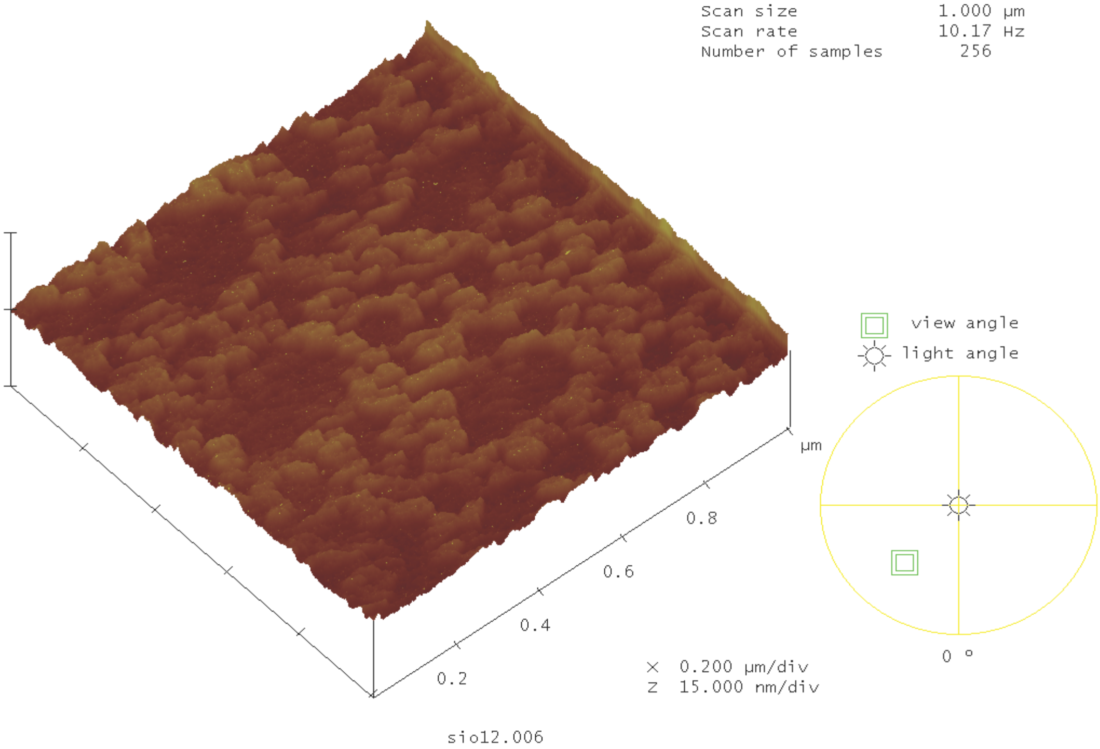

Fig. 5.2d AFM image of SiO$_2$ surfaces treated with O$_2$ plasma at 40W RF power for 12 minutes (S5)

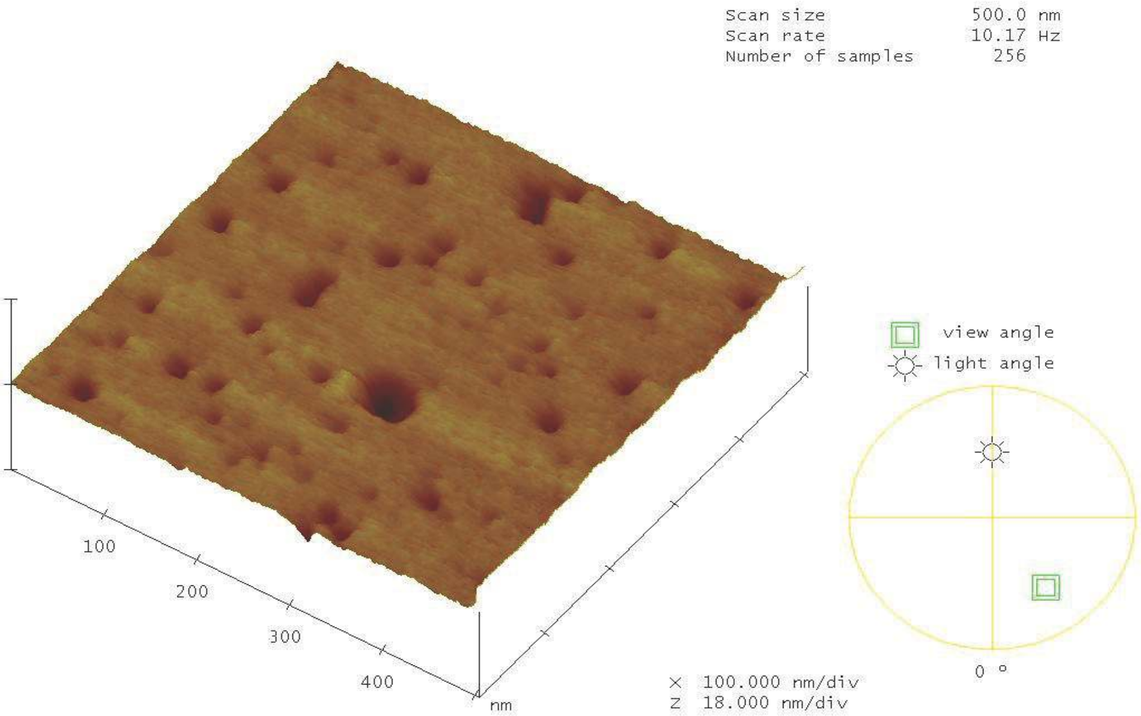

Fig. 5.2e AFM image of SiO$_2$ surfaces treated with O$_2$ plasma at 50W RF power for 4 minutes (S7)

