4.1. INTRODUCTION

A Schottky diode fabricated from a material grown on semiconducting surface often faces the problem of cross diffusion at the hetero interface. The metal-semiconductor (MS) contact in the knowledge of semiconductor device is utilized these days. The electronic parameters of Schottky diodes and quality of MS contacts depend upon the preparation, condition and interfaces between metals and semiconductors [10, 13, 26, 44, 65]. Therefore, one has to improve the quality to the existing semiconductor device for continuous demand and operation. Because of their importance and vital physical and chemical properties, InP notably, have turned out to be an area of dominant research. However, a crucial role is played by the fabrication of InP structures, which is useful for the construction of the modern technology. It finds many applications such as opto-electronic devices, high-speed operational electronic applications, storage devices etc [10, 26]. Thus, the barrier diode is the most important in order to improve the quality and behaviour of electrical devices.

InP is the best compound semiconductor material to fabricate Schottky contacts. Also, this is a strong dependence upon metal-compound semiconductor. Among the properties of diodes, SBH is a very important electrical parameter to estimate the efficiency of the diode. The MS structure always needs low reverse leakage current and high barrier height. This is a most confront issue in order to improve the quality of diode by the metal interface. Several researchers prepared Schottky contacts on n-type InP with various metallization. In all cases, high value of SBH will be introduced by a good Schottky contact, resulting in better device characteristics. A large number of bilayer metal schemes are made on n-InP as a Schottky contact; a better and high reliable one has not yet been formed. Also, the strength of interfacial reactions determines the quality of barriers in InP, many times between the metal and semiconductor [13]. In order to lead a good quality Schottky contact a better device is required to study the characteristics and minimize the reverse leakage current as well as high break down voltage. Thus, Ruthenium and Titanium metals are proposed to fabricate bilayer Ru/Ti on n-type InP using e-beam evaporation process and study its behaviour. As we know that the first layer Titanium metal is of its low work function and yields smallest voltage drop. Similarly the second layer Ruthenium is preferred due to its chemical and thermal stability. The complete electrical properties of present
investigated diode are described using I-V, C-V and C-f methods. The main aim of this work deals with the properties of SBH, $n$, $R_S$ and $N_{SS}$. Also, this study effectively describes the structural and morphology using X-ray and AFM methods. The entire scheme has divided into three major parts and is described below.

- The fabricated Ru/Ti metal InP diode using e-beam evaporation process first carried out to study the electrical properties at room temperature. This work highlights not only the common electrical parameters but also the effective capacitance value at various applied voltages.

- This part of work is secondly focuses as to investigate the double metal layer performance with annealing temperature. RTA is imposed for electrical properties, XRD is used for determination of the structure and surface roughness was observed by them. All these studies were at different annealed temperatures.

- The p-n junction diodes switch from one state to another state slowly. However, Schottky diodes switch quickly between the states. Therefore, Schottky diode is mainly used in switching and high frequency applications. Indeed the operation is a temperature-dependent. Thus, this part of work is finally proposed to study the temperature effect on the investigated diode. The variability of SBH, ideality factor, $R_S$ and $N_{SS}$ are estimated as a function of temperature. Also, this work has discussed the inverse current transport process.

4.2. EXPERIMENTAL PROCEDURE

A cleaned and polished n-type InP substrate of thickness 350 µm was used to prepare Ru/Ti Schottky contact in this study. The wafer was grown by the Liquid Encapsulated Czochralski (LEC). The carrier concentration of the wafer was about $5.0 \times 10^{15} \text{cm}^{-3}$. Organic solvents like trichloroethylene, acetone etc are used to clean the wafer. This method removes the unwanted impurities on wafer and protects surface damages. Every layer happens to be performing this cleaning process for the period of 5 min time and finally stirred in DI water. High purity nitrogen is used for drying the wafers. Also, HF (49%) and H$_2$O (1:10) were used for 1 min to etch the
samples. The native oxides of wafer surface remove this procedure. The metals as first and second layers are evaporating as dots with 0.7 mm diameter. Stainless-steel mask was used for deposition under this evaporation system. The pressure of about $5.0 \times 10^{-6}$ mbar [66] was kept for the entire evaporation process in vacuum coating unit at the mentioned temperature.

- The e-beam evaporation system was used to evaporate Ti (20nm) and Ru (30nm) on polished n-type InP wafer at room temperature.
- Keithley source measure unit (2400) was used to study the I-V characteristics.
- An automated deep level spectrometer (SEMILAB DLS-83D) was used to carry out the C-V measurements.
- Agilent 4156C analyzer and LCR meters were used to study C-V-f and G-V-f measurements.
- Bruker AXS: D8 diffractometer is used to study the interfacial reactions.
- AFM is used to characterize the surface morphology at annealed temperatures.
- DLS-83D-1 cryostat temperature controller was used to control the device temperature to ± 1K accuracy.

4.3. RESULTS AND DISCUSSION

This section described the complete discussion on the investigated diode and is as follows.

4.3.1 AT ROOM TEMPERATURE

4.3.1 (a) I-V Characteristics

The fabricated SBD Ru/Ti/n-InP initially studied the performance at room temperature. The reverse leakage current of the diode is determined as $8.834 \times 10^{-10}$ A at −1 V. The thermionic emission across the Schottky contact forward-bias current is given by [66]:

$$I = A A'' T^2 \exp\left(-\frac{q\Phi_b}{kT}\right) \left[\exp\left(\frac{qV}{nkT}\right) - 1\right]$$  \hspace{1cm} \text{(4.1)}
The above equation can be modified as

\[ I = I_o \exp\left(\frac{q(V-I\cdot R_s)}{nkT}\right) \]  \hspace{1cm} 4.2

The saturation current \( I_o \) can be understood with the value of SBH deduced from I-V curves. The necessary theory to calculate \( I_o \) is given in the chapter III equation 3.2. Fig. 4.1 shows a graphical relation between current and forward/reverse bias voltage. This curve determines the parameters of ideality factor, \( n \) and barrier height by the method of linear curve fit graphical studies on \( \ln(I) \) versus \( V \). The slope of the forward bias curve gives ideality factor and the equation 4.2 and its extension equation 3.2 are used in order to determine the barrier height. This is by means of

\[ n = \frac{q}{kT} \left[ \frac{d(V-I\cdot R_s)}{d(\ln I)} \right] \]  \hspace{1cm} 4.3

