Thermal Noise Behavior In Single Injection Solid State Diode With Distributed Shallow Traps

S.A.Bhardwaj[1]

Department of physics ,Bharati Vidyapeeth College of Engineering Pune-412115,India

Abstract: -. The defects structures of the insulating material are generally studied with the help of the current injection technique. A metal and insulator are used to fabricate the ohmic contact for the process of carrier injection in insulator where the significant concentration of trapping states is present according to the trap distribution function. The high field electrical transport properties and thermal noise behavior of the insulating material is greatly affected by the impurities and defect states .The change of injection level of currents occurs with the change in applied voltage across the insulator. The scattering process of the currents carriers with the lattice imperfections of the is responsible for the thermal noise generated inside the sample. It is a main source of noise caused by the scattering process to give fluctuations in current and voltage across the terminals of the insulator. The thermal noise affects greatly the sensitivity and accuracy of the injection device The complete thermal noise characteristic has sufficient structure which is drastically affected by the distributed traps.

Keywords: - *defect stats, distributed traps, Electrical Transport, Ohmic contact, Salami method,*

I. INTRODUCTION

. The high field mobility relationship is considered for the high field transport mechanism present inside the insulator .The poisson's equation has several physical parameters which give the complexties in the solutions of the problem.The regional approximation method is applied to obtain the approximate solutions on the basis of the previous procedure .The results of the current injection portion are used for the thermal noise expressions.In the later part of the paper ,the noise resistance and the spectral intensity of voltage fluctuations are used to obtain the analytical expressions for the thermal noise in the full variation of applied voltage .The salami method is used for the thermal noise calculations.The several new results are obtained for the practical applications of the high field injection devices operating under single injection mode.

The general equations characterizing the current flow and poisson's law for high field space-charge –limited single injection current flow in insulator with distributed shallow traps are given by

$$J = e\mu(E)n(x)E(x) \quad .. \ (1)$$

$$\frac{dE}{dx} = (n - n_0) + (n_t - n_{t,0}) \quad .. \ (2)$$

$$N_E = N_O \frac{exp\,[E - E_t]/kT}{\{exp\ [(E - E_t)/kT_t] + 1\}^2} \quad .. \ (3)$$

Where, N_E is the density of states per unit energy range ,E is the energy ,N_0 is the number of trapping states at energy level E_t , E_t is the energy of the maximum of trap distribution ,T_t is the characteristic temperature and it is constant of the trap distribution .The equation (3) represents a sharp distribution for T$\leq T_t$ and it designates a diffuse of traps in energy for T_t is greater than T.

II. REGIONAL APPROXIMATION SCHEME

III. At appropriate injection level of currents, the insulator is divided into four separate regions with the help of imaginary transition planes as where the regional approximation method is applied to the given problem.the three regions are described as

