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**MOS** **Si/$SiO_2$**

/ /

(2014/5/ 5 2013/ 12 /11 )

MOS

Si(111) (5-20)min 600$^o$C

.FTIR $SiO_2$ Si/$SiO_2$

(Si-O-Si) (1079cm$^{-1}$)

(I-V) (C-V) .

(ac)

. (f >5kHz)

.

MOS (I-V) .

.15min 0.4 volt 0.6 volt (5,10) min

.0.2 volt (20) min

Si/$SiO_2$ $SiO_2$ $CO_2$ :

# The Effect of Si/$SiO_2$ Interface on the Electrical Properties of MOS Device with Nano Layer Silicon Dioxide Grown by Induced Laser Oxidation

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## ABSTRACT

In this work a MOS device was fabricated with nano dioxide layer on silicon using a laser induced oxidation technique, at 600$^o$C temperature for different times oxidation (5-20) min.

FTIR spectrums were studied and analyzed for the Si (111) substrate, the Si/SiO2 interface and the $SiO_2$ layer.

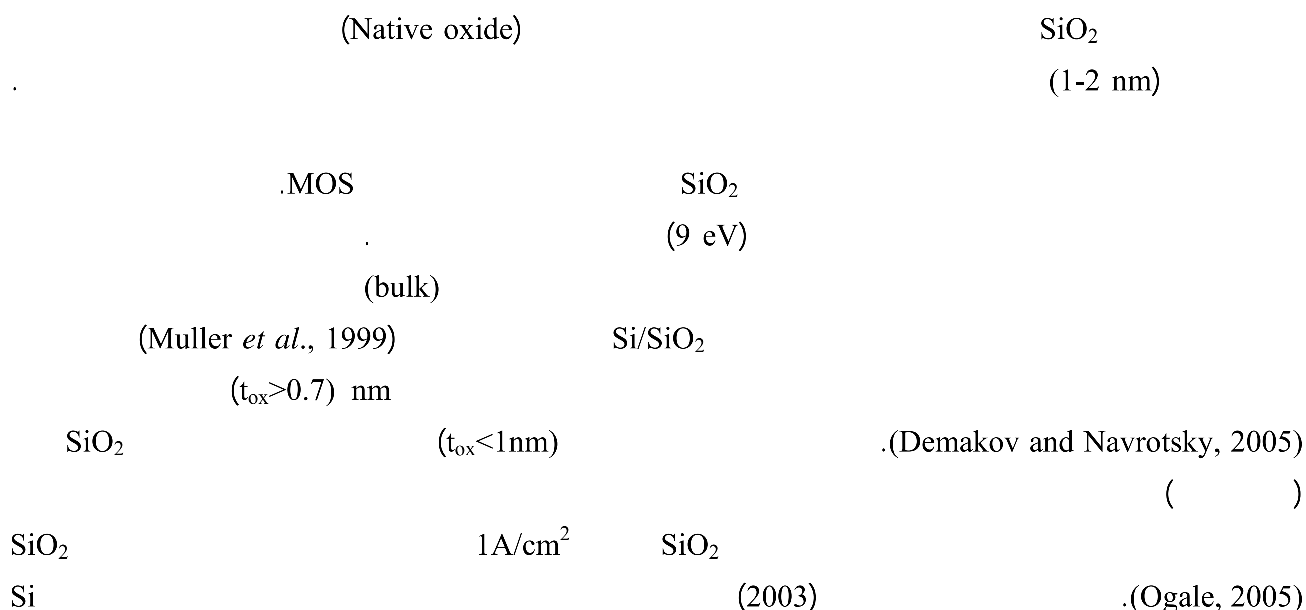
The results gave a characteristic sharp peak presence at the wave number (1079 $cm^{-1}$) corresponding to the level of elongation vibration (Si-O-Si) which consists the required oxide.

The electrical measurement results show the response of the MOS device for the (C-V) and (I-V) characteristics. The capacity was inhomogeneous at the interface between insulator and semiconductor because of the (ac) signal harmony, as an extra-capacity created depending on the frequency, while it does not appear at frequency (f >5kHz). This determines the nature of the electronic response of the device.