The value of \( n \) is equal to 1 in the case of ideal diode and thus the present experiment found the value of ideality factor was more than ideal value. The reason for this observation is the formation of the interfacial layer and series resistance effect [67-69]. Since SBH is bias voltage dependent, and can be calculated as

![Fig. 4.1. Current–voltage characteristics of Ru/Ti/n-InP SBD](image-url)
\[ \phi_b = \frac{kT}{q} \ln(\frac{AA^*T^2}{I_o}) \]

The dark I-V measurements give the information on rectifying contact nature, the leakage current and the series resistance of the device. It is clear from the Fig. 4.1 that a good diode exhibits rectifying behaviour. However, the plot is deviating from linearity at high-applied voltage region. The observation made that the founded SBH is 0.83 eV and \( n \) is 1.18 studied from I-V measurements. Fig. 4.2 shows the relation between junction resistance and applied voltage. The observed \( R_S \) and shunt resistance (\( R_{sh} \)) of the present diode can be determined and their values are 259 M\( \Omega \) and 1.2943 \( \times 10^{10} \) \( \Omega \). Fig. 4.2 shows a significant deviation is observed because of sufficient applied voltage at interface states and it is linear at initial voltage.

![Plot of the junction resistance versus voltage.](image)

Cheung’s method [70] is employed in order to calculate the precise SBH, \( n \) and \( R_S \) values. The mathematical expressions of Cheung’s described as

\[ \frac{dV}{d \ln I} = IR_S + \frac{n kT}{q} \]

thus, the modified Cheung’s function can be written as

\[ H(I) = IR_S + n \square_b \]
In the present study, the above said equations give a straight line. The plots of $dV/d(ln I)$ versus I and $H(I)$ versus I for present diode are shown in Fig. 4.3. These plots also determine the electrical properties, $n$ and $R_S$ and the founded values is 1.23 and 46 MΩ. As shown in Fig. 4.3, a plot of $H(I)$ versus I will provide a straight line and the slope determine the value of $R_S$. Thus, Cheung’s approach consistency was checked by these $R_S$. The observed plot slope is used to determine both $\Phi_b$ and $R_S$ values from the equation 4.6. This straight line finds the both $\Phi_b$ and $R_S$ values as 0.86 and 55 MΩ. However, $dV/d(ln I)$ versus I finds the $n$ value and $R_S$ as 1.23 and 46 MΩ. The calculated $R_S$ from both plots implies their consistency.

The modified Norde function [62] is also used to determine SBH and $R_S$. The mathematical expressions are given by

$$F(V) = \frac{V}{\gamma} - \frac{1}{\beta} \ln[I(V)/AA^*T^2]$$  \hspace{1cm} 4.7

$$\Phi_b = F(V_o) + \frac{V_o}{\gamma} - kT/q$$  \hspace{1cm} 4.8

$$R_S = \frac{kT(\gamma - n)}{qI_{min}}$$  \hspace{1cm} 4.9

The equations 4.8 and 4.9 hail the values of SBH and $R_S$ and the founded values are
0.87 eV and 17 MΩ. Thus, the calculated SBH value from Norde function is very close to I-V characteristic and Cheung’s function. Similarly, a closed Rs is obtained while studying the relation between Norde function and Cheung’s functions. In order to study the behaviour of current transport process, a graphical relation between log (V) versus log (I) is shown in Fig. 4.5. The present investigated SBD shows regions I, II and III under forward bias. These have their individual slopes and the values are found to be 0.5589, 1.2731 and 2.0656 respectively. The first region is disclosing the current transport based on ohmic behaviour. The second region is characterized by the dependence of charge transport power. A high value of slope (2.0656) is observed for third region and this is attributing to trap-filling at the metal interface [69].  

![Fig. 4.4. Modified Norde plot of Ru/Ti/n-InP.](image)
The Poole-Frankel emission is employed to analyze the reverse leakage current. The Fig. 4.6 shows i) Poole-Frankel emission between $I_R/E$ and $E^{1/2}$ and ii) Schottky emission between $I_R/T^2$ and $E^{1/2}$. As shown in the figure, both emissions are a linear fashion and slope of the emission provides Poole-Frankel emission [71]. The theoretical slopes obtained from the fit of Poole–Frenkel emission is $0.00954(V \cdot cm^{-1})$. 

Fig. 4.5. The graph of log (I) against log (V).

Fig. 4.6. Graph of $I_R/E$ V/s $E^{1/2}$ and $I_R/T^2$ V/s $E^{1/2}$. 
and Schottky emission is 0.00476 (V cm\(^{-1}\))\(^{1/2}\). The slope determined from the plot of \(I_R/E\) versus \(E^{1/2}\) (Fig. 4.6) is 0.00323 (V cm\(^{-1}\))\(^{1/2}\). This value is smaller than theoretical value of 0.2240 (V cm\(^{-1}\))\(^{1/2}\) and thus Schottky emission is 0.00309 (V cm\(^{-1}\))\(^{1/2}\) [72]. This indicates the absence of the Poole–Frenkel mechanism in the investigated diode. As shown in the same figure, the slope determined from the graph of \(I_R/T^2\) versus \(E^{1/2}\) is 0.00432 (V cm\(^{-1}\))\(^{1/2}\) which closely matches with the theoretical value of Schottky emission. Thus in the case of our investigated SBD, we observe that the conduction mechanism rules out the Schottky emission.

4.3.1 (b) C-V characteristics

The theoretical capacitance-voltage expression [10] is given by

\[
[C]^2 = \left[\frac{2(V_R+V_d)}{q \varepsilon_s N_D A^2}\right]
\]

where \(\varepsilon_s\) = permittivity of the semiconductor (\(\varepsilon_s = 11.40 \varepsilon_0\))
\(\varepsilon_0 = 8.850 \times 10^{-14} \text{ F cm}^{-1}\) (vacuum dielectric constant)
\(V_R\) = reverse bias voltage
\(V_d\) = diffusion potential and
\(N_D\) = doping concentration.