:Region-I $(0 \le x \le x_1)$: $n(x) >> n_t >> n_0$ perfect insulator region

$$J = e\mu_o n(x)[E_c E(x)]^{1/2} \quad ... \ (4)$$

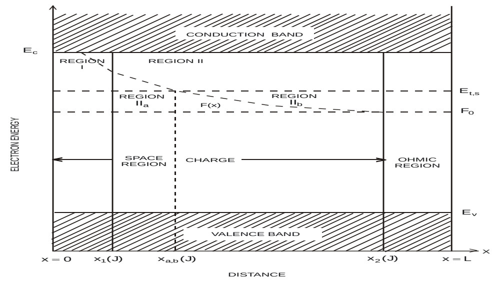

FIG 2.2 : SCHEMATIC ENERGY BAND DIAGRAM FOR THE CURRENT INJECTION INTO AN INSULATOR WITH SHALLOW TRAPS AT HIGH FIELDS

$$\frac{\in}{e}\frac{dE}{dx} = n \qquad \text{... (5)}$$

$$n(x_1) = n_t(x_1) = N_T \qquad \text{... (6)}$$

Region-II $(x_1 \le x \le x_2)$: $n_t(x) >> n(x) >> n_0$, Trapped charge region

$$J = e\mu_o n(x)[E_c E(x)]^{1/2}, \qquad \text{...(7)}$$

$$\frac{\in}{e}\frac{dE}{dx} = n_t(x), \qquad \text{... (8)}$$

$$n(x_2) = n_o \qquad \text{... (9)}$$

Region-III $(x_2 \le x \le L)$ $n_o >> n(x)$, Ohmic region

$$J = e\mu_o n_o[E_{C.}E(x)]^{1/2}, \qquad \text{... (10)}$$

$$\frac{\in}{e}\frac{dE}{dx} = 0, \qquad \text{...(11)}$$

Where L is the device length.The continuity of the field strength is valid through out the insulator. It is given at the two imaginary transition planes as

$$\mathrm{E}(x_1^-) = \mathrm{E}(x_1^+)\ , \qquad \mathrm{E}(x_2^-) = \mathrm{E}(x_2^+), \qquad \text{... (12)}$$

where the electric field strength E(x_1^-) and E(x_2^-) are the values when the imaginary transition planes x_1 and x_2 approach from the left and E(x_1^+) and E(x_2^+) are the field strength approach to the imaginary transition planes x_1 and x_2 from the right side. The imaginary transition plane divides the region-II into two sub-regions aThree sets of the critical currents and critical voltages are present in the complete current-voltage characteristic of the insulator. These critical values are defined as

$$x_2(J_{cr,1}) = L\ ,\ x_{a,b}(J_{cr,ab}) = L,$$

$$x_1(J_{cr,2}) = L\ ,$$

$$x_2(V_{cr,1}) = L, \quad x_{a,b}(V_{cr,ab}) = L\ ,\ x_1(V_{cr,2}) = L$$

$$n_t(x) = N_o \int_{F_O}^{F} \frac{\exp[(E-E_t)/kT_t]dE}{\{\exp[(E-E_t)/kT_t]+1\}^2}, \qquad \text{..(13)}$$

$$= N_T\left[\frac{1}{(n_o/N)^{1/l}+1} - \frac{1}{[n(x)/N]^{1/l}+1}\right], \qquad \text{..(14)}$$

$$n_o = N_c \exp[(F_o - E_c)/kT] \qquad \text{..(15)}$$

$$N = N_c \exp[(E_t - E_c)/kT] \qquad \text{..(16)}$$

And, $l = \frac{T_t}{T}$.

where, n(x) = $N\exp[\{F(x) - E_c\}/kT]$,

III ELECTRIC FIELD DISTRIBUTION AND CRITICAL PARAMETERS

The distribution of the electric field strength is derived with the help of general equations of different regions as given below: which are very slowly varying functions of the current because they depend on of the factor $J^{2/3}$. The distance of imaginary transition plane from the cathode is derived

$$x_1 = \left[\frac{2 \in J^2}{3e^3 \mu_o^2 E_c N_T^3}\right], \quad ...(17)$$

$$N_T >> N \quad x_{a,b} = \frac{\in J^2}{e^3 \mu_o^2 N^2 N_T E_c}, \quad ...(18)$$

$$x_2 = \left(\frac{2l}{2l+1}\right)\left[\frac{\in J^2}{e^3 \mu_o^2 n_o^2 B^{1/l} E_c N_T}\right], \quad ...(19)$$

$$J_{cr,1} = \left\{\left(\frac{2l+1}{2l}\right)\frac{e^3 \mu_o^2 n_o^2 E_c N_T L B^{1/l}}{\in}\right\}^{1/2}, \quad ...(20)$$

$$J_{cr,2} = \left[\frac{3e^3 \mu_o^2 N_T^3 E_c L}{2 \in}\right]^{1/2}, \quad ...(21)$$

$$J_{cr,ab} = \left[\frac{e^3 \mu_o^2 n_o^2 N_T E_c L}{\in B^2}\right]^{1/2}, \quad ...(22)$$

