Electronic Supplementary Information

Ni(II) and Zn(II)-metallogels based anti-bacterial scaffolds for fabricating light-responsive junction type semiconducting diodes with non-ohmic conduction mechanism

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1. Gelation ability test of different metal salts with the sebacic acid.

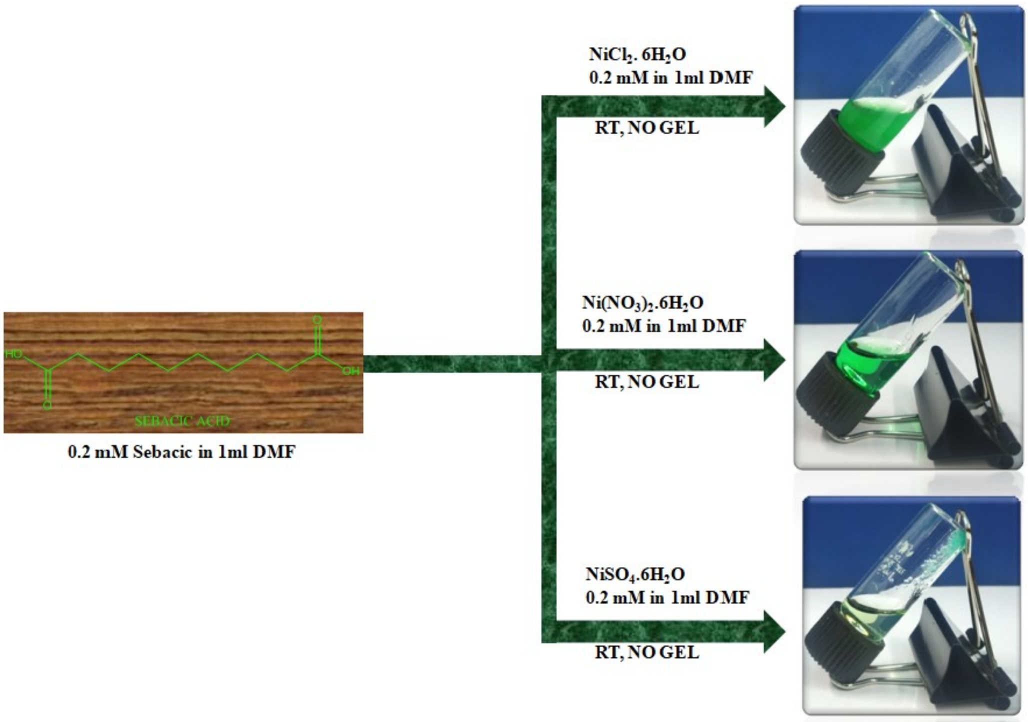

Fig. S1. Gelation ability of different metal salts like Ni(II) chloride hexahydrate, Ni(II) nitrate hexahydrate and Ni(II) sulphate hexahydrate with the sebacic acid in DMF solvent medium.