However, we observed that the capacitance of the samples is perceived at the frequency of 1 MHz. Fig. 4.7 shows the plot of \([C]^2\) vs applied voltage (V). The SBH is given by:

\[
\phi_b = V_d + (kT/q) + \phi_n
\]

where \(\phi_n\) is the Fermi energy measured from the conduction band. This plot provides diffusion potential at zero bias. The calculated doping concentration \(N_D\) and the barrier height \(\phi_b\) are 2.43 \(\times 10^{19}\) cm\(^{-3}\) and 1.00 eV. The parameters of investigated diode from I-V and C-V measurements are given in Table 4.1. It is observed that the SBHs estimated from I-V method are smaller when comparing to C-V [44, 66, 72, 73].
Table. 4.1. Calculated parameters of SBD at room temperature.

<table>
<thead>
<tr>
<th>Method</th>
<th>Barrier height ($\phi_b$) (eV)</th>
<th>Ideality factor (n)</th>
<th>Series Resistance ($R_s$) MΩ</th>
<th>Interface states Density $N_{SS}$ ($cm^{-2}$ eV$^{-1}$)X$10^{12}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>I-V</td>
<td>0.83</td>
<td>1.18</td>
<td>259</td>
<td>4.00586</td>
</tr>
<tr>
<td>Norde</td>
<td>0.87</td>
<td></td>
<td>17</td>
<td>4.00290</td>
</tr>
<tr>
<td>Cheung’s function</td>
<td>dV/d(lnI) versus I</td>
<td>1.23</td>
<td>46</td>
<td></td>
</tr>
<tr>
<td>Cheung’s function</td>
<td>H(I) versus I</td>
<td>0.86</td>
<td>55</td>
<td></td>
</tr>
<tr>
<td>C-V</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

4.3.1 (c) Determination of Interface States Density ($N_{SS}$)

This is determined by forward bias I-V data. This is because of voltage dependent, $n$ and SBH. Card and Rhoderick [74] proposed the voltage dependent ideality factor, which is given by

$$n(V) = 1 + (\delta/\epsilon_s)[\epsilon_s/W_D + qN_{SS}]$$  \[4.15\]
where

Semiconductor permittivity $\varepsilon_s = 11.40 \varepsilon_0$

Interfacial layer permittivity $\varepsilon_i = 3.50 \varepsilon_0$. [10, 13]

The value of $W$ was calculated from reverse bias $1/C^2$ versus $V$ plot as in the following equations:

$$W = \sqrt{\frac{2\varepsilon_s V_d}{qN_0}} \quad 4.16$$

The $C$-$V$ data gives the interfacial layer thickness $\delta$ at interfacial layer capacitance ($C = \varepsilon_i \varepsilon_0 A/\delta$) and the range of frequency 1 MHz [72]. The values of $\delta$ and $W$ are found to be about 16 Å and 1160 Å. Moreover, the energy of the interface states among conduction band in semiconductor (n-type) is represented as:

$$E_C - E_{SS} = q (\Box_b - V) \quad 4.17$$

Fig. 4.8 is the outline of $N_{SS}$ and this is a function of difference between $E_C$ and $E_{SS}$. The observed value is found to be $4.00586 \times 10^{12}$ cm$^{-2}$ eV$^{-1}$. An apparent non-linear rising of $N_{SS}$ is observed from the graph and thus the present diode interface states density is lower than the literature value [75].

![Graph showing interface state density distribution](image)

**Fig. 4.8. Outline of Interface state density distribution ($N_{SS}$).**
4.3.1 (d) C-f characteristics

This is noted to estimate density distribution of the interface states by plotting capacitance versus frequency of the diode. This provides the suitability of interface state capacitance $C_{SS}$ [63]. The necessary theory to determine the capacitance at every step voltage with respect to frequency is described in the chapter 3.5.2. The interface state capacitance dependence on frequency at applied voltage describes this measurement. The capacitance is determined using Fig. 4.9 at different applied voltage. The applied voltages are like $V=0.05$, 0.10 and 0.15 V. However, 0.05 V is the initial and 0.45 V is final bias voltage. The frequency is automatically varied from 100 kHz to 1000 kHz with increment of 100 kHz in each step.

![Graph of C-f characteristics at various bias voltages.](image)

Fig. 4.9. Graph of C-f characteristics at various bias voltages.
Fig. 4.10. Graph of G-f characteristics at different applied voltages.

In the both figures (Fig. 4.9 and 4.10), the bottom relation is at 0.05 V and top one is at 0.45 V. The interface state capacitance is calculated at every applied bias voltage with the necessary theory explained in chapter 3.5.2 [76]. Table 4.2 gives the electrical parameters of investigated SBD at various bias voltages.

**Table 4.2. Different electrical parameters from C-f characteristics.**

<table>
<thead>
<tr>
<th>Voltage (V)</th>
<th>$E_{C-E_{SS}}$ (eV)</th>
<th>$N_{SS} \times 10^{12}$ eV(^{-1}) m(^{-2})</th>
<th>Interface Capacitance $C_{SS}$ (pF)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00</td>
<td>0.841</td>
<td>3.859</td>
<td>543.44</td>
</tr>
<tr>
<td>0.05</td>
<td>0.834</td>
<td>3.938</td>
<td>552.61</td>
</tr>
<tr>
<td>0.10</td>
<td>0.820</td>
<td>4.006</td>
<td>573.33</td>
</tr>
<tr>
<td>0.15</td>
<td>0.819</td>
<td>4.014</td>
<td>587.59</td>
</tr>
<tr>
<td>0.20</td>
<td>0.818</td>
<td>4.134</td>
<td>613.42</td>
</tr>
<tr>
<td>0.25</td>
<td>0.817</td>
<td>4.353</td>
<td>632.187</td>
</tr>
<tr>
<td>0.30</td>
<td>0.809</td>
<td>4.390</td>
<td>658.765</td>
</tr>
<tr>
<td>0.35</td>
<td>0.805</td>
<td>4.410</td>
<td>683.801</td>
</tr>
<tr>
<td>0.40</td>
<td>0.793</td>
<td>4.614</td>
<td>710.575</td>
</tr>
<tr>
<td>0.45</td>
<td>0.654</td>
<td>4.821</td>
<td>746.283</td>
</tr>
<tr>
<td>0.50</td>
<td>0.539</td>
<td>5.031</td>
<td>779.194</td>
</tr>
</tbody>
</table>
The observation is made that weakly dependent capacitance is at low frequency and increases capacitance while at high frequency. Also, this observation describes that the intermediate frequency region can allow the signal. Fig. 4.10 shows G-f behaviour at different bias voltage and it shows that the conductance increases with increasing frequency. However, at high frequency, the decrement of conductance is observed due to electron emission [13, 77].

