A 2D Analytical Investigation of Surface Potential and Electric Field for InSb based Triple Material Gate QWFET

C.Divya *[1] N.Arumugam[2] B.Selva Karthick [3] J.Jagannathan[4] N.Krishnan[5]

[1]Assistant Professor , CITE , Manonmaniam Sundaranar Univerisity, Tamilnadu, India.
[2 3] PG Scholar,CITE , Manonmaniam Sundaranar Univerisity, Tamilnadu, India.
[4] Assistant Professor, Department of ECE, Shri Sapthagiri Institute of Technology, Tamilnadu, India.
[5] Professor, CITE , Manonmaniam Sundaranar Univerisity, Tamilnadu, India.

---***---

Abstract - *In this Paper an analytical model for Two-dimensional Triple Material Gate (TMG) AlInSb/InSb/AlInSb Quantum Well Field Effect Transistor (QWFET) structure have been modeled. In this model, the parabolic approximation method is used to so***lve the 2D Poisson's equation by considering** *the appropriate boundary conditions. The accurate analytical method for surface potential, electric fields corresponding to the channel position are obtained from this method. The hot carrier effect at the drain side was interpreted from the analytical and simulated output. Also shows that it suppresses electric field at the drain side and enhanced device performance in the sub-nanometer regime. Finally the analytical result is simulated using MATLAB.*

Keywords: Quantum Well Field Effect Transistor, analytical modeling, 2D Poisson's equation, parabolic approximation, Boundary conditions, surface potential, electric field.

1. INTRODUCTION

The invention of electronic machine increases the speed and improves the density of package in miniaturization has been a constant to the nano electronics field. Since it is used in nano electronics field the fabrication of electronic devices should be designed in such a way that the speed of operation should be high. The capabilities of digital electronics field are strongly associated with Moore's law [8]. Since it is proven to be accurate it is now used in semiconductor industry to set target for R&D. The quantum well field effect transistor (QWFET) basic structure employs barrier layers of higher band gap materials to avoid device leakage and breakdown. The transistors are mostly fabricated on a semiconductor substrate. The QWFET [6] takes advantage of quantum tunnelling by increasing the speed of operation of transistor and by avoiding traditional transistor's area of electron transmission.

Gate Engineering technique is used in Triple material gate (TMG) MOSFET. Three different materials having different work functions are merged together in order to produce a single gate of device. In this TMG structure, device ensure low threshold voltage and offers a much lower leakage current, which is because of the work function difference created at the interface of three metals[13-18]. Recently many researchers have modelled HEMT, TFET, MOSFET characteristics by using 2D Poisson's equation and parabolic approximation methods but there is not as much in QWFET modelling, so we propose numerical analysis modelling for making accurate results.

Chain [2] proposed a model using GSW equation for HEMT which shows the behavior of electron drift velocity versus electric field, transconductance, channel conductance and gate capacitance. In HEMT structure AlGaAs /GaAs sandwich is used. Arun [4] proposed a 2D analytical model for DMG TFET using parabolic approximation technique and 2D Poisson equation using appropriate boundary conditions. For analyzing the tunneling generation rate and tunneling rate the surface potential and electric field are calculated.

Buckle [3] presents gate leakage currents in InSb/AlInSb QWFET, Gate current is used to obtain barrier heights using Arrhenius style plots. Niaz [1] reports on InAsSb QWFET capacitance voltage (CV) characterization analysis. The 1D coupled Schrodinger Poisson equations were used to analyze electrostatic performance. Based on the characteristics of CV, the physical parameters like oxide thickness, channel thickness were computed.

2. MODEL ANALYSIS

The cross sectional view of a Triple Material Gate Quantum Well FET(TMGQWFET) is shown in Fig -1.A DMG $Al_{0.3}In_{0.7}Sb/InSb/Al_{0.4}In_{0.6}Sb$ QWFET is used in this structure. Since our device is TMG, Three gate metals are used. They are M1,M2 and M3.