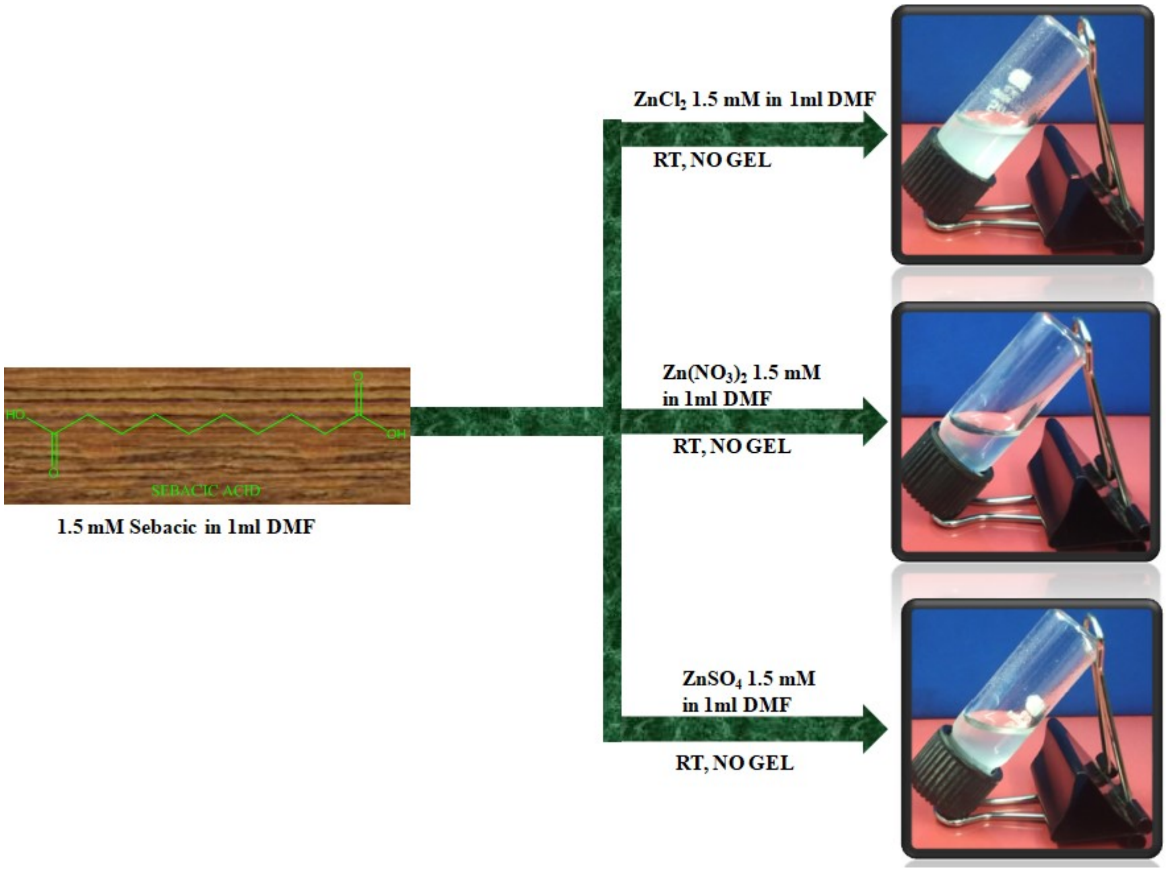

Fig. S2. Gelation ability of different metal salts like Zn(II) chloride, Zn(II) nitrate hexahydrate and Zn(II) sulphate heptahydrate with the sebacic acid in DMF solvent medium.

2. Minimum Critical Gelation Concentration (MCG) of the Synthesized Ni-SB, and Zn-SB Metallogels.

The minimum critical gel concentrations (MGC) of nickel sebacic acid (**Ni-SB**), and zinc sebacic acid (**Zn-SB**) metallogels were examined carefully. For all the sebacic acid based metallogels, the concentrations of gel-forming chemical components i.e. $Ni(CH_3COO)_2{\cdot}4H_2O$, $Zn(CH_3COO)_2{\cdot}2H_2O$ and sebacic acid were retained as 1:1, w/w. Following this stoichiometric feature the concentration of metal salt and organic gelator were varied to determine the MGC.

The finest quality supramolecular gel of the **Ni-SB** metallogel was observed when the concentration of Ni(II)-salt and sebacic acid were taken as 49.8 and 40.4 mg/ml respectively (Table S1 showing the concentrations of gel-forming chemicals and the serial no designated as (a), (b), (c), (d) and (e) are shown in Fig. S3 respectively).

Table S1. Determination of Minimum Critical Gelation Concentration of the **Ni-SB**.

Serial No	$Ni(CH_3COO)_2 \cdot 4H_2O$ (in 1 ml DMF)	Sebacic acid (**SB**) (in 1 ml DMF)	Phase
(a)	12.4 mg/ml	10.1 mg/ml	Sol
(b)	17.4 mg/ml	14.1 mg/ml	Viscous sol
(c)	22.4 mg/ml	18.2 mg/ml	viscous sol
(d)	24.9 mg/ml	20.2 mg/ml	More viscous sol
(e)	49.8 mg/ml	40.4 mg/ml	Gel