The different times for the oxide configuration gives a different value for the capacity that's where the capacity increases with the time of laser induction oxidation increase. The oxide thickness has an inverse relationship with the time of laser induction of the oxidation.

The (I-V) characteristics show the MOS devices fabricated with oxidation time at (5,10) min has leakage current started after 0.6 volt, where the devices which oxidized for 15 min has leakage current at 0.4 volt, but the leakage current begun at 0.2 volt for the devices with 20 min oxidation time.

**Keywords:** $CO_2$ laser, silicon dioxide, $Si/SiO_2$ interface



.

Si

.

.(El-Kareh, 2009)

.

.(Saadon, 2012)

.

$SiO_2$ (2005)

. (I-V)

oxidation selective

.

0.86nm MOS .

(Hess and Lambers, 2004; Kailath *et al.*, 2009)

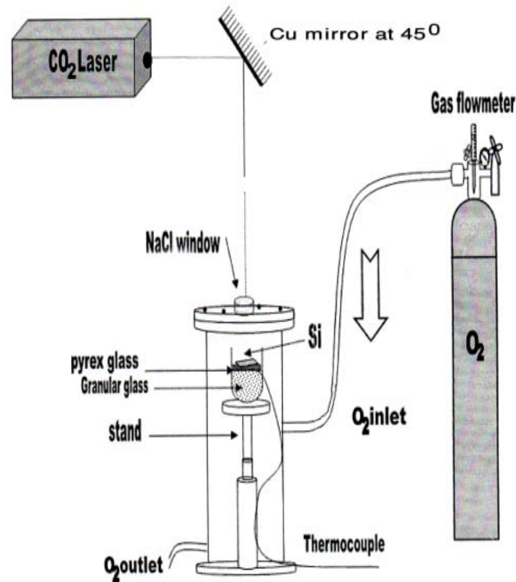
$SiO_2$ MOS

. (I-V), (C-V) FTIR

p-type Si(111) ( substrates )

. 1.3Ω.cm

.




**:1**

:

$SiO_2$ $CO_2$

(22 ) (10.6 µm) .(1)

.(NaCl)

(10)Amp 22 watt $CO_2$

45° NaCl (1)

(150watt/m.K) .(Chung, 2007)

$CO_2$ :

.(Chung, 2007) :

$CO_2$ (Chung, 2007; Koren, 1985)

600 °C (1) lit/min

.(5,10,15 and 20) min .

.FTIR

$SiO_2$ (Razeghi, 2006)

$$X_{\circ} = \frac{A_g \varepsilon_{\circ x} \varepsilon_{\circ}}{C_{\circ X}} \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(1)$$

$C_{\circ X}$ $A_g$ $(7.85\times10^{-7})m^2$

$\varepsilon_{\circ x}$ (3.9) $\varepsilon_{\circ}$ $.(8.85\times10^{-12})F/m$

MOS .

99.9% (Varian 3317) $10^{-}$

$.^{4}$torr (1 mm)

$SiO_2$ .

( - ) ( - )

( - ) MOS (1-10) kHz 5kHz 10kHz (ac)

(50 mvolt p.p) (0.22 µF) (dc)

:

$$C = \frac{I}{2\pi f V_g} \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(2)$$

**FTIR** **Si(111)** **(P)**

(2) FTIR .