4.3.2 ANNEALING EFFECT

4.3.2 (a) I-V Characteristics
Sequential annealing was done on the Schottky contacts at 250 °C, 350 °C, 450 °C etc in a RTA system. The samples were thermal annealed for a time period of 1 min in nitrogen ambient flow. Fig. 4.11 shows the forward and reverse I-V measurement of the SBD before and after annealed. The reverse leakage current is 8.834 X 10^{-10} A. Similarly the contacts also annealed randomly at 250 °C, 350 °C and 450 °C. The corresponding leakage currents are 1.113 X 10^{-9}, 1.332 X 10^{-9} and 1.654 X 10^{-9} A are observed at -1 V. As a result the SBH of the present Schottky in the case of as-deposited is 0.83 eV. On observation, it is found that there is decrease of SBH for contacts annealed at the temperatures 250 °C, 350 °C and 450 °C. The founded SBH values are 0.82 eV, 0.81 eV and 0.80 eV. It is disclosed by experiments that

Fig. 4.11. I-V characteristics of Ru/Ti/n-InP SBD.
better rectification is exhibited by the as-deposited contact in comparison with annealed contacts [78, 79]. There is a possibility that metals may react with semiconductors resulting in the formation of new compounds during the annealing process [80]. So, the annealing temperature strongly influences the SBH. It is the opinion of Duboz et al. [81] that reduction in N_{SS} leads to the lower value of SBH for the respective sample. It is possible that the linear region slope is used to estimate the ideality factor (n). The observed ideality factor at the temperatures 250 °C, 350 °C and 450 °C are 1.25, 1.58 and 1.63. Thus, the n value in this case is more than one. This is because of the association of defects at the interface. The N_{SS}, inter-diffusion etc can be derived from thermodynamically thermal annealing [82]. This leads to recombination centers [83] and SBH inhomogeneities [84]. An ideal TE behavior and flow of excess current may be caused by this. It has been found that the amount of transferred charge increases, as the increase annealing temperature [85, 86].

![Diagram of voltage dependent resistance of SBD](image)

**Fig. 4.12. The voltage dependent resistance of SBD.**

The applied voltage dependence resistance of present SBD is shown in Fig. 4.12. There are two notable parameters like R_s and R_{sh} affecting the diode characteristics. These values can be determined by studying the relation between resistance and applied voltage. Therefore, the diode resistance can also determine
from I-V characteristics. Fig. 4.12 gives the values of $R_S$ and $R_s$ as 261 MΩ and 24 $\times 10^9$ Ω for as-deposited, 205 MΩ and 20 $\times 10^9$ Ω for 250 °C, 160 MΩ and 19 $\times 10^9$ Ω for 350 °C, 121 MΩ and 17 $\times 10^9$ Ω for 450 °C, respectively. Cheung and Cheung [70] method is employed in order to calculate $R_S$ value. The necessary theory was described in the section 4.3.1 (a). In order to determine the series resistance, a graph

![Graph between dV/dln(I) and I.](image1)

**Fig. 4.13.** A graph between $dV/d\ln(I)$ and I.

![Graph between H(I) and I.](image2)

**Fig. 4.14.** A graph between $H(I)$ and I.
of \(\frac{dV}{d\ln(I)} \ V/s \ I\) is shown in Fig. 4.13. From this, \(n\) and \(R_S\) values were calculated. The founded values are 1.24 and 68 M\(\Omega\) in the case of as-deposited. Also, these values at 250 °C are 1.29 and 50 M\(\Omega\), at 350 °C are 1.62 and 30 M\(\Omega\) and at 450 °C 1.69 and 26 M\(\Omega\). Fig. 4.14 gives a straight line while study the relation between \(H(I) \ V/s \ I\) and this is used to estimate an ideality factor [87]. This graph also gives \(R_S\) and \(\phi_b\) in both as-deposited and at various annealed temperatures. The observed values are noted in the Table 4.3. It is observed that these values closely match with the studies between \(H(I) \ V/s \ I\) and \(\frac{dV}{d\ln(I)} \ V/s \ I\). Further, the stability of Cheung’s method is clearly evidence from this [88, 89]. In this investigation, the observed \(R_S\) value is high for the present SBD. It describes that a thin native oxide layer is formed on the semiconductor in the case of RTA process [90]. This is due to non-linear behaviour of the forward bias I-V characteristics.

Moreover, the \(\phi_b\) and \(R_S\) of the SBDs are estimated using Norde’s method [62]. The value of \(R_S\) is determined by the Node function as

\[
R_S = \frac{kT(\gamma - n)}{qI_{\text{min}}} \tag{4.18}
\]
The calculations show that $0.87$ eV is the barrier height of as-deposited contact. The same are $0.85$ eV, $0.83$ eV and $0.82$ eV for $250$ °C, $350$ °C and $450$ °C annealed contacts. We can calculate $R_s$ of present SBD using I-V data and the estimated values are listed in Table 4.3. The results show that the high SBH in the case of as-deposited than annealed contacts and are closely matched with I-V measurements. To estimate $R_s$, the Cheung’s approach is employed and this value differs from Norde’s. The Cheung’s approach performs are in non-linear region, whereas Norde’s is in entire curves of I-V. It has been clearly noted that with the raise of RTA temperature, the SBH of contacts decreases. This is also confirmed by Bhandari et al. [91]. The conclusion is that the decrease in the series resistance can be caused by decrease of SBH with increase in annealing temperature.

4.3.2 (b) C-V Characteristics

These characteristics of SBD’s were studied at 1MHZ frequency for any temperature. But the voltage of the AC source is adjusted to 100 mv. The Fig. 4.16 shows the reverse bias $C^{-2}$ against applied voltage V of the present investigated diode.

Fig. 4.16. Reverse bias $C^{-2}$ against V of SBD.
The capacitance value of SBD is estimated by the intercept of X-axis. This intercept value indicates $V_0$, corresponding to $V_{bi}$ [92].

Fig. 4.17. The C-V characteristics of SBD.