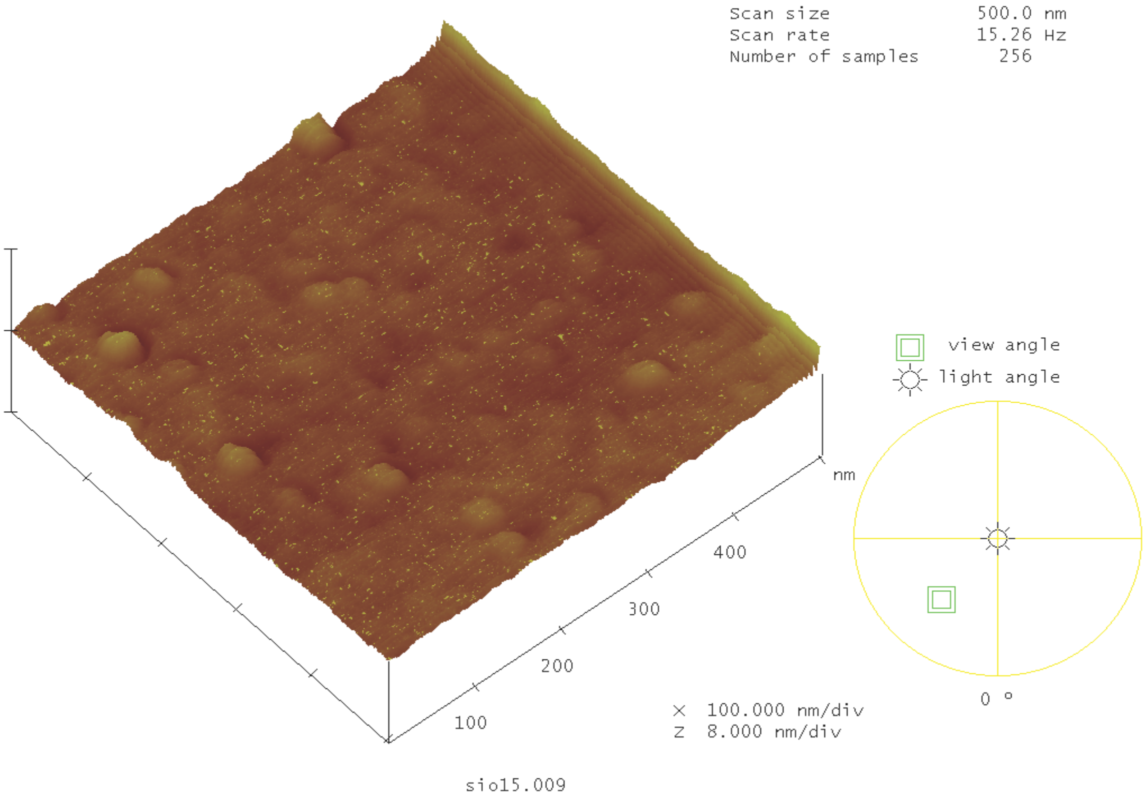

Fig. 5.2f AFM image of SiO_2 surface treated with O_2 plasma at 50W RF power for 8 minutes (S8)

These figures show the granular and porous structure having a large no. of grains with some porosity. The porosity of the surface increases with exposure time and attains maximum value at 8 min. duration for 40 W RF power which is shown in Fig.5.2c. For 12 min., 40 W plasma exposure SiO_2 film surface begins to damage appreciably which is clear from the Fig. 5.2d. At this power and time grain size (10.859 nm) and surface roughness (14.971nm) are found to be maximum. However, for the RF plasma power of 50 watt, when plasma exposure duration is 4 min., the oxide surface consists of big pores in the film but there are very small granular microstructures present in the SiO_2 film. The AFM image of sample (S7) is illustrated in Fig. 5.2e. Due to good porosity found in the film of sample (S7) it shows the good sensitivity (~87%) which is less as compared to sensitivity of sample S2, S3 and S4. At 50 W plasma power and higher duration exposure time (8min., and 12 min.) the SiO_2 film get damaged. This is shown in Fig. 5.2f. Table 5.2 shows the comparative study of all nine sensors on the basis of sensitivity (%), average roughness and grain size.

Table 5.2 Comparative study of various MOS sensors

Sample No.	**Sample description**	**Sensitivity (%)**	**Avg. roughness (nm)**	**Grain size (nm)**
S1	non plasma treated	73	5.90	0.59
S2	Plasma treated (40W, 2 min.)	88.6	*	*
S3	Plasma treated (40W, 4 min.)	88.9	13.38	8.83
S4	Plasma treated (40W, 8min.)	91.1	14.971 nm	10.859
S5	Plasma treated (40W, 12 min.)	72	7.083	1.065
S6	Plasma treated (50W, 2 min.)	78.8	*	*
S7	Plasma treated (50W, 4 min.)	87.36	12.37	6.99
S8	Plasma treated (50W, 8 min.)	69.2	5.063	1.117
S9	Plasma treated (50W, 12 min.)	71.5	*	*

*AFM data is not available

This is evident from the sensitivity vs concentration response as presented in Fig. 5.13 and Fig. 5.14, where sensitivity is found to decrease for higher duration as well as high power plasma exposure of S5, S8 and S9. Pulfree *et al*. [Pulfree *et al*. (1974)] reported that due to high power plasma exposure surface sputtering may take place which results decrease in sensitivity at 50 W, which is shown Fig. 5.14. Plasma is an electrically neutral matter in a gaseous state, consisting of electrically neutral gas molecules, photons, ions (+ve and -ve) and electrons. The parameters that affect the characteristics of plasma to activate the gas are: Plasma density (the no. of charged particles per unit volume), the electron energy usually given in terms of a temperature and the ion impact energy these all affect the ability of the plasma to promote the etching of SiO_2 film [Richard *et al*. (1995)]. Aguas *et al.* [Aguas *et al*. (2001)] reported that oxygen plasma treatment of the surface oxides is an effective method to increase the oxide barrier by changing the oxide stoichiometry which improves the electrical properties of the surface. It had been observed that sensor made up by porous gate metal film as well as SiO_2 film posses higher gas sensitivities due to the increase in effective surface area [Tan *et al*. (2008), Kumar *et al*. (2014(a))]. When the effective surface area of the sensor increases, it results in an increase of the oxygen species available for reaction with reducing gas in contact with the sensor. This results in an increase in sensitivity [Li *et al*. (1999)]. The gas sensing mechanism of SiO_2 sensor is based on surface reaction between the oxygen species and the reducing gas in contact with the sensor [Gaggiotti *et al*. (1995), Chung *et al*. (1995), Tan *et al*.(2008), Daudi *et al.* (2003)]. Oxygen plasma constitutes single and multiple oxygen ions like O^-, O^{2-},O^{3-}, O^{4-}, O^{+4},O^{3+},O^{2+},O^+ etc and e^-[Ligenza *et al.* (1970), Bell (1996)]. When these species interact with each other, the no. of adsorption sites inside the device also gets modulated accordingly. On the exposure of reducing gases like hydrogen the adsorbed gas molecules (in this case H_2) interact with these species (single or multiple) which are present at the SiO_2 surface due to plasma treatment, and can exchange electrons with SiO_2 surface and results in increase in sensitivity of sensor [Dwivedi *et al.* (2000)].The basic principle of operation of gridded gate Pt/SiO_2/Si MOS sensor had already been reported by Kumar *et al*. [Kumar *et al*. (2014(a))].