which shows that the imaginary transition plane is shifted rapidly towards the anode with the increase of injection level of currents. The applied voltage across the different regions present inside the insulator is drived with the help of the electric field strength .the voltage across the region I derived from the equations

$$V_1 = \int_0^{x_1} E(x)\, dx = \frac{3}{5}\left(\frac{3J}{2 \in \mu_0 E_c^{1/2}}\right)^{2/3} x_1^{5/3}$$

$$= \frac{2 \in J^4}{5e^5 \mu_o^4 E_c^2 N_T^5}$$

$$V_{cr,ab} = \frac{e N_T L^2}{2 \in}. \quad ...(23)$$

$$= \frac{\in J^4}{2e^5 \mu_o^4 E_c^2 N^4 N_T}, \quad ...(24)$$

$$V_{cr,1} = \frac{(2l+1)^2}{2l(4l+1)} \frac{e N_T L^2}{\in} B^{[3/(2l+1)]} \quad ..(25)$$

$$V_{cr,2} = \frac{9 e N_T L^2}{10 \in} \quad ......(26)$$

The critical voltage corresponds to the critical current when the imaginary transition plane approaches to the anode.

The complete thermal noise characteristic of steady state space-charge-limited current flow in insulator with distributed shallow traps at high fields is estimated in the full variation of applied voltage as describe.

3.1Thermal Noise in True Ohm's Regime $(J \ll J_{cr,1})$

In the starting of the complete thermal noise characteristic of the insulator, the injection level of current is very low and the entire insulator has very small amount of injected free carriers. It gives only the region III situated inside the insulator because the contributions of other regions are negligibly small. The thermal noise is contributed by the scattering of thermal free carriers which is the main source for the current and voltage fluctuations. The other regions contribute negligible amount because the imaginary transition planes are very close to cathode . The random fluctuations caused by the other current carriers are negligibly small. The noise resistance of small sections of the insulator operating under true Ohm's regime at high fields as $\Delta R = \frac{J \Delta x}{e^2 \mu_o^2 n_o^2 E_c A}$. ... (27)

$$= \frac{JL}{e^2 \mu_o^2 n_o^2 E_c A}, \quad ...(28)$$

$$S_{v_t}(f) = 4kTR_{\Omega} = \frac{4kTJL}{e^2 \mu_o^2 n_o^2 E_c A}, \quad ...(29)$$

which depends on the injection level of currents. The mean square noise emf of this regime is evaluated from the equation in terms of the physical parameters as

$$\overline{v_t} = \sqrt{4kTR_{\Omega}\Delta f} = \left[\frac{4kTJL}{e^2 \mu_o^2 n_o^2 E_c A}\right]^{1/2}. \quad ...(30)$$

The injected space charge increases sufficiently to compensate the ohmic conduction inside the insulator. As a matter of fact, the true Ohm's regime is terminated gradually from the insulator. There is no fixed hallmark for this situation.

3.2 Thermal Noise in Ohmic Regime $(J < J_{cr,1})$

The four regions contribute to the total noise resistance of the insulator operating under high field regime. The results derived in the current injection portion of the problem are applied to calculate the thermal noise of this regime. The noise resistance of different regions is calculated as described below:

$$R_O = R_I + R_{IIa} + R_{IIb} + R_{III} \quad ..(31)$$

$$= \frac{2}{5}\frac{\in J^3}{e^5 \mu_o^4 E_c^2 N_T^5 A} + \frac{\in J^3}{2e^5 \mu_o^4 E_c^2 N^4 N_T A} +$$

$$\frac{2l}{(4l+1)}\left(\frac{\in J^3}{e^5 \mu_o^4 E_c^2 N^4 N_T A}\right)\left[\left\{\frac{1}{B^{[(2l+1)/l]}} - \frac{1}{2l}\right\}^{[(4l+1)/(2l+1)]} - 1\right] +$$