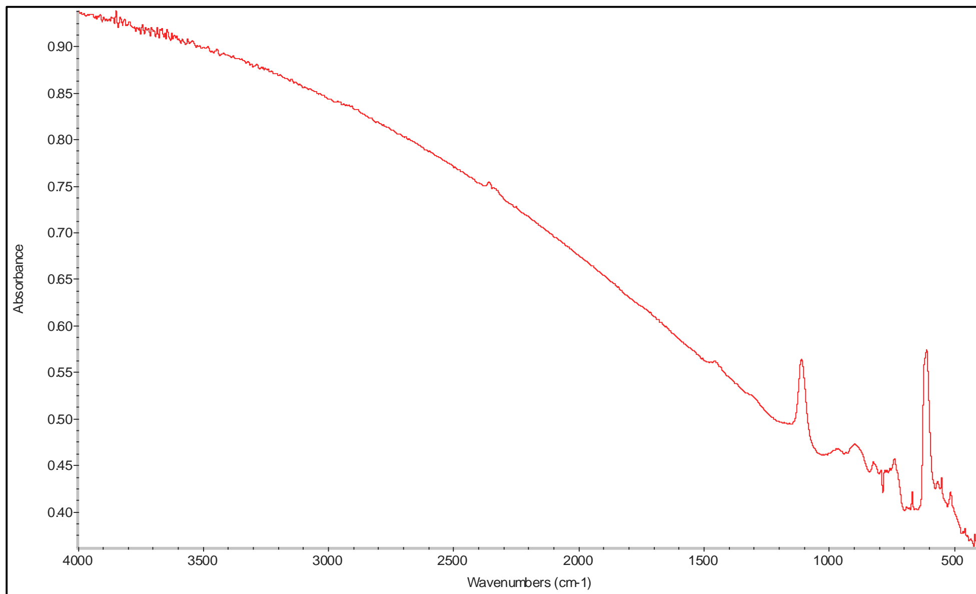
(1070 -1080) $cm^{-1}$ (Si-O) .

:

Si(111) p Si(100)

.

.




**:2 FT-IR Si(111) p**

(Clean room) .(Si-O)

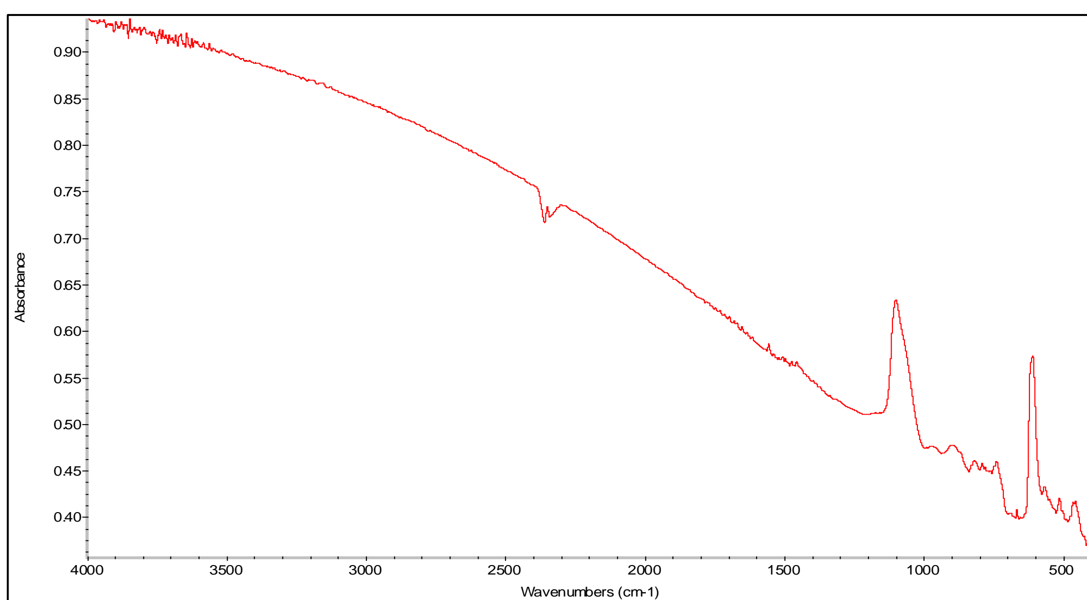
**FTIR** **$Si/SiO_2$**

(3) FT-IR $Si/SiO_2$ (3)

(1070 -1080) $cm^{-1}$ Si(111) p

$SiO_2$ $CO_2$ .