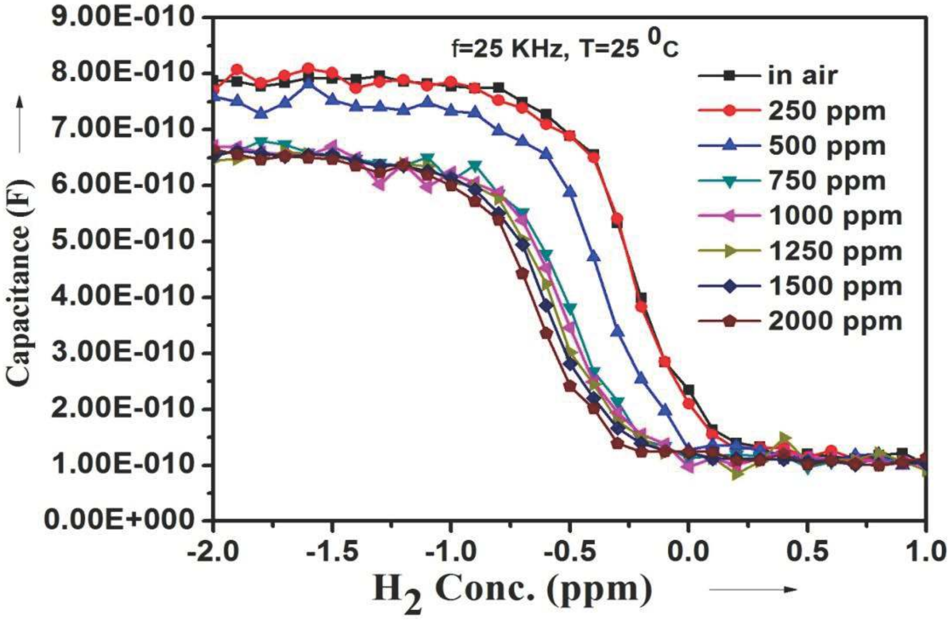

Fig. 5.3 C-V response of Non plasma treated gridded gate Pt/SiO$_2$/Si MOS sensor (S1) in air at room temperature.

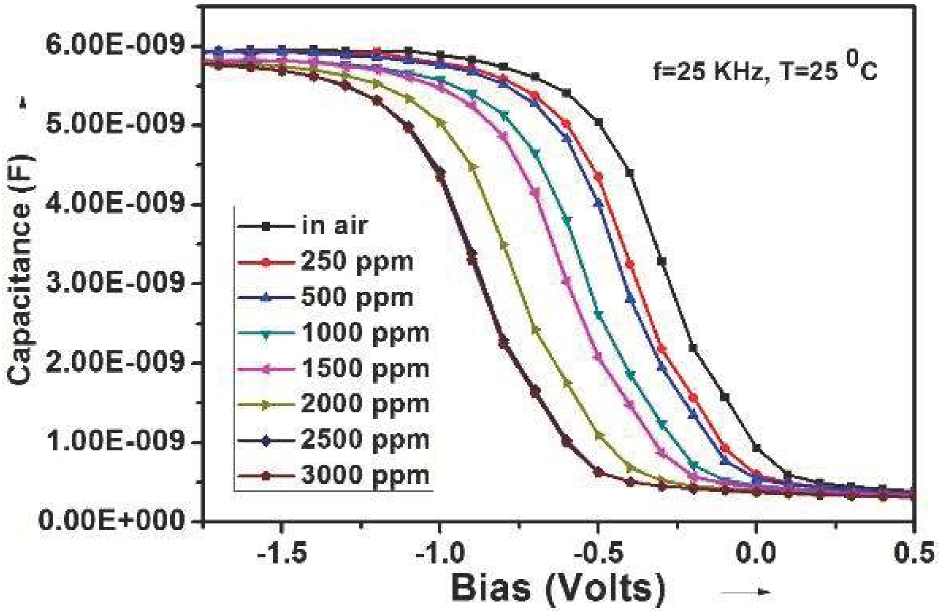

Fig. 5.4 C-V response of O$_2$ RF plasma treated at (40 W, 2 min.) gridded gate Pt/SiO$_2$/Si MOS sensor (S2) in air, at room temperature.