$$\left(\frac{J}{e^2 \mu_o^2 n_o^2 E_c A}\right)\left[L - \left(\frac{2l}{2l+1}\right)\frac{\in J^2 B^{-1/l}}{e^3 \mu_o^2 n_o^2 E_c N_T}\right]$$

$$a_1 = \frac{\in}{e^5 \mu_0^4 E_c^2 A}\left[\frac{2}{5N_T} + \frac{1}{2N^4 N_T} - \left(\frac{2l}{2l+1}\right)\frac{B^{-1/l}}{n_o^4 N_T} + \right.$$

$$\left.\left(\frac{2l}{2l+1}\right)\frac{1}{N^4 N_T}\left\{\left(B^{[-(2l+1)/l]} - \frac{1}{2l} \right)^{[(4l+1)/(2l+1)]} - 1 \right\}\right] \quad .(32)$$

The ohmic noise regime is terminated at the first critical current , first critical voltage and first critical noise resistance at which the imaginary transition plane approaches to the anode and the region III disappears from the insulator. The contribution of ohmic conduction mechanism to the total thermal noise is reduced greatly at the first critical current and the entire insulator operates under the space charge conditions.

3.3 Thermal Noise at First Critical Current $(J = J_{cr,1})$

The first critical noise resistance is observed in the $R_{cr,1}$ insulator when the applied voltage across the insulator is equal to the first critical voltage $V_{cr,1}$ The expression for the first critical resistance $R_{cr,1}$ is evaluated from the equations

$$R_{cr,1} = \frac{V_{cr,1}}{I_{cr,1}} = \frac{V_{cr,1}}{J_{cr,1}A}$$

$$= \frac{1}{A}\left\{\frac{(2l+1)^3}{2l(4l+1)^2}\frac{N_T^3 L^3 B^{[(4l-1)/l(2l+1)]}}{e \in \mu_o^2 n_o^2 E_c}\right\}^{1/2} \quad ...(33)$$

$$\bar{v}_{cr,1} = \sqrt{S_v(f)_{cr,1}\Delta f}$$

$$= \sqrt{4kTR_{cr,1}\Delta f} = \sqrt{\frac{4kT}{A}\left\{\frac{(2l+1)^3}{2l(4l+1)^2}\frac{N_T L^3 B^{[(4l-1)/l(2l+1)]}}{e \in \mu_o^2 n_o^2 E_c}\right\}^{1/2}\Delta f}$$

$$[S_v(f)]_{Cr,1} = 4kTR_{cr,1}$$

$$= \frac{4kT}{A}\left\{\frac{(2l+1)^3}{2l(4l+1^2)}\frac{N_T L^3 B^{[(4l-1)/(2l+1)]}}{e \in \mu_o^2 n_o^2 E_c}\right\}^{1/2} \quad ..$$

(34)

The total noise resistance of the insulator in the shallow trap regime

$$R_{ST} = R_I + R_{II\,a} + R_{II\,b} \quad ..(36)$$

$$= \frac{2}{5}\frac{\in J^3}{e^5 \mu_o^4 E_c^2 N_T^5 A} + \frac{\in J^3}{2e^5 \mu_o^4 E_c^2 N^4 N_T A} +$$

$$\frac{2l}{(4l+1)}\left(\frac{\in J^3}{e^5 \mu_o^4 E_c^2 N^4 N_T A}\right)\left[\left\{\left(\frac{2l+1}{2l}\right)\frac{e^3 \mu_o^2 N^2 E_c N_T L}{\in J^2} - \frac{1}{2l}\right\}^{[(4l+1)/(2l+1)]} - 1\right]$$

$$R_{ST} = a_2 J^3 + b_2 J^3\left[\left(\frac{c_2}{J^2} - d_2\right)^{[(4l+1)/2l+1)]} - 1\right] \quad ..(37)$$