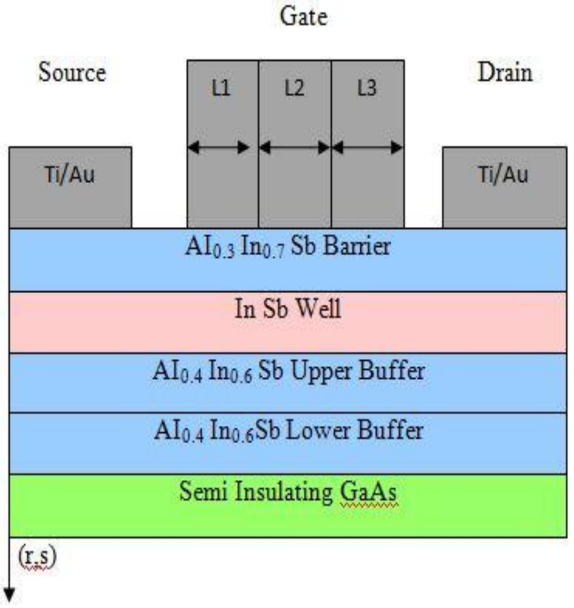

Fig -1: Cross sectional view of a Triple Material Gate Quantum Well FET (TMGQWFET).

The Fig -1 represents the Cross sectional view of a Triple Material Gate Quantum Well FET (TMGQWFET). In this structure, the gate is made of three materials M_1,M_2 and M_3 of different work functions. The length of those metals are L_1, L_2 and L_3 where L_1=10nm,L_2= 10nm and L_3=10nm. The total gate length is $L=L_1+L_2+L_3$. Ti /Au metallization is used for both source and drain electrodes. QWFET was grown on GaAs substrate. GaAs is exceedingly resistive due to its ample band gap combining with high dielectric constant, this assets makes GaAs a extraordinarily superior electrical substrate than Si. This makes an ideal material for RF circuits. $Al_{0.3}In_{0.7}Sb$/InSb/$Al_{0.4}In_{0.6}Sb$ structure is used as Quantum Well due to its High Electron Mobility Transistor (HEMT), Electron Velocity and Ballistic Length. $Al_{0.4}In_{0.6}Sb$ layer is used as Upper buffer and Lower buffer over that InSb Well is grown. $Al_{0.3}In_{0.7}Sb$ is used as a barrier over it. The source and drain regions are uniformly doped. The work function of the metal gate M_1, M_2 and M_3 is taken as Φ_{M1}= 4.8eV, Φ_{M2}=4.6eV and Φ_{M3} =4.4 eV .

2.1 2D-ANALYTICAL MODEL FOR QUANTUM WELL

Let us assume that the impurity density in the Well region is uniform, the 2D potential distribution can be obtained by solving 2D Poisson's equation.

The 2D Poisson's equation is given by,

$$\frac{d^2\phi(r,s)}{dr^2}+\frac{d^2\phi(r,s)}{ds^2}=\frac{qN_A}{ds^2} \quad \text{for } \begin{matrix}0\le r\le L\\ 0\le s\le t_w\end{matrix} \qquad (1)$$

Where q is the charge of the electron, ε_W is the dielectric constant of InSb, t_w is the thickness of InSb Quantum Well, N_A is the doping concentration, L is the length of gate (i.e.) $L=L_1+L_2+L_3$, The potential profile in the vertical (S) direction is assumed to be a second order polynomial equation using parabolic function [11].

$$\Phi(r,s) = \Phi_W(r) + W_1(r)\, s + W_2(r)\, s^2 + W_3(r)\, s^3 \qquad (2)$$

Where $\Phi_W(r)$ is the Surface potential, $W_1(r)$, $W_2(r)$ and $W_3(r)$ are arbitrary coefficient for the functions of r only. Since it is a TMG structure, the potential is represented for three metals is given by

$$\phi_1(r,s) = \phi w_1(r) + w_{11}(r)s + w_{12}(r)s^2 + w_{13}(r)s^3$$
$$\text{for } 0 \le r \le L_1 \text{ at } s = 0 \quad (3)$$

$$\phi_2(r,s) = \phi w_2(r) + w_{21}(r)s + w_{22}(r)s^2 + w_{23}(r)s^3$$
$$\text{for } 0 \le r \le L_1 + L_2 \text{ at } s = 0 \quad (4)$$

$$\phi_3(r,s) = \phi w_3(r) + w_{31}(r)s + w_{32}(r)s^2 + w_{33}(r)s^3$$
$$\text{for } 0 \le r \le L_1 + L_2 + L_3 \text{ at } s = 0 \quad (5)$$