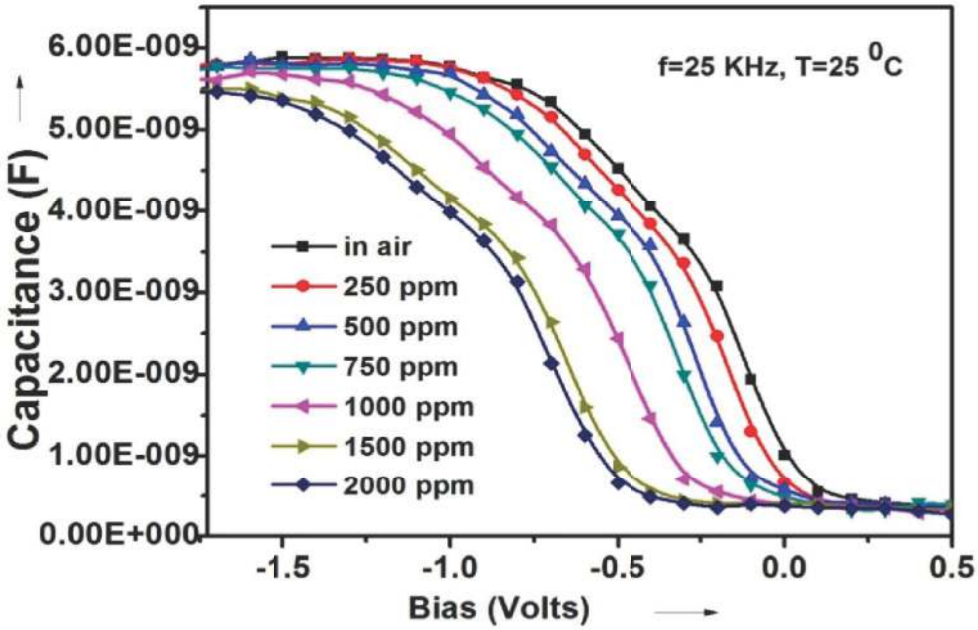

Fig. 5.5 C-V response of O$_2$ RF plasma treated at (40 W, 4 min.) gridded gate Pt/SiO$_2$/Si MOS sensor (S3) in air, at room temperature

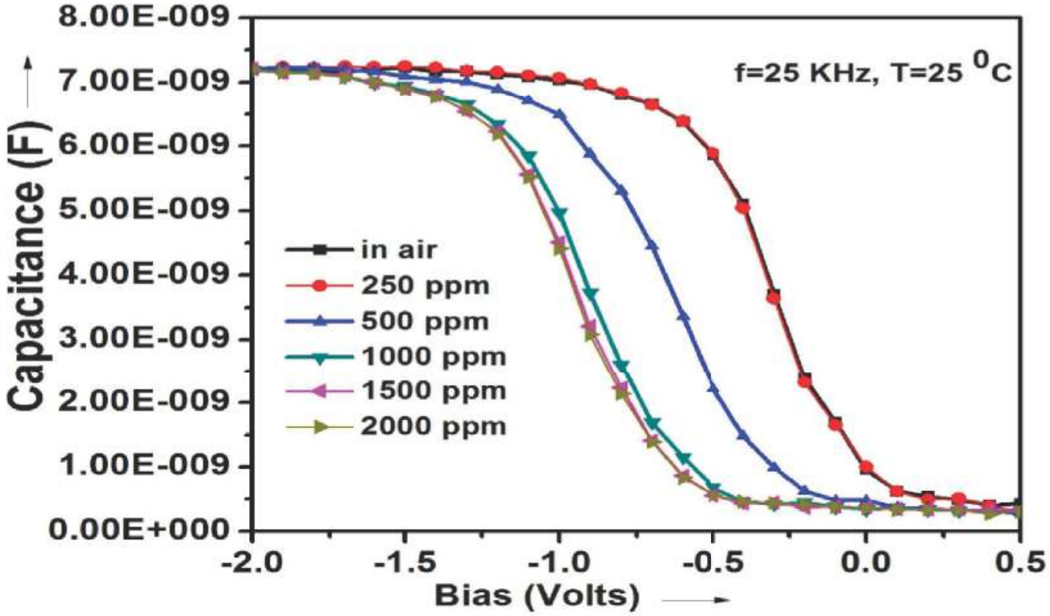

Fig. 5.6 C-V response of O$_2$ RF plasma treated at (40 W, 8 min.) gridded gate Pt/SiO$_2$/Si MOS sensor (S4) in air, at room temperature

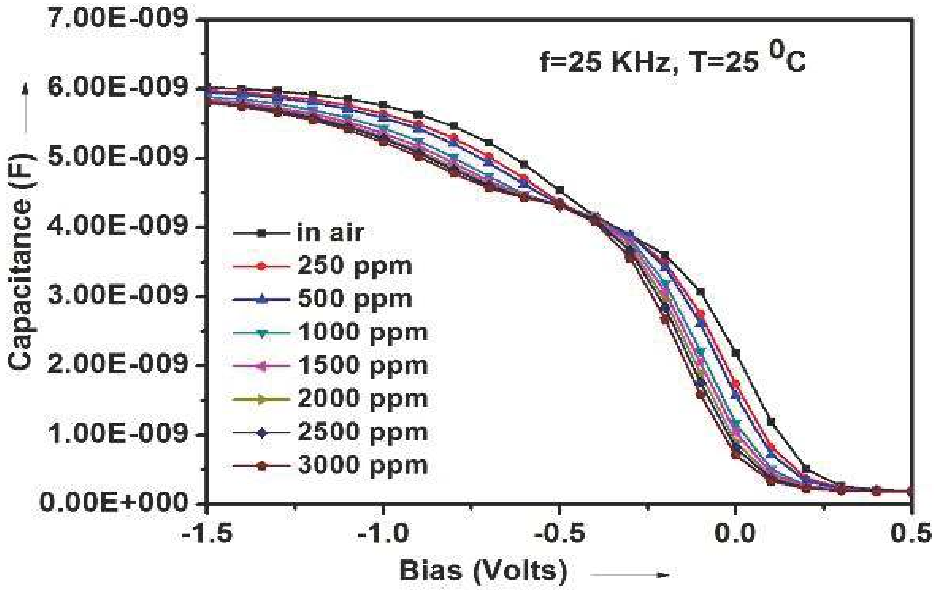

Fig. 5.7 C-V response of O$_2$ RF plasma treated at (40 W, 12 min.) gridded gate Pt/SiO$_2$/Si MOS sensor (S5) in air, at room temperature