(600)$cm^{-1}$ .Si-Si



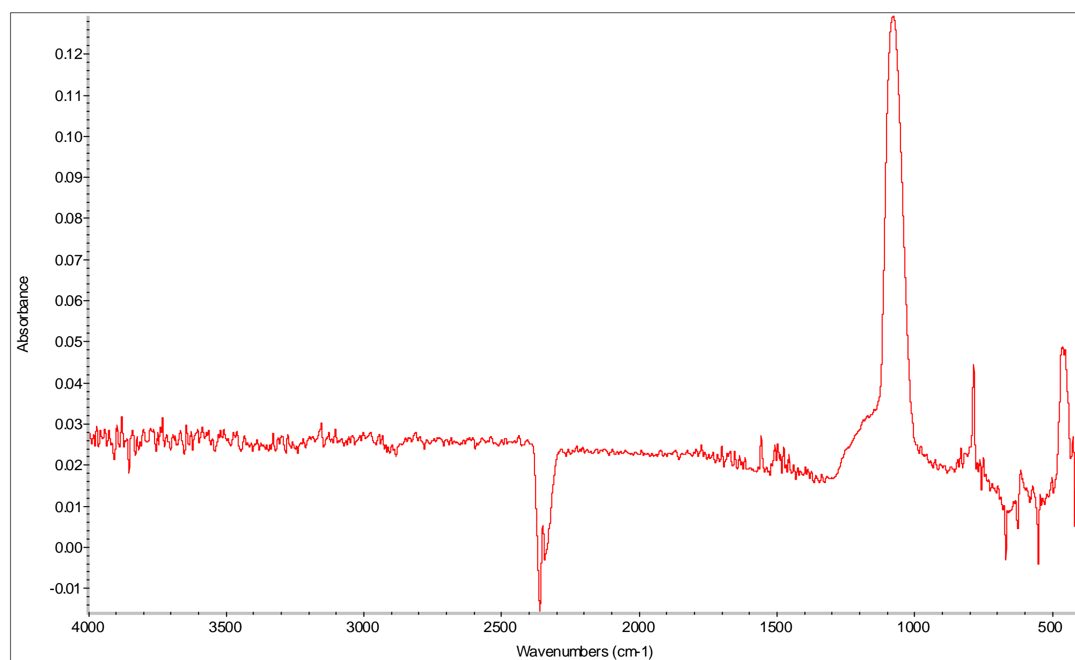

**:3 FT-IR $Si/SiO_2$**

**FT-IR $SiO_2$**

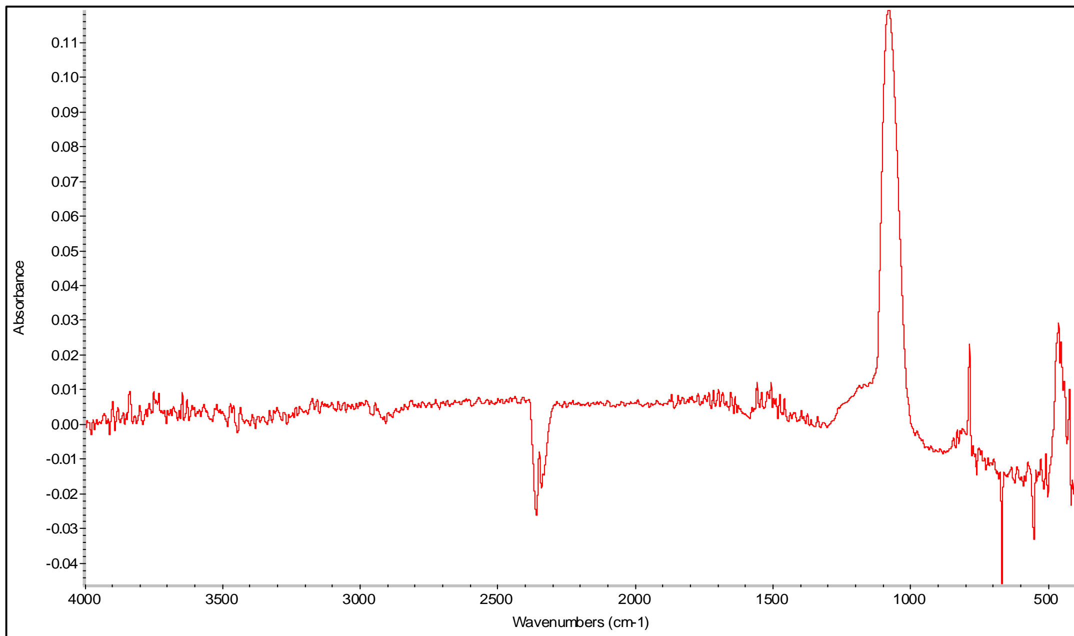