The boundary condition in the Quantum well is given below:

(i) Electric flux at the Barrier/Well interface is continuous for TMG QWFET

$$\frac{d\phi_1(r,s)}{ds} = \frac{\varepsilon_b}{\varepsilon_w}\frac{\phi w_1(r)-\varphi_{g1}}{t_b} \quad \text{for Metal 1 at } s = 0 \qquad (6)$$

$$\frac{d\phi_2(r,s)}{ds} = \frac{\varepsilon_b}{\varepsilon_w}\frac{\phi w_2(r)-\varphi_{g2}}{t_b} \quad \text{for Metal 2 at } s = 0 \qquad (7)$$

$$\frac{d\phi_3(r,s)}{ds} = \frac{\varepsilon_b}{\varepsilon_w}\frac{\phi w_3(r)-\varphi_{g3}}{t_b} \quad \text{for Metal 3 at } s = 0 \qquad (8)$$

Where

ε_b is the dielectric constants of the barrier layer, ε_W is the dielectric Constants of quantum well layer, t_b is the thickness of the barrier layer, $\Phi_{W1}(x)$,$\Phi_{W2}(x)$ and $\Phi_{W3}(x)$ are the potential function for M1,M2and M3in barrier/well interface and

$\Psi_{g1}=V_{gs}-V_{fb1}$,$\Psi_{g2}=V_{gs}-V_{fb2}$ and $\Psi_{g3}=V_{gs}-V_{fb3}$ Where, V_{gs} represents the gate source voltage, V_{fb1} ,V_{fb2} and V_{fb3}

represents the flat band voltage under M1,M2 and M3 respectively.

(ii)Electric flux at the Well/ upper Buffer interface is continuous for TMG QWFET

$$\frac{d\emptyset_1(r,s)}{ds} = \frac{\epsilon_b}{\epsilon_w}\frac{\emptyset w_1(r)-\varphi_{g1}}{t_b} \quad \text{for Metal 1 at } s=0 \qquad (9)$$

$$\frac{d\emptyset_2(r,s)}{ds} = \frac{\epsilon_b}{\epsilon_w}\frac{\emptyset w_2(r)-\varphi_{g2}}{t_b} \quad \text{for Metal 1 at } s=0 \qquad (10)$$

$$\frac{d\emptyset_3(r,s)}{ds} = \frac{\epsilon_b}{\epsilon_w}\frac{\emptyset w_3(r)-\varphi_{g3}}{t_b} \quad \text{for Metal 3 at } s=0 \qquad (11)$$

Where

ε_W is the dielectric constants of the Well layer, t_{ubu} is the thickness of the upper buffer layer, ε_{ubu} is the dielectric constants of the upper buffer layer, $\Phi_B(x)$ is the potential function in the well/ upper buffer interface and $\Psi_{sub}=V_{sub}-V_{fb1}$,$\Psi_{sub}=V_{sub}-V_{fb2}$, and $\Psi_{sub}=V_{sub}-V_{fb3}$ where V_{sub} represents the substrate voltage, V_{fb1}, V_{fb2}, V_{fb3} represents the flat band voltage under M1, M2 and M3 respectively.

(iii)Electric flux at the Upper Buffer / Lower Buffer interface is continuous for TMG QWFET

$$\frac{d\emptyset_1(r,s)}{ds} = \frac{\varepsilon_{lbu}}{\varepsilon_{ubu}}\frac{\emptyset_B(r)-\emptyset_C(r)}{t_{lbu}} \quad \text{for Metal1 at } S=t_{ubu} \qquad (12)$$

$$\frac{d\emptyset_2(r,s)}{ds} = \frac{\varepsilon_{lbu}}{\varepsilon_{ubu}}\frac{\emptyset_B(r)-\emptyset_C(r)}{t_{lbu}} \quad \text{for Metal2 at } S=t_{ubu} \qquad (13)$$

$$\frac{d\emptyset_3(r,s)}{ds} = \frac{\varepsilon_{lbu}}{\varepsilon_{ubu}}\frac{\emptyset_B(r)-\emptyset_C(r)}{t_{lbu}} \quad \text{for Metal3 at } S=t_{ubu} \qquad (14)$$