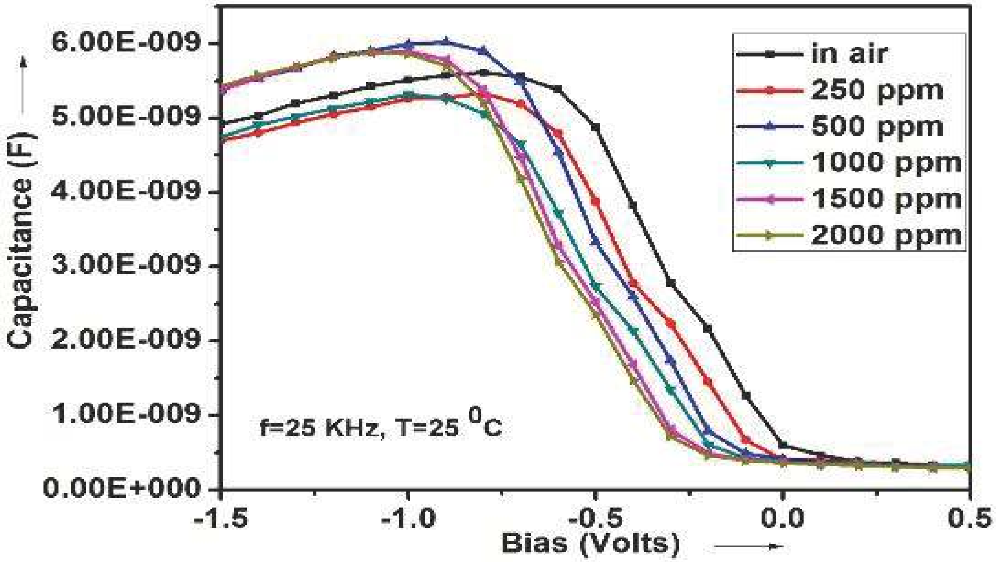

Fig. 5.8 C-V response of O$_2$ RF plasma treated at (50 W, 2 min.) gridded gate Pt/SiO$_2$/Si MOS sensor (S6) in air, at room temperature

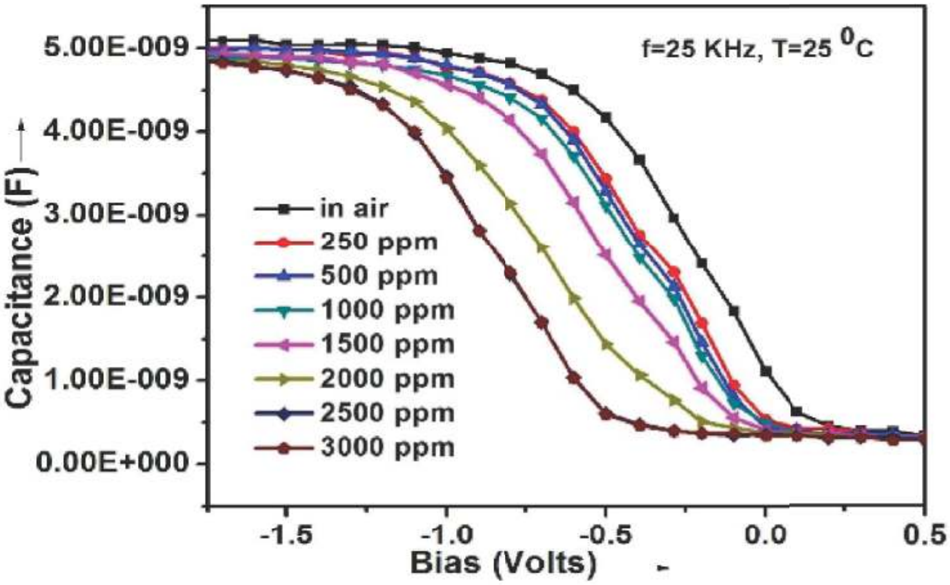

Fig. 5.9 C-V response of O_2 RF plasma treated at (50 W, 4 min.) gridded gate $Pt/SiO_2/Si$ MOS sensor (S7) in air, at room temperature

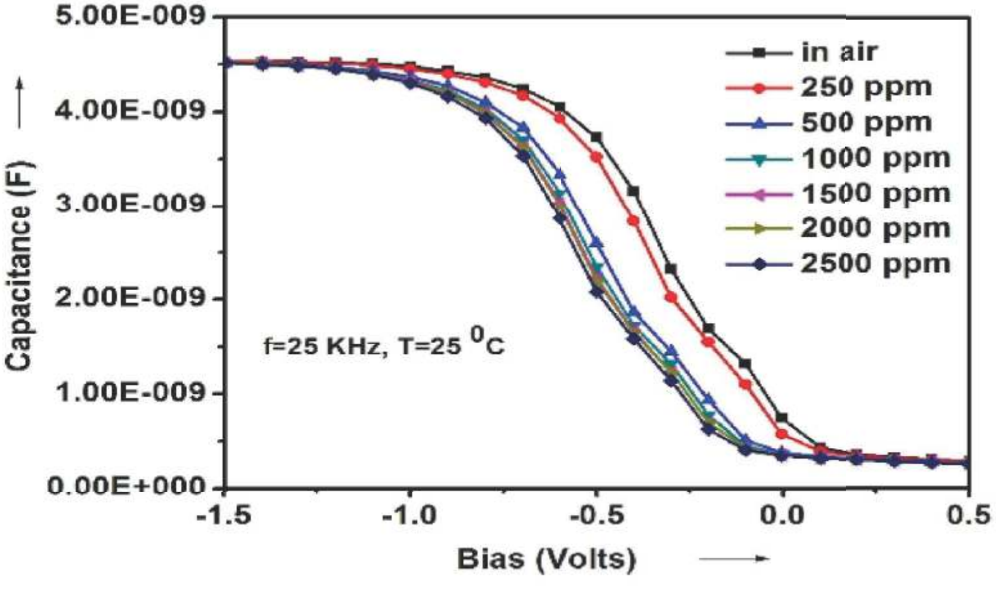

Fig. 5.10 C-V response of O_2 RF plasma treated at (50 W, 8 min.) gridded gate $Pt/SiO_2/Si$ MOS sensor (S8) in air, at room temperature.