3.4 Thermal Noise in Shallow Trap Regime $(J_{cr,a} < J < J_{cr,ab})$

The thermal noise mechanism for the shallow trap regime of insulator at high fields is affected by the concentration of the excess charge and trapped carriers. The random fluctuations are reduced with the increase of space charge and trapped carriers. The contribution by the ohmic conduction to the total thermal noise in the sample is negligibly small. Because, the region III is absent from the insulator. The equation may be written in a convenient form as

$$R_{IIb} = \frac{1}{JA}\left[\frac{J}{e\mu_o E_c^{1/2} N}\right]^{[2/(2l+1)]} \int_{x_{ab}}^{L}\left[\left(\frac{2l+1}{2l}\right)\frac{eN_T x}{\in} - \frac{1}{2l}\left(\frac{J^2}{e^2 \mu_o^2 N E_c}\right)\right]^{[2l/(2l+1)]} dx \quad ..(35)$$

$$a_2 = \frac{\in}{e^5 \mu_o^4 E_c^2 N_t A}\left[\frac{2}{5N_T^4} + \frac{1}{2N^4}\right] \qquad b_2 = \left(\frac{2l}{4l+1}\right)\frac{\in}{e^5 \mu_o^4 E_c^2 N_T N^4 A} \qquad c_2 = \left(\frac{2l+1}{2l}\right)\frac{e^3 \mu_o^2 N^2 E_C N_T L}{\in},$$

$$d_2 = \frac{1}{2l}, \quad .(38)$$

which represent that the presence of trapping states influence greatly the thermal noise generated in the shallow trap regime and it is done mainly by the physical parameter N_T and ***l***.The spectral intensity of voltage fluctuations of the steady state space-charge-limited single injection current flow in insulator with distributed shallow traps operating under shallow trap regime at high fields is given by

$$\bullet S_{v_{ST}}(f) = 4kT\,R_{ST}$$

$$= 4kT\left[a_2 J^3 + b_2 J^3 \left\{\frac{c_2}{J^2} - d_2\right\}^{[(4l+1)/(2l+1)]}\right]^{1/2} \quad \ldots (40)$$

$$= 4kT\left[a_2 J^3 + b_2 J^3 \left\{\frac{c_2}{J^2} - d_2\right\}^{[(4l+1)/(2l+1)]} - 1\right]$$

$$v_{ST} = \sqrt{S_{v_{ST}}(f)\Delta f} \quad \ldots (39)$$

$$= \sqrt{4kTR_{ST}\Delta f}$$

The shallow trap noise regime is greatly affected by the distributed shallow traps and this effect is present in the thermal noise expression in the form of the characteristic parameter *l* of the distributed trapping states. This regime is terminated from the insulator at the middle critical current.

3.5 Thermal Noise at Middle Critical Current $(J = J_{cr,ab})$

The imaginary transition plane approaches to the anode for the sufficient increase of injection level of currents. The only two regions are present inside the insulator to influence the current flow and thermal noise. Corresponding to the critical current and critical voltage the critical noise resistance is derived from the equation as

$$R_{cr,ab} = [R_I + R_{IIa}]_{at\ J = J_{cr,ab}} \quad ..(41)$$

$$[R_{IIa}]_{at\ J=J_{cr,ab}} = \frac{1}{AJ_{cr,ab}}\left[\frac{eN_T}{2\in}\left(L^2 - \frac{4n_o^4 L^2}{9N_T^4 B^4}\right) + \frac{J^2{}_{cr,ab}}{3e^2 \mu_o^2 N^2 E_c}(L - x_1)\right]$$

The spectral intensity of voltage fluctuations and mean square noise emf of the trap -filled- limit regime of the insulator at high fielda as

$$= 4kT\left(a_3 J^3 + b_3 J + \frac{C_3}{J}\right), \quad \ldots (47) \quad \bar{v}_{TFL} = \sqrt{4kTR_{TFL}\Delta f}$$

$$= \left\{\left[4kT\left(a_3 J^3 + b_3 J + \frac{c_3}{J}\right)\Delta f\right]\right\}^{1/2}, \quad \ldots (48)$$

.