(4-7) FT-IR $SiO_2$ $CO_2$

((5,10,15 and 20) min) . (4 - 7) FT-IR

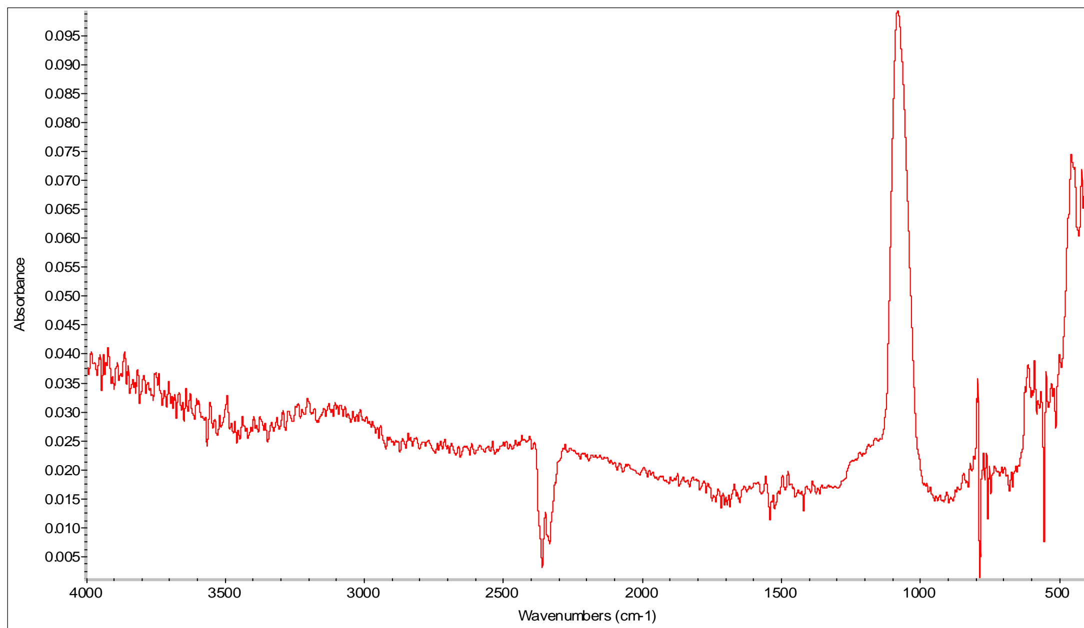
.(400-4000)$cm^{-1}$ IR .(950 -1350)$cm^{-1}$