Fig. 4.18. The C-V characteristic Mott-Schottky of SBD.
From the Fig. 4.17, it can be observed that, there are two defined regions and the measured saturation capacitance $C_m$ is observed in the region I. The total depletion region of the junction makes this evident. Region II shows the dependence-measured capacitance $C_m$. It is clear that the depleted region width decreases with the forward bias voltage increase at any annealing temperatures. The Mott-Schottky plot is shown in Fig. 4.18. It is observed that at 1 MHz, the $N_{SS}$ is not related to capacitance $C_m$. Hence, the high frequency signals cannot be followed. The extrapolation of the graph shown in Fig. 5.8 gives the values of built-in voltage. These values are 0.96 V, 0.90 V, 0.78 V and 0.72 V at as-deposited, 250 °C, 350 °C and 450 °C.

Table 4.3. Different parameters of Ru/Ti/n-InP SBD.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>As-dep</th>
<th>250 °C</th>
<th>350 °C</th>
<th>450 °C</th>
</tr>
</thead>
<tbody>
<tr>
<td>From I-V</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$I_0$ (A)</td>
<td>8.834×10^{-10}</td>
<td>1.113×10^{-9}</td>
<td>1.332×10^{-9}</td>
<td>1.654×10^{-9}</td>
</tr>
<tr>
<td>$\phi_b$ (eV)</td>
<td>0.83</td>
<td>0.82</td>
<td>0.82</td>
<td>0.80</td>
</tr>
<tr>
<td>$n$</td>
<td>1.18</td>
<td>1.25</td>
<td>1.58</td>
<td>1.63</td>
</tr>
<tr>
<td>$R_s$ (MΩ)</td>
<td>261</td>
<td>205</td>
<td>160</td>
<td>121</td>
</tr>
<tr>
<td>$R_{sh}$ (Ω)</td>
<td>24×10^7</td>
<td>20×10^7</td>
<td>19×10^7</td>
<td>17×10^7</td>
</tr>
<tr>
<td>From Cheung’s</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$dV/d (\ln I)$ V/s I</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$R_s$ (MΩ)</td>
<td>68</td>
<td>50</td>
<td>30</td>
<td>26</td>
</tr>
<tr>
<td>$n$</td>
<td>1.24</td>
<td>1.29</td>
<td>1.62</td>
<td>1.69</td>
</tr>
<tr>
<td>From Nord’s</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$H(I)$ V/s I</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$R_s$ (MΩ)</td>
<td>74</td>
<td>57</td>
<td>40</td>
<td>28</td>
</tr>
<tr>
<td>$\phi_b$ (eV)</td>
<td>0.85</td>
<td>0.84</td>
<td>0.83</td>
<td>0.81</td>
</tr>
<tr>
<td>From C-V</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\phi_b$ (eV)</td>
<td>0.87</td>
<td>0.85</td>
<td>0.83</td>
<td>0.82</td>
</tr>
<tr>
<td>$R_s$ (MΩ)</td>
<td>69</td>
<td>58</td>
<td>33</td>
<td>21</td>
</tr>
<tr>
<td>$N_{SS}$ (eV^{-1}cm^{-2})</td>
<td>4.004×10^{12}</td>
<td>5.683×10^{12}</td>
<td>1.344×10^{13}</td>
<td>1.487×10^{13}</td>
</tr>
</tbody>
</table>
It is found that by C-V method, the calculated SBH in the case of as-deposited is 1.00 eV. In case of annealed contacts, the Schottky barrier height at the temperature of 250 °C, 350 °C, and 450 °C are 0.96 eV, 0.90 eV and 0.88 eV. The above table shows the variation of SBH values between I-V and C-V. This is called SBH inhomogeneity. So many factors are cause for this special distribution of interface charge, different thicknesses of layers at interface etc as reported by Song et al. [20]. The random reactions made at the interface are one more cause to inhomogeneity [47].

4.3.2 (c) Determination of Interface States Density (N_{SS})

This is determined using forward bias I-V data by Card and Rhoderick [74]. When the states and semiconductor are in balanced, the N_{SS} is given by [13, 74, 93]

\[ N_{SS}(V) = \frac{1}{q} \left[ \frac{\varepsilon_i}{\delta} (n(V) - 1) - \frac{\varepsilon_s}{W_D} \right] \]

Also, the conduction band edge, \( E_C \) with respect to the interface states energy (\( E_{SS} \)) at the semiconductor surface, is given by [94, 95]

\[ E_C - E_{SS} = q\phi_b - V \]

where \( E_{SS} \) indicates the energy of the bottom of the conduction band. Fig.5.9 shows the plot of \( N_{SS} \) V/s \( E_C - E_{SS} \) at various annealing temperatures.

![Fig. 4.19. Interface states Density N_{SS} against E_C-E_{SS}.](image)
It is clear that obtained $N_{SS}$ values are decreasing with applied voltages. Also, there is the existence of $N_{SS}$ towards the bottom of the conduction band. The observed $N_{SS}$ values are $4.004 \times 10^{12} \text{ eV}^{-1} \text{cm}^{-2}$ for as-deposited, $5.683 \times 10^{12} \text{ eV}^{-1} \text{cm}^{-2}$ for 250 °C, $1.344 \times 10^{13} \text{ eV}^{-1} \text{cm}^{-2}$ for 350 °C and $1.487 \times 10^{13} \text{ eV}^{-1} \text{cm}^{-2}$ for 450 °C temperature.

It is shown by experimental results that increasing annealing temperatures tend to increase in $N_{SS}$ values. There is a variation in the charge of the $N_{SS}$ and thus the interface state energy distribution changes with applied voltage. The applied voltage and the depletion capacitance are altered because of this [13, 92, 96]. It can be stated on the bias of these results that the interfacial layer and interface states dominate on the determination of the barrier parameters.