$$\boldsymbol{R_{cr,ab} = \frac{eN_T L^2}{2 \in J_{cr,ab} A}} \quad ..(42)$$

The critical spectral intensity of voltage fluctuations and the mean square noise emf at the critical current are evaluated from the equations

$$\left[S_{v_{cr,ab}}(f)\right] = 4kTR_{cr,ab} = \frac{2kTeN_T L^2}{2 \in J_{cr,ab} A} \quad \ldots (43) \qquad \bar{v}_{cr,ab} = \sqrt{4kTR_{cr,ab}\Delta f} = \sqrt{\frac{2kTeN_T L^2}{\in J_{cr,ab} A}} \quad \ldots (44)$$

the shallow trap regime is terminated from the insulator at the critical current.

3.6 Thermal Noise in Trap-Filled-Limit Regime $(J_{cr,ab} < J < J_{cr,2})$

The imaginary transition plane is sufficiently away from the electrodes. The space charge and trapping effects are present to influence the thermal noise mechanism of this regime in which the trapping states are gradually filled with electrons with the increase of injection level of currents. The total noise resistance of the steady state space-charge-limited single injection current flow in insulator with distributed shallow traps operating under trap-filled-limit regime at high fields is given by

$$R_{TFL} = R_I + R_{IIa} \quad ..(45)$$

$$= \frac{2 \in J^3}{5e^5 \mu_o^4 E_c^2 N_T^5 A} + R_{IIa}$$

$$R_{TFL} = \frac{2}{45} \frac{\in J^3}{e^5 \mu_o^4 E_c^2 N_T^5 A} + \frac{JL}{3e^2 \mu_o^2 N_T^2 E_c A} + \frac{eN_T L^2}{2 \in JA}$$

Which may also be written in the following convenientfor

$$R_{II\,a} = a_3 J^3 + b_3 J + \frac{C_3}{J}, \quad ..(46)$$

$$a_3 = -\frac{2}{45} \frac{\in}{e^5 \mu_o^4 E_c^2 N_T^5 A}, \quad b_3 = \frac{L}{3e^2 \mu_o^2 N_T^2 E_c A}, \quad C_3 = \frac{e N_T L^2}{2 \in A}.$$

3.7 Thermal Noise at the Second Critical Current $(J = J_{cr,2})$

All the trapping states of the insulator are completely filled with electrons at the second critical current and second critical voltage .This is the second critical point on the complete thermal noise characteristic at which the second critical noise resistance is derived from the equation with as

$$R_{cr2} = \frac{3}{5} \frac{1}{J_{cr,2} A} \left(\frac{3}{2} \frac{J_{cr,2}}{\in \mu_o E_c^{1/2}} \right)^{2/3} L^{5/3}$$

$$= \left\{ \frac{27}{50} \frac{L^3}{\in e\mu_o^2 N_T E_c A^2} \right\}^{1/2} \quad ... (49)$$

$$\left[S_{v_{cr,2}}(f) \right] = 4kTR_{cr,2}$$

$$= 4kT \left\{ \frac{27L^3}{50 \in e\mu_o^2 N_T E_c A} \right\}^{1/2}$$

$$\bar{v}_{cr,2} = \sqrt{4kTR_{cr,2} \Delta f}$$

$$= \left[4kT \left\{ \frac{27L^3}{50e \in \mu_0^2 N_T E_c A^2} \right\}^{1/2} \Delta f \right]^{1/2} \quad ... (50)$$

which are constants of the injection device at high fields and the trap-filled-limit regime is terminated from the insulator at . $J = J_{cr,2}$