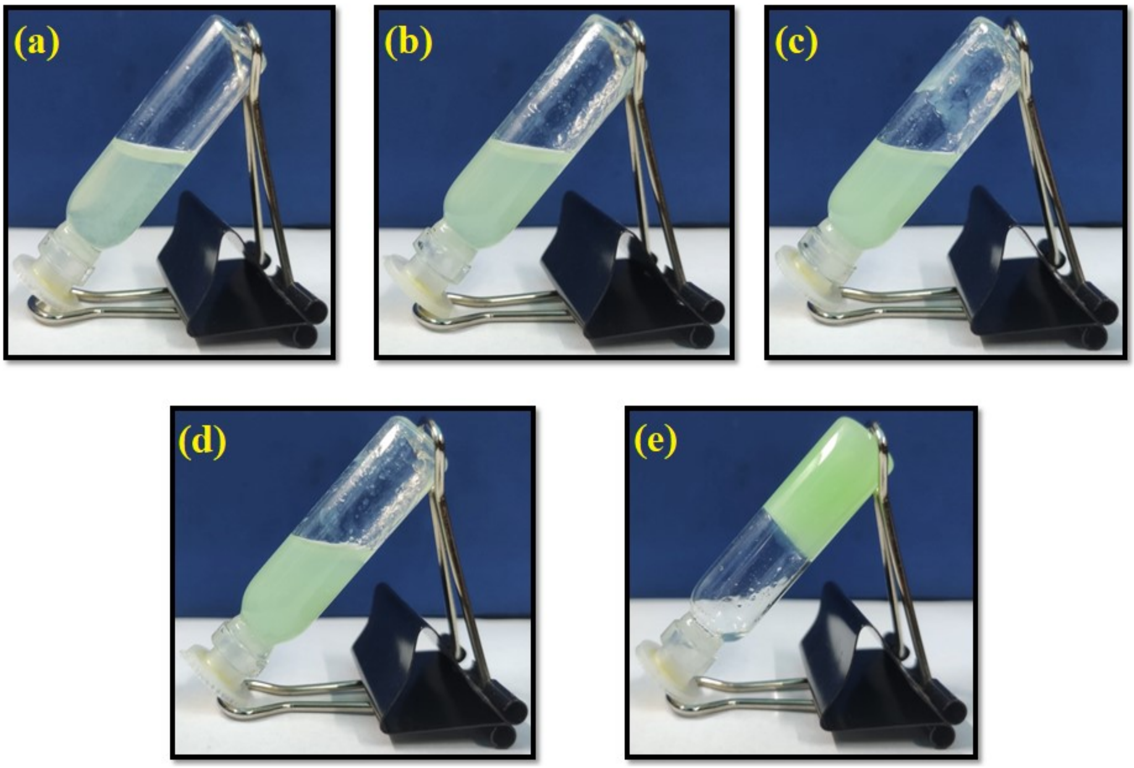

Fig. S3. Determination of Minimum Critical Gelation Concentration (MCG) of the **Ni-SB** metallogel with step-wise photography of **Ni-SB** metallogel forming chemical constituents with different concentrations.

Likewise the best quality gel of the supramolecular **Zn-SB** metallogel was achieved when the concentration of Zn(II)-salt and sebacic acid were taken as 328.5 and 303 mg/ml respectively (Table S2 showing the concentrations of gel-forming chemicals and the serial no designated as (a), (b), (c), (d), and (e) are shown in Fig. S4, respectively).

Table S2. Determination of Minimum Critical Gelation Concentration of the **Zn-SB.**

Serial No	$Zn(CH_3COO)_2{\cdot}2H_2O$ (in 1 ml DMF)	Sebacic acid (**SB**) (in 1 ml DMF)	Phase
(a)	21.9 mg/ml	20.2 mg/ml	Sol
(b)	109.5 mg/ml	101 mg/ml	sol
(c)	219.4 mg/ml	202 mg/ml	viscous sol
(d)	262.8 mg/ml	242.2 mg/ml	Weak gel and sol
(e)	328.5 mg/ml	303 mg/ml	Gel