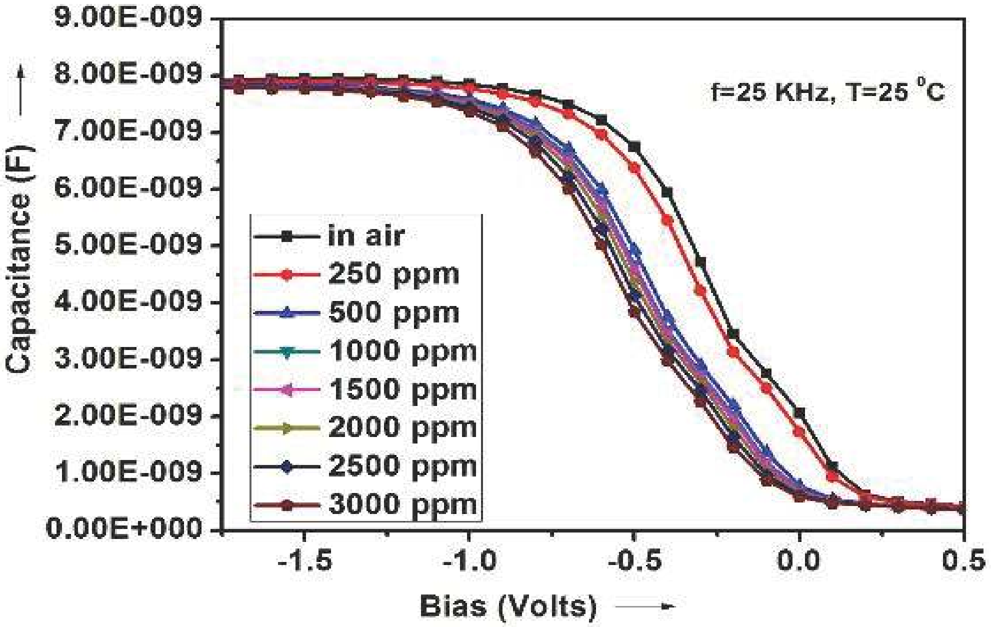

Fig. 5.11 C-V response of O_2 RF plasma treated at (50 W, 12 min.) gridded gate Pt/SiO$_2$/Si MOS sensor (S9) in air, at room temperature

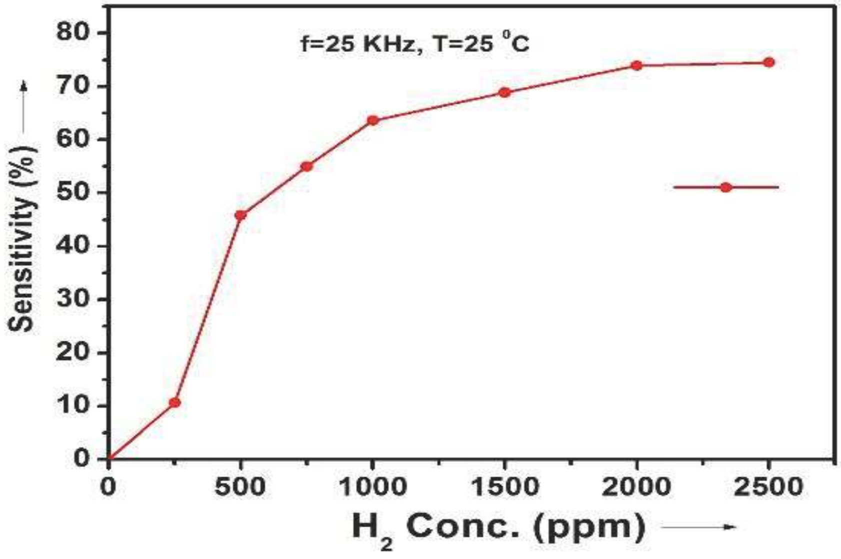

Fig.5.12 Variation of sensitivity vs concentration of Non plasma treated gridded gate Pt/SiO$_2$/Si MOS sensor (S1) in air, at room temperature.

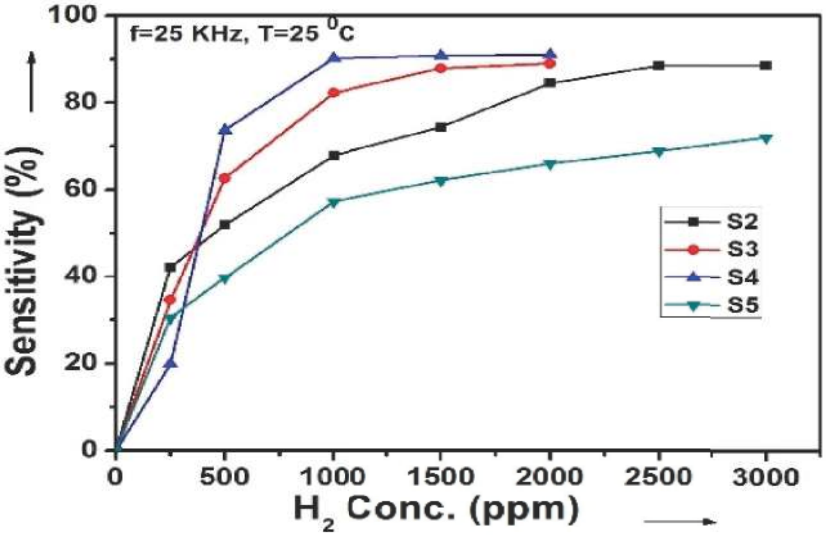

Fig.5.13 Variation of sensitivity vs concentration of O$_2$ RF plasma treated at 40 W RF plasma power gridded gate Pt/SiO$_2$/Si MOS sensors (S2-S5) for different durations (2 min.,4 min., 8 min. and 12 min.) in air, at room temperature.