Where ϵ_{lbu} is the dielectric constants of the lower buffer layer, ϵ_{ubu} is the dielectric constants of the upper buffer layer, $\Phi_B(r)$,$\emptyset_c(r)$, is the potential function, t_{lbu} is the thickness of lower buffer layer.

iv) Potential and Electric flux at three dissimilar metals interface is continuous

$$\Phi_1(L_1,0)=\Phi_2(L_1,0)=\Phi_3(L_2,0) \qquad (15)$$

$$\frac{d\emptyset_1(r,s)}{ds} = \frac{d\emptyset_2(r,s)}{ds} = \frac{d\emptyset_3(r,s)}{ds} \quad \text{at } r=L_1 \qquad (16)$$

v) Potential at source and drain end is

$$\Phi_1(r,s)=\Phi_{W1}(0)=V_{bi} \qquad (17)$$

$$\Phi_1(L,0)=\Phi_{W2}(L)=\Phi_{W3}(L)=V_{bi}+V_{ds} \qquad (18)$$

V_{bi} is the built in voltage and
V_{ds} is the drain source voltage

By using the above boundary condition equation (6) to (18) in the parabolic approximation method equation (3),(4)and(5) for calculating the arbitrary coefficient

$w_{11}(r), w_{12}(r), w_{13}(r), w_{21}(r), w_{22}(r)$,
$w_{23}(r), w_{31}(r), w_{32}(r), w_{33}(r)$ respectively,

$$w_{11}(r) = c_f\left[\frac{\emptyset w_1(r)-\varphi_{g1}}{\varepsilon_w}\right] \qquad (19)$$

$$w_{12}(r) = \left[\frac{\varphi_{sub}+\varphi_{g1}\left[\frac{c_f}{c_b}+\frac{c_f}{c_s}\right]-\emptyset_{w1}(r)\left[\frac{c_f}{c_b}+\frac{c_f}{c_s}+1\right]}{t_w^2\left[1+\frac{2c_s}{c_b}\right]}\right] \qquad (20)$$

$$w_{13}(r) = \frac{\left[\varphi_{g1}\left[\frac{c_c c_f}{c_a}+\frac{c_f}{c_s}\right]-\varphi_{sub}\left[\frac{2\varepsilon_{ubu}c_b}{c_a c_s}+\frac{c_b t_w}{c_s}\right]+\emptyset_B(r)\left[\frac{2\varepsilon_{ubu}c_b}{c_a c_s}+\frac{c_b t_w}{c_s}+1\right]-\emptyset_{w1}(r)\left[\frac{c_c c_f}{c_a}+\frac{c_f}{c_a}+1\right]\right]}{t_w^3\left[1+\frac{3c_d}{c_a}\right]} \qquad (21)$$

$$w_{21}(r) = c_f\left[\frac{\emptyset w_2(r)-\varphi_{g2}}{\varepsilon_w}\right] \qquad (22)$$

$$w_{22}(r) = \left[\frac{\varphi_{sub}+\varphi_{g2}\left[\frac{c_f}{c_b}+\frac{c_f}{c_s}\right]-\emptyset_{w2}(r)\left[\frac{c_f}{c_b}+\frac{c_f}{c_s}+1\right]}{t_w^2\left[1+\frac{2c_s}{c_b}\right]}\right] \qquad (23)$$

$$w_{23}(r) = \frac{\left[\varphi_{g2}\left[\frac{c_c c_f}{c_a}+\frac{c_f}{c_s}\right]-\varphi_{sub}\left[\frac{2\varepsilon_{ubu}c_b}{c_a c_s}+\frac{c_b t_w}{c_s}\right]+\emptyset_B(r)\left[\frac{2\varepsilon_{ubu}c_b}{c_a c_s}+\frac{c_b t_w}{c_s}+1\right]-\emptyset_{w2}(r)\left[\frac{c_c c_f}{c_a}+\frac{c_f}{c_a}+1\right]\right]}{t_w^3\left[1+\frac{3c_d}{c_a}\right]} \qquad (24)$$

$$w_{31}(r) = c_f\left[\frac{\emptyset w_3(r)-\varphi_{g3}}{\varepsilon_w}\right] \qquad (25)$$