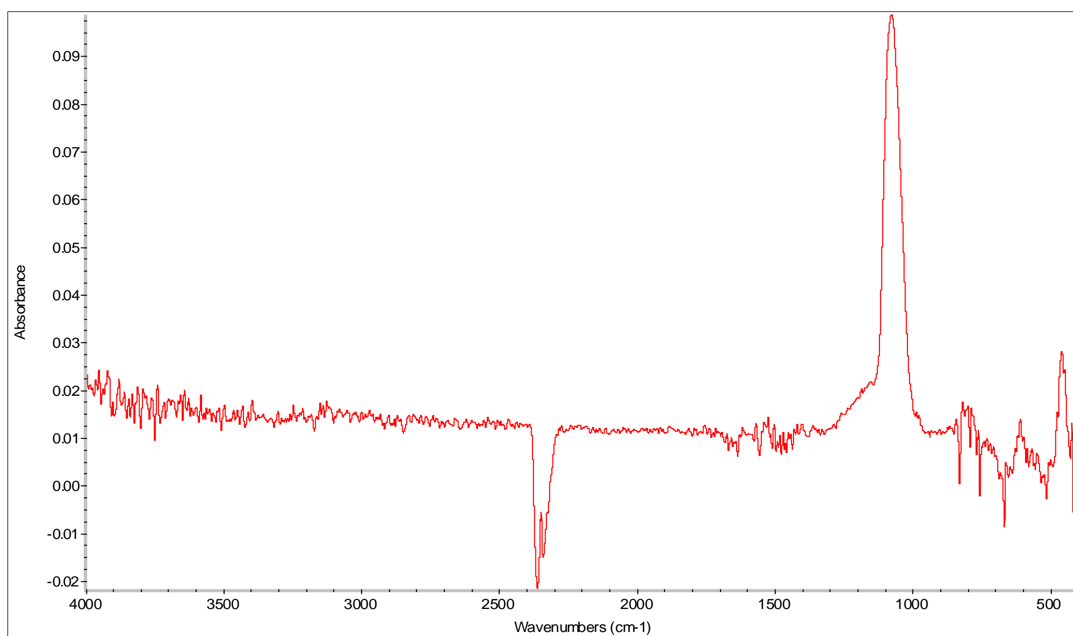

**:4 FTIR $SiO_2$ (5min)**




**(10min) $SiO_2$ FTIR : 5**




**(15min) $SiO_2$ FTIR :6**




**(20min) $SiO_2$ FTIR :7**

.(Lambers and Hess, 2003) (Si-O-Si)

: (4-7)

-1 (~1079)cm$^{-1}$ (Tsuji *et al.*, 1991; Takoa *et al.*, 2007)

( Si-O-Si )

.(Lucovsky and Irene, 1987; Lambers and Hess, 2003)

-2 (950) cm$^{-1}$

(Si-OH) .(Maruyama and Shirai, 1993)

-3 ( ) (~1200) cm$^{-1}$

.(Hess and Lambers, 2004)

(4-7) (~1079) cm$^{-1}$

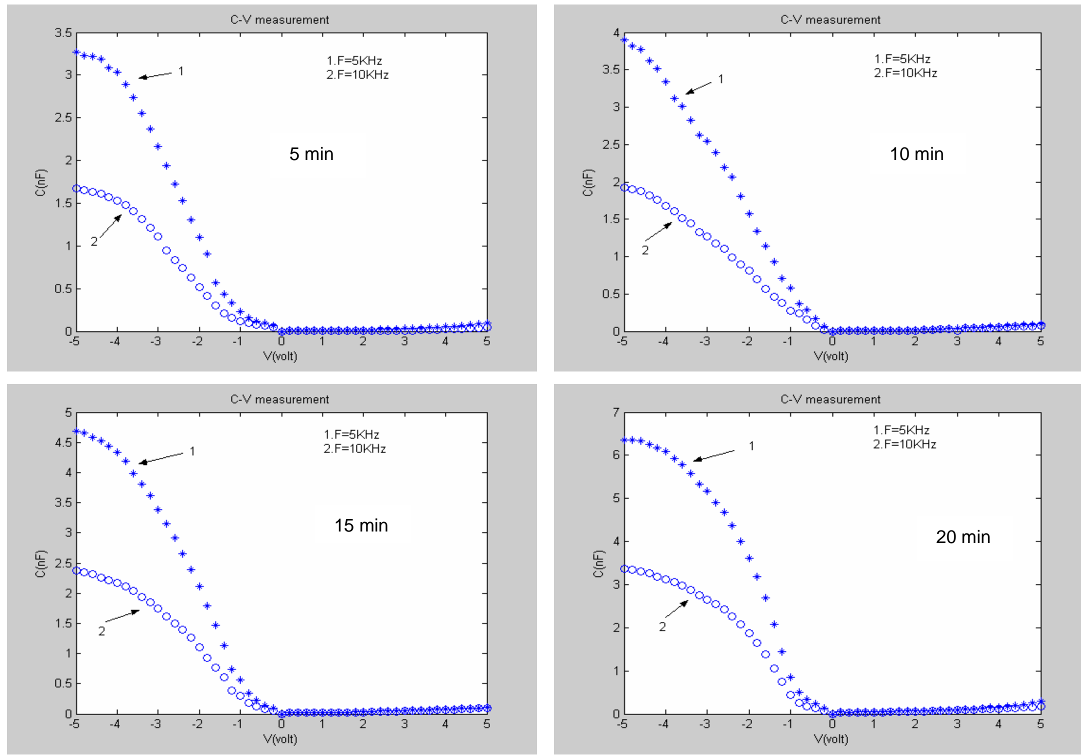
(~1079) cm$^{-1}$

(Lambers and Hess, 2003) .