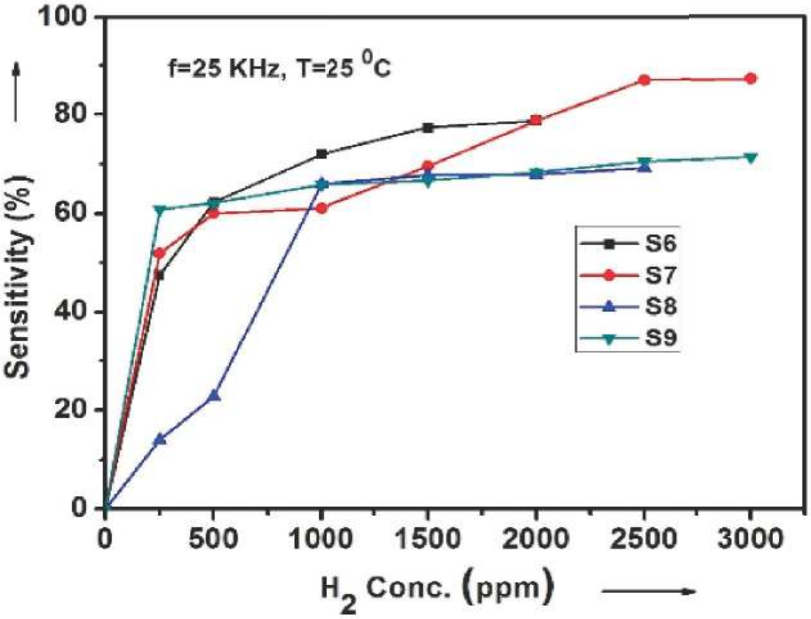

Fig. 5.14 Variation of sensitivity vs concentration of plasma treated at 50 W RF plasma power gridded gate Pt/SiO$_2$/Si MOS sensors (S6-S9) for different durations (2 min., 4 min., 8 min. and 12 min.) in air, at room temperature.

Further, the flat band capacitance (C_{FB}) is evaluated as described below [Jakobowaski and Iniewski (1983)].

$$\frac{C_{FB}}{C_i}=\frac{1}{[\frac{1}{2.06\sqrt{U_F}}(\frac{C_i}{C_{\min}}-1)+1]} \qquad \text{- - - - (5.2)}$$

where,

$$U_F=1.16+2.17\ln\left[\frac{C_i C_{\min}}{C_i-C_{\min}}\times\frac{1}{A}\right]$$

U_F- normalized Fermi potential, C_i- insulator capacitance,

$C_{\min}$- Semiconductor capacitance under strong inversion, A- gate area (cm^2)

The value of C_{FB} is fitted to the experimental C-V curves Fig. (5.3) to Fig. (5.11) for evaluating the flat band voltage (V_{FB}). Once V_{FB} is known than Q_{ss} is calculated by the following formula Yadava *et al*. [Yadava *et al*. (1990)].

$$V_{FB}=\Phi_{ms}-Q_{ss}/C_i \qquad \text{- - - - (5.3)}$$

The flat band voltage depends upon metal semiconductor work function (Φ_{ms}), fixed surface state density (Q_{ss}/q) and insulator capacitor (C_i).

In the present work the fixed charge density for all nine sensors (S1-S9) has been evaluated as a function of hydrogen concentration treated at different RF plasma power (40 W and 50 W) and exposure time (2min., 4min., 8 min., and 12 min.). Fig. 5.15 illustrates the fixed charge density versus hydrogen concentration for non plasma treated sensor (S1). The increasing tendency of fixed charge density with increase in hydrogen concentration for non plasma treated gridded gate Pt/SiO_2/Si MOS sensor had already been reported elsewhere [Yadava *et al*. (1990), Kumar *et al*. (2014(b))].

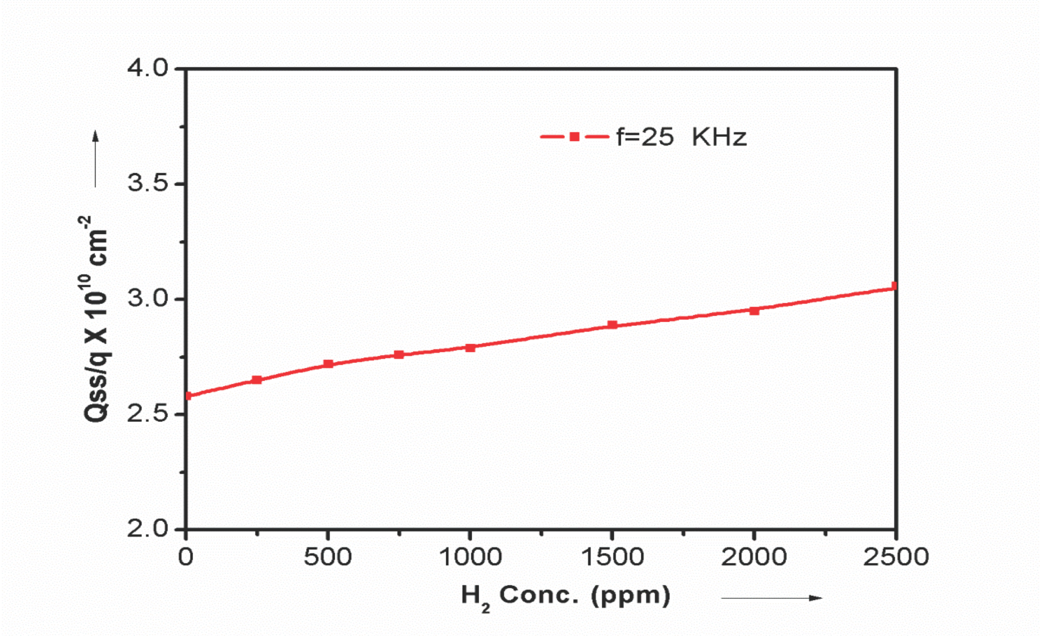

Fig. 5.15. Variation of fixed oxide charge density vs concentration of Non plasma treated sample (S1) in air, at room temperature.