$$w_{32}(r) = \left[\frac{\varphi_{sub}+\varphi_{g3}\left[\frac{c_f}{c_b}+\frac{c_f}{c_s}\right]-\emptyset_{w3}(r)\left[\frac{c_f}{c_b}+\frac{c_f}{c_s}+1\right]}{t_w^2\left[1+\frac{2c_s}{c_b}\right]}\right] \qquad (26)$$

$$w_{33}(r) = \frac{\left[\varphi_{g3}\left[\frac{c_c c_f}{c_a}+\frac{c_f}{c_s}\right]-\varphi_{sub}\left[\frac{2\varepsilon_{ubu}c_b}{c_a c_s}+\frac{c_b t_w}{c_s}\right]+\emptyset_B(r)\left[\frac{2\varepsilon_{ubu}c_b}{c_a c_s}+\frac{c_b t_w}{c_s}+1\right]-\emptyset_{w3}(r)\left[\frac{c_c c_f}{c_a}+\frac{c_f}{c_a}+1\right]\right]}{t_w^3\left[1+\frac{3c_d}{c_a}\right]} \qquad (27)$$

Where
$c_f=\frac{\varepsilon_b}{t_b}$, $c_b=\frac{\varepsilon_{ubu}}{t_{ubu}}$, $c_a=\frac{\varepsilon_{lbu}}{t_{lbu}}$, $c_s=\frac{\varepsilon_w}{t_w}$, $c_c=\frac{\varepsilon_{ubu}}{\varepsilon_w}$ and $c_d=\frac{\varepsilon_{ubu}}{t_w}$

And finally by using the arbitrary coefficient equation (19) to (27) in the parabolic approximation method equation (3) ,(4) and (5) respectively.

International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 -0056
Volume: 02 Issue: 02 | May-2015 www.irjet.net p-ISSN: 2395-0072

The $\emptyset_1(r,s), \emptyset_2(r,s) and\ \emptyset_3(r,s)$ and is obtained, then applying in 2D Poisson's equation (1) to find the surface potential. The surface potential is formed from a second order non homogenous equation with constant coefficients at metals M1, M2 and M3 is given by

$$\emptyset_{w_1}(r) = Ae\sqrt{vr} + Be^{-}\sqrt{vr} - \frac{u_1}{v} \quad (28)$$

$$\emptyset_{w_2}(r) = Ce\sqrt{vr} + De^{-}\sqrt{vr} - \frac{u_2}{v} \quad (29)$$

$$\emptyset_{w_3}(r) = Ee\sqrt{vr} + Fe^{-}\sqrt{vr} - \frac{u_3}{v} \quad (30)$$

Where

$$u_1 = \frac{qN_A}{\varepsilon_{si}} - 2\varphi_{g1}\left[\frac{\frac{c_f}{c_b}+\frac{c_f}{c_s}}{\left[t_w^2 1+\frac{2c_s}{c_{cw}}\right]}\right] - 2\varphi_{sub}\left[\frac{1}{t_w^2\left[1+\frac{2c_s}{c_b}\right]}\right] \quad (31)$$

$$u_2 = \frac{qN_A}{\varepsilon_{si}} - 2\varphi_{g2}\left[\frac{\frac{c_f}{c_b}+\frac{c_f}{c_s}}{\left[t_w^2 1+\frac{2c_s}{c_{cw}}\right]}\right] - 2\varphi_{sub}\left[\frac{1}{t_w^2\left[1+\frac{2c_s}{c_b}\right]}\right] \quad (32)$$

$$u_3 = \frac{qN_A}{\varepsilon_{si}} - 2\varphi_{g3}\left[\frac{\frac{c_f}{c_b}+\frac{c_f}{c_s}}{\left[t_w^2 1+\frac{2c_s}{c_{cw}}\right]}\right] - 2\varphi_{sub}\left[\frac{1}{t_w^2\left[1+\frac{2c_s}{c_b}\right]}\right] \quad (33)$$

$$v = \frac{2\left[1+\frac{c_f}{c_b c_a}+\frac{c_f}{c_s}\right]}{t_w^2\left[1+\frac{2c_s}{c_b c_a}\right]} \quad (34)$$

$$A = \frac{[V_{bi}+V_{ds}+X_2]-[e^{\lambda_2(L_1+L_2)}\ (V_{bi}-X_1)]-[[\frac{X_1-X_2}{2}](e^{\lambda_1 L_2}+e^{\lambda_2 L_2})]}{e^{\lambda_1 L_2}e^{\lambda_2 L_2}-e^{\lambda_2 L_1}+e^{\lambda_2 L_2}} \quad (35)$$