4.3.2 (d) XRD analysis
The present study on the investigated contacts was performed by XRD method. Fig. 4.20 shows the investigated Schottky contacts XRD plots at different temperatures. Fig. (a) is as-deposited one, Fig. (b) is at 250 °C and Fig. (c) is at 450 °C temperature. The resolved peaks are observed for these and are characteristic ones. As shown in Fig. (a), the peaks (2 0 0) and (4 0 0) are for the InP and the other
corresponding peaks are observed. The other observed peaks are (1 1 1) for In$_3$Ru, (2 2 0) for In$_4$Ti$_3$, (2 0 1) for In$_4$Ti$_3$, (2 2 2) for In$_3$Ru and (1 2 3) for RuP$_4$. The XRD peaks annealed at 250 ºC shows the new interfacial phases in addition to the peak beside as-deposited one and thus observed as Ti$_3$P (1 0 2). While the contact is annealed at 450 ºC, an additional peak corresponding to (1 2 1) plane for RuP$_2$ was observed. Moreover, at 250 ºC and 450 ºC temperature the peaks related to In$_3$Ru of (1 1 1) plane, In$_4$Ti$_3$ of (2 2 0) plane and In$_4$Ti$_3$ of (2 0 1) plane disappeared. Thus different interfacial planes were observed due to the Ru and Ti contacts on InP in the present study.

4.3.2 (e) AFM analysis

The analysis of surface morphology was carried out by the Atomic Force Microscopy (AFM). Fig. 4.21 shows different AFM micrographs of the investigated Schottky diode. Fig. (a) is in the case of as-deposited, (b) is at 250 ºC and (c) at 450 ºC respectively. The important surface roughness on the semiconductor contact plays a dominant role in the estimation of electrical properties.
Fig. 4.21. Different AFM images of SBD.

The observation made is that the image of surface is fairly smooth in the case of as-deposited one and found that the RMS roughness is 3.335 nm. While at 250 °C the surface roughness increases to 4.136 nm. Lastly this division finds the roughness of surface of 6.325 nm at the annealed temperature 450 °C. It is found that there is no alteration in the surface morphology, when the temperature is above 450 °C. It concludes that the highest SBH value in the case of as-deposited than in annealed contacts.
4.3.3 TEMPERATURE-DEPENDENT

There is much significance of the metal-semiconductor (MS) structures in order to characterization of SBDs [97-101]. It is very important to have a detailed knowledge about the temperature dependence of SBDs behaviour. However, the processes of charge transport information through MS contacts can be understood through temperature-dependent studies [102-106]. Thus, the conduction mechanism has to be investigated for a full understanding of the conduction current. Since the investigated Ru/Ti Indium phosphide Schottky contact and because of its many electronic applications [107-109], the parameters like SBH, $n$, $R_S$ and $N_{SS}$ were studied in the temperature between 120 K and 400 K.

4.3.3 (a) I-V Characteristics

The information regarding the conduction process cannot be got by studying I-V method at room temperature because the parameters are temperature dependent. Thus forward I-V measurements are employed in this division also in order to estimate the important parameters like SBH and ideality factor ($n$). The temperature is chosen between 120 K and 400 K in steps of 40 K in the dark. The accuracy of present used temperature controller is ± 1K in all cases [110]. However, thermionic emission (TE) over the interface barrier also gives the current measured across Schottky contact as:

$$I = I_0 \exp\left(\frac{q(V - IR_s)}{nkT}\right) \left[1 - \exp\left(-\frac{-q(V - IR_s)}{kT}\right)\right]$$

4.21

Also, the necessary theory in order to calculate SBH was described in the same section 4.3.1(a). Fig. 4.22 shows the forward and reverse I-V measurements of present investigated diode. The right side of graph is forward bias and left side of graph is reverse bias with respect to zero absolute voltage (0 V). From this graph, the slope of linear region in forward I-V characteristics estimate the $n$ value as

$$n = \frac{q}{kT} \frac{dV}{d\ln I}$$

4.22

TE theory impose the slopes of ln(I) V/s voltage (V) and their intercepts found the practical values of SBH and $n$. Table 4.4 shows the observed parameters of Ru/Ti InP diode at different temperatures. As noted in the table, the SBH changes from 0.25 eV to 0.74 eV when the temperature is increases from 120 K to 400 K. Similarly it finds
the changes of $n$ value from 4.63 to 1.82 with the same temperature limit.

**Fig. 4.22.** Forward and reverse I–V characteristics.

It has been observed that as temperature increases, $n$ decreases. Therefore, the current transport mechanism over MS interface is occurs and this process is triggered by temperature. The electrons can easily surmount the lower barriers in low temperatures. While the temperature increases, it is found that huge electrons get required energy to overcome the higher barrier. The results observe that the SBH rises with respect to temperature as well as voltage [94]. At low temperature, the non-uniform thickness will have the decrease SBH and rise in $n$ value. The other factors also proposed that, the excess current through interfacial states [111]. At low voltages, the I–V characteristics show linearity but at high voltages, these are non-linear due to $R_s$ effect. Also, it affects determination of SBH and $n$ values. To estimate the SBH, $n$ and $R_s$, the Cheung’s method is employed [70]. The necessary theory (Cheung’s functions) for estimation of these values is discussed in 4.3.1 (a).
Fig. 4.23. Plots of Cheung’s function \( \frac{dV}{d(\ln I)} \) V/s current I.

Fig. 4.24. Plots of Cheung’s function \( H(I) \) V/s current I.

Fig. 4.23 shows the experimental observation of Chung’s function with respect to current of the investigated diode at various temperatures. As shown in graph, the linear region slope is used to calculate the \( R_S \) value. This is observed that the \( R_S \) value dominates the data obtained from downward curvature region and also this is Y-axis interception. While the temperature varies from 120 K – 400 K, the sharpness of linearity is observed. The interception of Y-axis describes ideality factor of Ru/Ti InP
diode. The experimentally found values of $R_S$ and $n$ at 120 K are 89.56 KΩ and 5.03. This decreases with increase in temperature and observed values at 400 K are 19.87 KΩ and 2.03. The observed $n$ value during the entire temperature is more than one. In order to confirm the observed ideality factor by the first case, a plot of $H(I)$ V/s $I$ is shown in Fig. 4.24. The figure gives a straight line at every temperature with Y-interception. In the previous case, Y-interception is due to $nkT/q$ and in this case $n\Phi_b$. This is the second determination of $R_S$ value to verify the stability of Chung’s functions. As shown in Fig. 4.24, the lower plot is at 400 K and upper one is at 120 K. It is observed that the current values are overlapped at the lower field between the temperatures 120 K and 240 K. This is due to the observation of thin section of native oxide layers. This graph also determines the values of both $R_S$ and SBH. The founded values of $R_S$ and SBH at temperature 120 K are 83.13 KΩ and 0.27 eV. A similar situation is also observed in this case is that is $R_S$ is decreased with temperature. The observation is made that the value of $R_S$ falls down to 16.98 KΩ at 400 K. Also, the