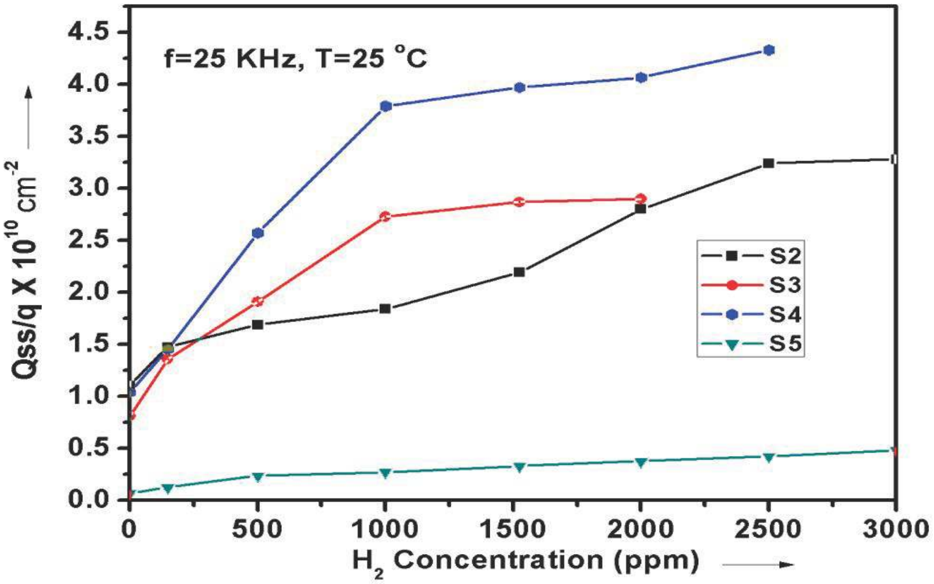

Fig. 5.16. Variation of fixed oxide charge density vs concentration of O_2 RF plasma treated at 40 W RF plasma power gridded gate Pt/SiO_2/Si MOS sensors (S2-S5) for different durations (2min., 4 min., 8 min., and 12 min.) in air at room temperature.

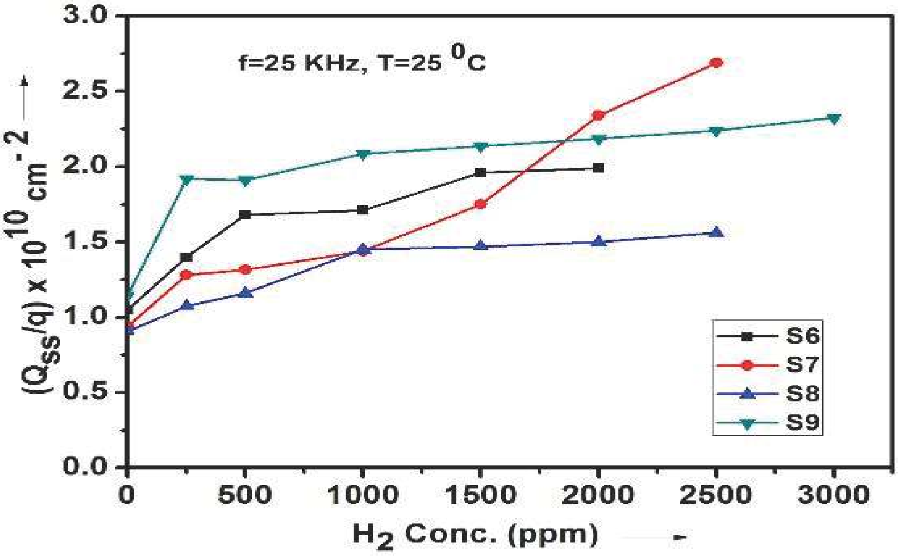

Fig. 5.17 Variation of fixed oxide charge density vs concentrations of O$_2$ RF plasma treated at 50 W RF plasma power gridded gate Pt/SiO$_2$/Si MOS sensors (S6-S9) for different durations (2min., 4 min., 8 min., and 12 min.) in air, at room temperature.

Fig. 5.16 and Fig. 5.17 illustrate the effect of plasma treatment on fixed charge density at 40 W and 50 W RF plasma power, respectively. In case of 40 W of plasma power, the value of fixed charge density has been found to be maximum for plasma exposure time of 8 min. but for higher duration (12 min.) at 40 W and higher plasma power (50 W) the fixed charge density decreases,due to surface sputtering [Pulfre and Reach (1974)].

5.4 Conclusions

From Fig. 5.12 to Fig. 5.14 it has been observed that all plasma treated gridded gate Pt/SiO$_2$/Si MOS sensors exhibit a better sensitivity except S8 as compared to non plasma treated gridded gate Pt/SiO$_2$/Si MOS sensor (S1) (73%) towards hydrogen. Sensor S4 out of all nine sensors exhibits highest sensitivity (~91%) as compared to other samples. In present case, the better response of the sensor is attributed to the following reasons: (i) Due to porous gate metal film as well as SiO$_2$ film, effective surface area of the sensor increases which results in an increase of the oxygen species available for reaction. This results in an increase in sensitivity **[**Li *et al.*(1999)**,** kumar *et al.* (2014(a))], (ii) Oxygen plasma comprises of single and multiple species like O$^-$, O^{2-},O^{3-}, O^{4-}, O^{+4},O^{3+},O^{2+},O^{+} etc and e^{-}[Bell (1996), Ligenza *et al*. (1970)], When these species interact with each other, a number of adsorption sites inside the device also gets modulated and hence sensitivity of the device increases, (iii) Spill-over mechanism [Lundstrom and Sodelberg (1981/82)], Side wall diffusion [Dobos *et al*. (1980)] and better chemical absorption of hydrogen in air ambient, (iv) Large grain size and high surface roughness, (v) large porosity, found in the film are few other reasons which are also responsible for improvement in sensitivity [Kumar *et al*.(2014(a))]. However, there are few practical disadvantages to the use of microwaves; plasma is often difficult to initiate and can be unstable. The Plasmon must be shielded as microwaves are hazardous and "scaling up" the plasma to enable large area film to be grown is difficult. Whereas, capacitively coupled RF plasma does not suffer these drawbacks and have found widespread applications in other thin film growth environments [Richard *et al*. (1995)]. Thus, it is concluded that RF oxygen plasma treated gridded gate Pt/SiO$_2$/Si MOS capacitor may be technologically a better and preferred choice for hydrogen detection.