$$B = \frac{[e^{\lambda_1(L_1+L_2)}\ (V_{bi}-X_1)]-[V_{bi}+V_{ds}-X_2]+[[\frac{X_1-X_2}{2}](e^{\lambda_1 L_2}+e^{\lambda_2 L_2})]}{e^{\lambda_1 L_2}e^{\lambda_2 L_2}-e^{\lambda_2 L_1}+e^{\lambda_2 L_2}} \quad (36)$$

$$C = \frac{[V_{bi}+V_{ds}+X_3]-[e^{\lambda_3(L_2+L_3)}\ (V_{bi}-X_2)]-[[\frac{X_2-X_3}{2}](e^{\lambda_2 L_3}+e^{\lambda_3 L_3})]}{e^{\lambda_2 L_3}e^{\lambda_3 L_3}-e^{\lambda_3 L_2}+e^{\lambda_3 L_3}} \quad (37)$$

$$D = \frac{[e^{\lambda_2(L_2+L_3)}\ (V_{bi}-X_2)]-[V_{bi}+V_{ds}-X_2]+[[\frac{X_2-X_3}{2}](e^{\lambda_2 L_3}+e^{\lambda_3 L_3})]}{e^{\lambda_2 L_3}e^{\lambda_3 L_3}-e^{\lambda_3 L_2}+e^{\lambda_3 L_3}} \quad (38)$$

$$E = C\exp(\lambda_2 L_2) + \left(\frac{\lambda_2-\lambda_3}{3}\right) \quad (39)$$

$$F = D\exp(\lambda_3 L_2) + \left(\frac{\lambda_2-\lambda_3}{3}\right) \quad (40)$$

Where

$$X_1 = \frac{-u_1}{v}, X_2 = \frac{-u_2}{v} \text{ and } X_3 = \frac{-u_3}{v}$$

$$E_1(r) = \frac{d\emptyset_1(r,s)}{dr} = \frac{d\emptyset w_1(r)}{dr} = A\sqrt{\mu}\, e^{\sqrt{u}r} - Be^{-\sqrt{u}r}$$

$$\text{for } 0 \le r \le L_1 \quad (41)$$

$$E_2(r) = \frac{d\emptyset_2(r,s)}{dr} = \frac{d\emptyset w_1(r)}{dr} = C\sqrt{\mu}\, e^{\sqrt{u}(r-L_1)} - De^{\sqrt{u}(r-L_1)}$$

$$\text{for } L_1 \le r \le L_1+L_2 \quad (42)$$

$$E_3(r) = \frac{d\emptyset_3(r,s)}{dr} = \frac{d\emptyset w_3(r)}{dr} = C\sqrt{\mu}\, e^{\sqrt{u}(r-L_1+L_2)} - De^{\sqrt{u}(r-L_1+L_2)}$$

$$\text{for } L_1+L_2 \le r \le L_3 \quad (43)$$

3. RESULTS AND DISCUSSIONS

The analytical model of InSb TMG QWFET is solved in section 2. It is necessary to verify the workout model by using 2D device simulation. For a voltage 0-0.5 V of V_{ds}, the gate bias induces an accumulation of electrons in the channel region. This leads to reduce channel resistance. Hence the well width is decreased which in turn increases the electric field across the well junction.

Fig -2 shows the simulated surface potential of TMG QWFET by varying V_{gs} the gate source voltage consider for this evaluation is 0.2,0.1 V respectively. The channel length is considered to be 30nm and V_{ds}=0.1V It depicts that as the gate voltage increases the surface potential also increases there is a step change of 0.4V in potential along the channel at the interface of M_1,M_2 and M_3.