<table>
<thead>
<tr>
<th>Temp (K)</th>
<th>Schottky barrier height ($\Phi_b$) eV</th>
<th>Ideality factor ($n$)</th>
<th>Series Resistance ($R_S$) kΩ</th>
</tr>
</thead>
<tbody>
<tr>
<td>I-V</td>
<td>C-V</td>
<td>Cheung’s functions</td>
<td>Norde</td>
</tr>
<tr>
<td></td>
<td>H(I) vs. I</td>
<td>dV/d(lnI) vs. I</td>
<td>dV/d(lnI) vs. I</td>
</tr>
<tr>
<td>---------</td>
<td>-------------------------------------</td>
<td>-----------------------</td>
<td>-----------------------------</td>
</tr>
<tr>
<td>120</td>
<td>0.25</td>
<td>0.27</td>
<td>0.28</td>
</tr>
<tr>
<td>160</td>
<td>0.33</td>
<td>0.34</td>
<td>0.33</td>
</tr>
<tr>
<td>200</td>
<td>0.41</td>
<td>0.42</td>
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<tr>
<td>240</td>
<td>0.48</td>
<td>0.48</td>
<td>0.51</td>
</tr>
<tr>
<td>280</td>
<td>0.55</td>
<td>0.52</td>
<td>0.59</td>
</tr>
<tr>
<td>320</td>
<td>0.62</td>
<td>0.63</td>
<td>0.65</td>
</tr>
<tr>
<td>360</td>
<td>0.68</td>
<td>0.68</td>
<td>0.69</td>
</tr>
<tr>
<td>400</td>
<td>0.74</td>
<td>0.74</td>
<td>0.77</td>
</tr>
</tbody>
</table>
SBH value increases from 0.27 eV to 0.74 eV during the temperature 120 K and 400 K. So, the downward non-linear I-V regions are used to estimate the ideality factor values. This is also different from each other and is due to bias dependence. The SBH is a bias dependent and therefore the voltage drop across the semiconducting layer change the interface state at low voltage region and thus I-V plot describe a better series resistance value.

The SBH and $R_S$ values of the investigated diode are further estimated using Norde’s method. The necessary theory in order to calculate both SBH and $R_S$ values are given in Appendix. The observed minimum Norde’s function $F(V_0)$ is kept at lower value for observed Norde’s function $F(V)$ for all the temperature ranges. A graphical relation between $F(V)$ and the applied voltage $V$ for the present diode at the various temperatures is shown in Fig. 4.25.

![Graph of Norde function F(V) V/s voltage V.](image)

Fig. 4.25. A graph of Norde function $F(V)$ V/s voltage $V$.

The calculated values of $R_S$, between temperature 120 K and 400 K show a fair decrement. That is $R_S$ value decreases from 80.29 KΩ to 20.76 KΩ, while the temperature increases. Similarly, the observed SBH increases from 0.28 eV to 0.77 eV during the same temperature. Thus, the values determined from I-V and Cheung’s methods are closer to this Norde’s method. Also, it reveals the parameters of investigated Schottky contact.
4.3.3 (b) C-V Characteristics

In general, the studies on interface states may not describe the required negative value curvature. The instrument Keithly source was kept at 1 M Hz and 100 mV an ac modulation in the dark along with the frequency. In all cases, the reciprocal square of the capacitance (C\(^{-2}\)) characteristics is nonlinear. This is due to the non-uniform distribution of NSS and presence of deep donor levels. The graphical relation between [C]\(^{-2}\) and bias voltage V is shown in Fig. 4.26.

![Graph showing C\(^{-2}\)-V characteristics](image)

**Fig. 4.26. Reverse bias C\(^{-2}\)-V characteristics.**

The capacitance value of the present diode as a function of applied voltage is expressed [10] as

\[
[C]^2 = \frac{2}{\varepsilon_0 q N_D A^2} \left[ V_{bi} - \frac{kT}{q} - V \right]
\]

where \(\varepsilon_0\) is the absolute dielectric constant and \(N_D\) is the donor concentration. The minimum voltage \(V_0\) is due to the intercept of the graph with the x-axis. Now the built-in potential arise due to \(V_0\) as \(V_{bi} = V_0 + kT/q\). The SBH can also be calculated by built-in potential as \(\phi_b = V_{bi} + V_n\) [92]. This expression is used to calculate the value of donor concentration. However, the donor concentration is a temperature dependent
and this is shown in Fig. 4.27, vary from $3.82 \times 10^{14} \text{ cm}^{-3}$ to $5.97 \times 10^{14} \text{ cm}^{-3}$ when the temperature is raised from 120 K to 400 K. A linear raise of $N_D$ shows that all impurities are chilled out at the low temperature. The results also explain that there is an effective increase in $R_S$ and makes a small measured capacitance. Further, it is observed that increases of capacitance with the increase of $N_D$. The SBH values are calculated at every temperature and it is observed there is slight decrement. The value of SBH at 120 K is 0.95 eV and at 400 K is 0.75 eV. A graphical relation between SBH and ideality factor obtained at various temperature is shown in Fig. 4.28. Both barrier height and ideality factor are shown with respect to temperature. The changes of SBH and $n$ with respect to temperature of the diode are shown in Fig. 4.28. The experimental results confirm that SBH values determined from I-V method found lower values than the C-V values. I-V method gives the values on the basis of TE and C-V gives on the basis of $N_D$. The reasons for the difference in SBHs have explained by many authors [20, 112, 113]. The main reason is due to Non-uniformity of the thickness of interfacial layer. Song et al. [20] explained that the variation in SBHs was also due to interface change distribution. Thus, several reasons are there in order to estimate the value of SBH through I-V and C-V methods. However, the experimental observations make for a uniform nature for these layers. Further, it was observed that

Fig. 4.27. A graph of $N_D$ V/s Temperature.
there was the existence of a native oxide coat at the metal-InP interface. This is also explained by Hacke et al. [112]. The destruction of metal-InP layer somewhat disturbs the I-V method and due to this, SBH values are affected [113]. We know that imperfections behave as recombination contacts for tunneling current. In general, there will be no dislocations or pinholes in case of C-V measurements. Hence, the determined SBH is considered more reliable. However the interface defects can alter the depletion width due to space charge region. Fig. 4.29 shows the plotting of the values of $R_S$ estimated from both Cheung’s and Norde’s methods. The $R_S$ values calculated from the Cheung’s and Norde’s functions are estimated with respective temperature. This gives the decreasing of $R_S$ values with an increase in temperature. This is due to increasing the ideality factor and free carrier concentration. However, it is observed that $R_S$ may decrease at low temperature rise only [114].
Fig. 4.29. Series resistance variation at different temperatures.