**MOS ( - )**

MOS ( - ) $SiO_2$

(600)C° (5,10,15 and 20) min .(8)




**(5,10,15 and 20) min $SiO_2$ MOS (C-V) :8**

(8)

.(Tataroglu *et al*., 2005; Tataroglu and Altindal, 2006)

(ac)

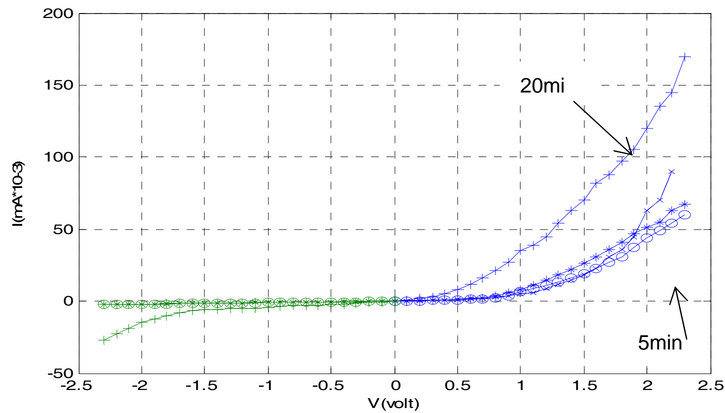
(ac) (f>5kHz) .

.(Tataroglu *et al*., 2006)

**MOS ( - )**

$SiO_2$ MOS ( - )

.(9) (5,10,15 and 20) min 600°C




**(20-15-10-5)min $SiO_2$ MOS (I-V) :9**

(14-16nm ) (5,10) min MOS (9)

.15 min 0.4 volt 0.6 volt

.0.2 volt (20) min

. 9 eV $SiO_2$ (5 -10) min

$Si/SiO_2$ FT-IR

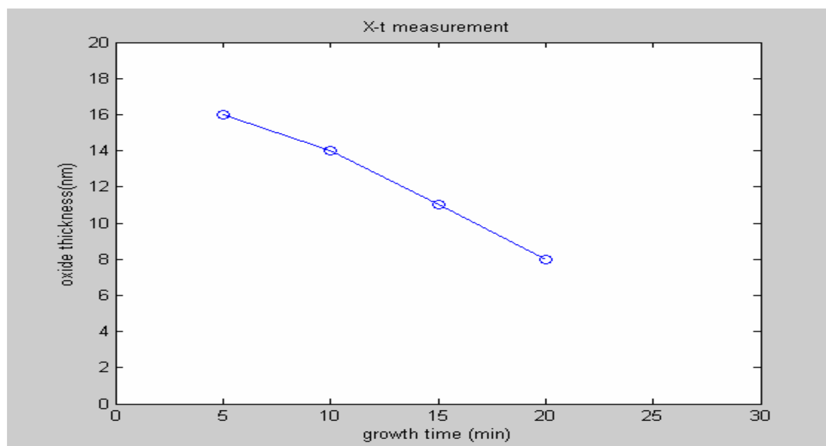
(9) .

.

.( 1990 )

**:**

. (10)




**:10**

(10 ) .

.$SiO_2$

.

. 0.1eV $SiO_2$

$SiO$ $Si_2O$ $SiO_2$

.(Kailath *et al.*, 2009 ; Singh *et al.*, 2004)

.(Osipov *et al.*, 2006)

$SiO_2$ FT-IR 1000 cm$^{-1}$ 1100 cm$^{-1}$

.(Lambers and Hess, 2003)

- (C-V) (I-V)

( f ≤ 5kHz) .(f >5kHz)

-

.

- .

.(2005)

.MOS **16**(1) 20-12 .

.(2003) – – . . **14**(1)

.101 -92

. .(1990) . . . " ." .

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