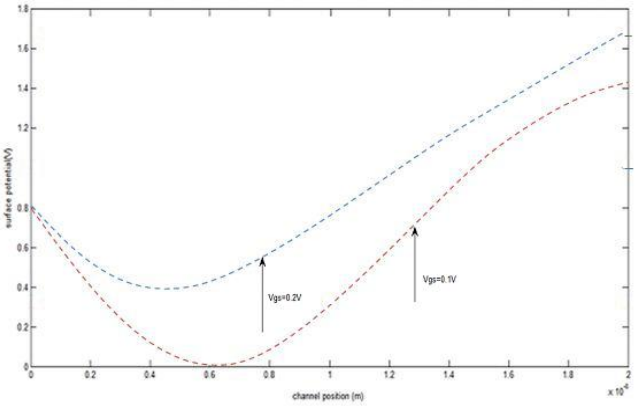

Fig -2: Surface potential of TMG QWFET with various gate source voltage.

Fig -3 shows the simulated output of electric field along the channel length with different V_{gs} It is evident from the figure that peak of the electric field appears near the other Metals. Thus electric field near the source decrease with the change in work function with different metals Such as M_1,M_2,M_3.

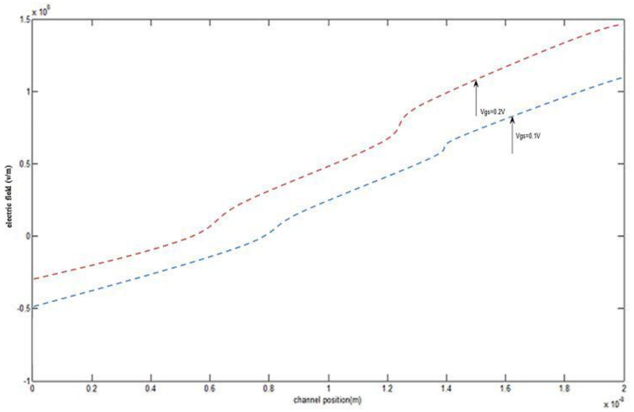

Fig -3: Electric field with various V_{gs}.

Fig-4 The work function considered for M_1,M_2, and M_3 respectively. The electric field is gradually throughout the channel L (L_1+L_2+L_3). The electric field at the source is very less whereas the electric field increases at the drain region.

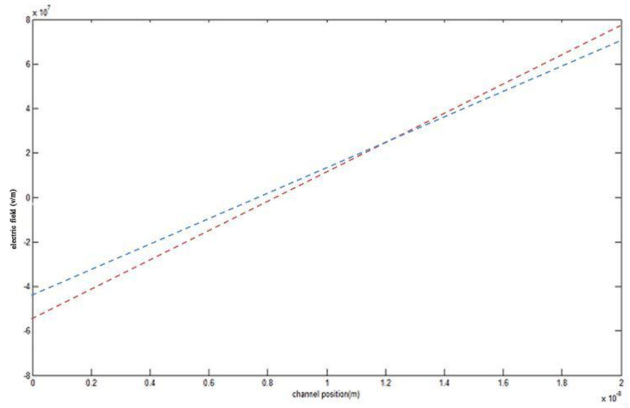

Fig -4: Various work function of M_1.M_2 and M_3

Table – 1: Values used for MAT LAB simulation.

Barrier thickness	50nm
Well thickness	70nm
Buffer thickness	20nm
Doping concentrations	10^{20}cm^{-3}
Channel length(L_1+L_2+L_3)	30nm+30nm+30nm = 90nm

4. CONCLUSION

An analytical model for InSb based TMG QWFET using 2D Poisson equation and boundary conditions, the surface potential and electric field analysis was formed. Thus we understand that one metal in gate is screened off due to the effect of drained voltage. The electric field at the drain side is reduced by the carriers in the channel which can be interpreted as the decrease of hot carrier effect at drain side. The proposed analytical method shows an excellent equality while comparison with other design.

REFERENCES

[1] Niaz, I.A.; Alam, M.H.; Ahmed, I.; Al Azim, Z.; Chowdhury, N.; Khosru, Q.D.M., "Physical/process parameter dependence of gate capacitance and ballistic performance of InAsySb1−y Quantum Well Field Effect Transistors," Nanoelectronics Conference (INEC), 2013 IEEE 5th International , vol., no., pp.389,392, 2-4 Jan. 2013

[2] Chian-Sern Chang; Fetterman, Harold R., "An analytic model for HEMT's using new velocity-field dependence," Electron Devices, IEEE Transactions on , vol.34, no.7, pp.1456,1462, Jul 1987

[3] S. Datta, T. Ashley, J. Brask, L. Buckle, M. Doczy, M. Emeny, D. Hayes, K. Hilton, R. Jefferies, T. Martin, T. J. Phillips, D. Wallis, P. Wilding, and R. Chau, "85 nm gate length enhancement and depletion mode InSb quantum well transistors for ultra high speed and very low power digital logic applications," in IEDM Tech. Dig., 2005, pp. 763–766.