In the case of reverse bias, Poole-Frankel and Schottky emission explains the reverse saturation current. This is also an electric field dependent. The carrier transport happens by means of trap states when an electric field is applied across the metal layer in Poole-Frankel emission. In the case of Schottky emission, the carrier emits the thermal energy across potential barrier whatever so absorbs at the metal-InP interface. The reverse current $I_R$ due to saturation current $I_0$ when the current is controlled by Poole-Frankel emission is given \[4.24\]

\[
I_R = I_0 \exp\left(\frac{\beta_{PF} KT}{E^{1/2}}\right)
\]

For the Schottky effect \[4.25\]

\[
I_R = AA^* T^2 \exp\left(\frac{\beta_{SE} KT}{E^{1/2}}\right)
\]

where $\beta_{PF}$ and $\beta_{SE}$ represents the field-lowering coefficients of Poole-Frenkel and Schottky. Theoretically these values are founded by \[4.26\]

\[
2 \beta_{SE} = \beta_{PF} = \left(\frac{q^3}{\pi e}\right)^{1/2}
\]

and the values of $\beta_{PF}$ and $\beta_{SE}$ are $\beta_{PF} = 2.26 \times 10^{-5}$ eV/m$^{1/2}$V$^{-1/2}$ and $\beta_{SE} = 1.13 \times 10^{-5}$ eV/m$^{1/2}$V$^{-1/2}$. It finds that $\beta_{PF}$ is greater than to that of $\beta_{SE}$ value. The theoretical coefficients of both Poole-Frankel and Schottky can understand while studying the
relation between logarithm of $I_R$ V/s $E^{1/2}$ of present contacts. A graph of $\ln(I_R)$ V/s $E^{1/2}$ is represented the Fig. 4.30 at various temperatures. As shown in figure lower one is

![Graph of $\ln(I_R)$ against $E^{1/2}$](image)

**Fig. 4.30. A graph of $\ln(I_R)$ against $E^{1/2}$.**

at 400 K and upper one is at 120 K temperature. The estimated slopes from the data of investigated diode are $2.08 \times 10^{-5}$ for 120 K, $2.63 \times 10^{-5}$ for 160 K, $2.75 \times 10^{-5}$ for 200 K, $3.14 \times 10^{-5}$ for 240 K, $3.08 \times 10^{-5}$ for 280 K, $3.15 \times 10^{-5}$ for 320 K, and $1.63 \times 10^{-5}$ for 360 K and $1.59 \times 10^{-5}$ eV/m$^{1/2}$V$^{-1/2}$ for 400 K. The slopes corresponding to the temperature between 120 K and 320 K are nearer to the $\beta_{PF}$ value and the slopes at 360 K and 400 K temperature are nearer to $\beta_{SE}$ value. It is found that the current $I_0$ is influenced by Poole-Frankel emission when the temperature is between 120 K and 320 K, where as $I_0$ is influenced by Schottky emission at 360 K and 400 K temperature.

4.3.3 (c) **Determination of Interface States Density ($N_{SS}$)**

The interfacial layer between metal and semiconductor produce a non-linear ideality factor, $n$. This is at the more current region and causes due to interface states $N_{SS}$, as well as series resistance, $R_S$. So, the estimation of SBH, $n$ and $R_S$ are at the
semiconductor rectifying contact and the role of interface states is important. Card and Rhoderick [74] suggested that the $n$ value at MS contact is more than one and $N_{SS}$ is determined as

$$N_{SS}(V) = \frac{1}{q} \left[ \frac{\varepsilon_i}{\varepsilon_s} (n(V) - 1) - \frac{\varepsilon_s V}{W_d} \right]$$  \hspace{1cm} 4.27$$

where $\varepsilon_i$ = permittivity of the interfacial layer = $3.50\varepsilon_0$

and $\varepsilon_s$ = permittivity of the semiconductor = $9.40\varepsilon_0$.

Also, in the case of InP, the semiconducting interface states with respect to conduction band is represented [116] as

$$E_C - E_{SS} = q\phi_b - V$$  \hspace{1cm} 4.28$$

The $N_{SS}$ due to density distribution curves are estimated from I-V curves. The values of $N_{SS}$ are obtained with respect to $E_{SS}$. A plot of $N_{SS}$ V/s $E_C-E_{SS}$ of the present diode is shown in the Fig. 4.31. It is observed that the forward $N_{SS}$ value is purely

![Graph](image_url)

**Fig. 4.31.** A graph of $N_{SS}$ V/s $E_C-E_{SS}$ for Schottky diode Ru/Ti/n-InP.
temperature dependent. Also, $N_{SS}$ is an exponential increase from the mid gap with respect to conduction band. The estimated $N_{SS}$ value rapidly decreases from $6.74 \times 10^{13} \text{ eV}^{-1} \text{ cm}^{-2}$ to $1.08 \times 10^{13} \text{ eV}^{-1} \text{ cm}^{-2}$ at 120 K temperature. Lastly, the same $N_{SS}$ value increases from $1.68 \times 10^{13} \text{ eV}^{-1} \text{ cm}^{-2}$ to $5.03 \times 10^{13} \text{ eV}^{-1} \text{ cm}^{-2}$ at 400 K temperature. This is because of the change of ideality factor and inhomogeneity of SBH at MS interface and the same is also explained by Akkal [117]. Thus, the temperature effect on molecular restructuring may result in decrease of $N_{SS}$ with increase in temperature. As explained in the chapter 1.10, the interface state energy distribution varies with bias only. Hence, $N_{SS}$ changes the diffusion potential and observed capacitance [10, 82, 118]. So, $N_{SS}$ value between the metal-InP is key role in order to estimate the parameters of SBD. It is also observed that Fermi level pinning is briefly discussed and thus this move towards conduction band edge. The motivation of this work precisely reached with the all parameters induced the laps of considerable layer formation due to evaporation.