3.8 Thermal Noise in the Trap-Free Regime $(J > J_{cr,2})$

All the trapping states are filled with electrons with the onset of the trap-free regime inside the insulator. It occurs at sufficiently high injection level of currents and the region I is only present in the insulator. The injected space charge is dominant in this regime and the space charge noise suppression effects are observed throughout the trap-free regime. The expression for the noise resistance of the steady state space -charge- limited single injection current flow in insulator with distributed shallow traps operating under trap-free regime at high fields as

$$R_{cr2} = \frac{3}{5} \frac{1}{J_{cr,2} A} \left(\frac{3}{2} \frac{J_{cr,2}}{\in \mu_o E_c^{1/2}} \right)^{2/3} L^{5/3}$$

$$= \left\{ \frac{27}{50} \frac{L^3}{\in e\mu_o^2 N_T E_c A^2} \right\}^{1/2}$$

$$a_4 = \frac{3}{5} \left(\frac{3}{2} \frac{1}{\in \mu_o E_c^{1/2}} \right)^{2/3} \frac{L^{5/3}}{A} \quad ,$$

where

The equation represents that the thermal noise is inversely proportional to the current density passing through the sample and the presence of space charge suppresses.The spectral intensity of voltage fluctuations and mean square noise emf of thetrap-free regime at high fields are derived from the equation

$$\left[S_{v_S}(f) \right] = 4kTR_s = 4kT \frac{a_4}{J^{1/3}} \quad , \quad ... \quad (51)$$

$$\bar{v}_s = \sqrt{4kTR_s \Delta f} = \left[4kT \frac{a_4}{J^{2/3}} \Delta f \right]^{1/2} \quad , \quad ...(52)$$

t

he thermal noise is suppressed very slowly with the increase of injection level of currents throughout the trap-free regime of the insulator with distributed shallow traps at high fields.

IV. DISCUSSION AND CONCLUSIONS

The present paper is devoted for the high field transport and thermal noise behaviour of the steady state space - charge- limited single injection current flow in insulator with distributed shallow traps. The current injection and thermal noise portions are developed with the help of the regional approximation and salami methods. The results of current injection portion are applied to the thermal noise calculations in the complete current-voltage characteristic which is divided into eight situations of the current-voltage regime which are well characterized by the corresponding physical conditions of the insulator. These conditions depend mainly on the injection level of currents. The entire high field transport of the insulator with the variation of the full applied voltage is the admixture of the effects of space charge, trapping and ohmic conductions.

The present problem is more generalized due to the fact that a wide range of the distributed shallow traps is considered to influence the high field conduction mechanism. The boundary conditions for the current injection are usual as considered in several problems.The trapping effects depend mainly on the physical parameter l which is characterized the trap distribution and the thermal noise behaviour is affected mainly in the middle span of the complete thermal noise characteristic.The regional approximation method is used to the current injection problem which is divided into five current-voltage regimes as given below:

a. Pure Ohm's law regime ,
b. Ohmic regime
c. Shallow trap regime,
d. Trap-filled-limit regime and
e. Space-charge-limited trap-free regime.

The thermal noise expressions of the current injection problem at high fields are evaluated in terms of the noise resistance, spectral intensity of voltage fluctuations and mean square noise emf of the single injection current flow in insulator with distributed shallow traps at high fields. The complete thermal noise characteristic is mainly affected by the distributed shallow traps and the high field mobility regime. The scattering of the current carriers with the lattice provides the main source of thermal noise which is generally present in all parts of the insulator at all injection level of currents operating under high field regime. The different physical parameters dominate in the different regions of the insulator at different injection of level of currents. The thermal noise studies give the important results mainly at high injection level of currents. The thermal noise is suppressed slowly and gradually in the perfect trap-free regime due to the sufficient increase of injected space charge which dominates over the trapping and ohmic effects. There is a high suppression effect of the space charge in the trap-free regime. The single injection devices derived from the insulator operating under high field regime have practical utility mainly in the space charge mode. The thermal noise suppression effect is observed through the analytical expressions of the injection problem under high field effects. Therefore, it may be concluded by the present study that the thermal noise in insulator with distributed shallow traps at high field is significantly dependent on the effects of the high field carrier mobility, thermal free carriers, trapping states, distribution of traps and injected space charge.

REFERENCES

1.Anders, Adnre and Olos, Efim., J. Appl. Phy. 99, 103301 (2006).