[4] Samuel, TS Arun, N. B. Balamurugan, S. Sibitha, R. Saranya, and D. Vanisri. "Analytical Modeling and Simulation of Dual Material Gate Tunnel Field Effect Transistors." Journal of Electrical Engineering & Technology 8, no. 6 (2013): 1481-1486.

[5] Long, Wei, et al. "Dual-material gate (DMG) field effect transistor." Electron Devices, IEEE Transactions on 46.5 (1999): 865-870.

[6] Hwang, E., et al. "Investigation of scalability of In0.7Ga0.3As quantum well field effect transistor (QWFET) architecture for logic applications." Solid-State Electronics 62.1 (2011): 82-89.

[7] Gildenblat, Gennady, et al. "PSP: An advanced surface-potential-based MOSFET model for circuit simulation." Electron Devices, IEEE Transactions on53.9 (2006): 1979-1993.

[8] Kim, Nam Sung, et al. "Leakage current: Moore's law meets static power."Computer 36.12 (2003): 68-75.

[9] Horowitz, Paul, Winfield Hill, and Thomas C. Hayes. The art of electronics. Vol. 2. Cambridge: Cambridge university press, 1989.

[10] Krishnamohan, Tejas, et al. "Double-Gate Strained-Ge Heterostructure Tunneling FET (TFET) With record high drive currents and≪ 60mV/dec subthreshold slope." Electron Devices Meeting, 2008. IEDM 2008. IEEE International. IEEE, 2008.

[11] K. K. Young, "Short-channel effects in fully depleted SOI MOSFET's," IEEE Trans. Electron Devices, Vol. 36, pp. 399-402, 1989.

[12] Vasallo, Beatriz G., et al. "Comparison between the noise performance of double-and single-gate InP-based HEMTs." Electron Devices, IEEE Transactions on 55.6 (2008): 1535-1540.

[13] Khandelwal, Sourabh, Nitin Goyal, and Tor A. Fjeldly. "A physics-based analytical model for 2DEG charge density in AlGaN/GaN HEMT devices."Electron Devices, IEEE Transactions on 58.10 (2011): 3622-3625.

[14] Khandelwal, S., & Fjeldly, T. A. (2012, March). A physics based compact model of gate capacitance in AlGaN/GaN HEMT devices. In Devices, Circuits and Systems (ICCDCS), 2012 8th International Caribbean Conference on (pp. 1-4). IEEE.

[15] Khandelwal, Sourabh, et al. "Robust surface-potential-based compact model for GaN HEMT IC design." Electron Devices, IEEE Transactions, 2013, 3216 - 3222.

[16] Si, Jia, et al. "Electric Field Distribution Around Drain-Side Gate Edge in AlGaN/GaN HEMTs: Analytical Approach." Electron Devices, IEEE Transactions, 2013, 3223 - 3229.

[17] Yigletu, Fetene Mulugeta, et al. "Compact Charge-Based Physical Models for Current and Capacitances in AlGaN/GaN HEMTs." Electron Devices, IEEE Transactions on 60.11 (2013): 3746-3752.

BIOGRAPHIES

C. Divya She is currently working as an Assistant Professor in Centre for Information Technology and Engineering, Manonmaniam Sundaranar University, Tirunelveli, India. Her research interest is on Wireless sensor networks, QWFET and Remote Sensing.

N.Arumugam He is currently pursuing the Masters of Technology degree in Computer and Information Technology from Manonmaniam Sundaranar University, Tirunelveli, India. His Research interests include Image Processing, Computer Communication, and Electronics.

B.Selva Karthick He is currently pursuing the Masters of Technology degree in Information and Communication Technologies from Manonmaniam Sundaranar University, Tirunelveli, India. His Research interests include Networking, Hardware, and Image Processing.

J. Jagannathan currently working as an Assistant Professor in Shri Sapthagiri Institute of Technology, Vellore Dt. His Research interests include Image Processing, Wireless Sensor Network, and QWFET transistors.