2.Burgess,R.E (ED),Fluctuation phenomena in solids,Academic press,New York (1965)

3.Chui,Talso and penanen ,konstanin ,phy.Rev.B71 132509 (2005)

4.Dascalu,d.,solid state Electronics 11491 (1968)

5.Harper , W.R,contact and Frictional Electrification , Oxford university Press (Oxford) 1967.

6.State -Concepts and Devices"(R.W. Pryor, B.B.Schwartz, S.R.Ovshinsky,Ed)pp.7-9York,NY,U.S.A,plenum(1988).

7.Lanyon, H.P.D., Phys. Rev.130, 134 (1963).

8.Lampert, M. A., and Rose, A., and Smith, R.W., J. Phys. Chem. Solids 8, 464 (1959).

9.Kao, K.C. and Hwang, W., Electrical Transport in Solids, Pergamon Press, New York (1981).

10.Moskalets,M. AND Buttiker,M.,phy.Rev.,B73245305 (2004).

IV. INDENTATIONS AND EQUATIONS

The first paragraph under each heading or subheading should be flush left, and subsequent paragraphs should have a five-space indentation. A colon is inserted before an equation is presented, but there is no punctuation following the equation. All equations are numbered and referred to in the text solely by a number enclosed in a round bracket (i.e., (3) reads as "equation 3"). Ensure that any miscellaneous numbering system you use in your paper cannot be confused with a reference [4] or an equation (3) designation.

V. FIGURES AND TABLES

To ensure a high-quality product, diagrams and lettering MUST be either computer-drafted or drawn using India ink.

Figure captions appear below the figure, are flush left, and are in lower case letters. When referring to a figure in the body of the text, the abbreviation "Fig." is used. Figures should be numbered in the order they appear in the text.

Table captions appear centered above the table in upper and lower case letters. When referring to a table in the text, no abbreviation is used and "Table" is capitalized.

VI. CONCLUSION

A conclusion section must be included and should indicate clearly the advantages, limitations, and possible applications of the paper. Although a conclusion may review the main points of the paper, do not replicate the abstract as the conclusion. A conclusion might elaborate on the importance of the work or suggest applications and extensions.

VII. ACKNOWLEDGEMENTS

An acknowledgement section may be presented after the conclusion, if desired.

REFERENCES

This heading is not assigned a number.

A reference list **MUST** be included using the following information as a guide. Only *cited* text references are included. Each reference is referred to in the text by a number enclosed in a square bracket (i.e., [3]). References **must be numbered and ordered according to where they are first mentioned in the paper,** NOT alphabetically.

Examples follow:

Journal Papers:

[1] M Ozaki, Y. Adachi, Y. Iwahori, and N. Ishii, Application of fuzzy theory to writer recognition of Chinese characters, *IOSR Journal of Engineering, 2(2),* 2012, 112-116.

Note that the journal title, volume number and issue number are set in italics.

Books:

[2] R.E. Moore, *Interval analysis* (Englewood Cliffs, NJ: Prentice-Hall, 1966).

Note that the title of the book is in lower case letters and italicized. There is no comma following the title. Place of publication and publisher are given.

Chapters in Books:

[3] P.O. Bishop, Neurophysiology of binocular vision, in J.Houseman (Ed.), *Handbook of physiology*, 4 (New York: Springer-Verlag, 1970) 342-366.

Note that the place of publication, publisher, and year of publication are enclosed in brackets. Editor of book is listed before book title.

Theses:

[4] D.S. Chan, *Theory and implementation of multidimensional discrete systems for signal processing*, doctoral diss., Massachusetts Institute of Technology, Cambridge, MA, 1978.

Note that thesis title is set in italics and the university that granted the degree is listed along with location information

Proceedings Papers:

[5] W.J. Book, Modelling design and control of flexible manipulator arms: A tutorial review, *Proc. 29th IEEE Conf. on Decision and Control*, San Francisco, CA, 1990, 500-506.

Note that the proceedings title is set in italic

Send your Manuscript to jen@iosrmail.org
for further peer review process.