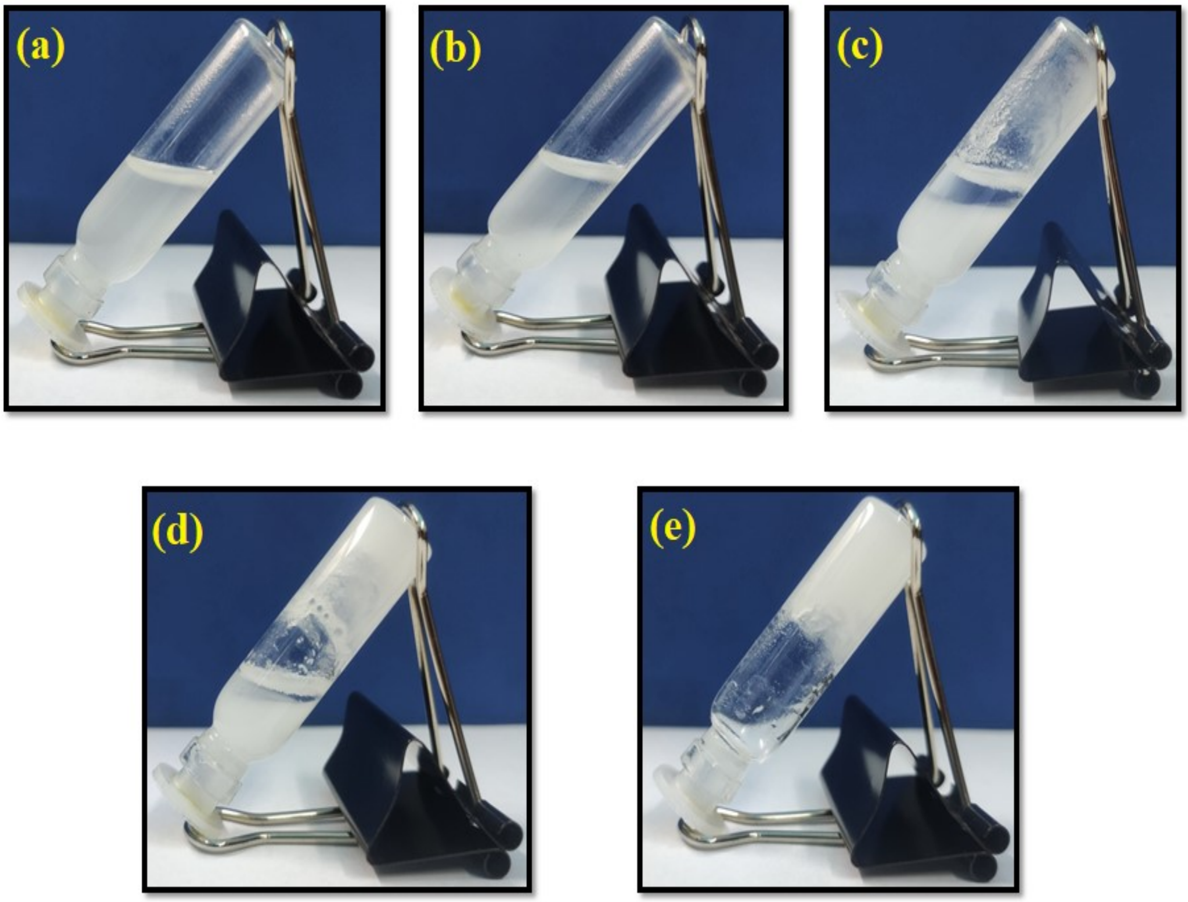

Fig. S4. Determination of Minimum Critical Gelation Concentration (MCG) of the **Zn-SB** metallogel with step-wise photography of **Zn-SB** metallogel forming chemical constituents with different concentrations.

3. Solvent dependent gelation ability of stable metallogels of Ni-SB and Zn-SB.

The role of different solvents ranging from polar to non-polar categories was tested to get the stable metallogels of **Ni-SB, and Zn-SB.** Solvents like water, benzene, acetonitrile, THF, chloroform, ethyl acetate, methanol, ethanol, dichloromethane, acetic acid, acetone, and petroleum ether are being involved in testing the gelation capability. The stoichiometric quantity of gel-constituting chemical agents like metal salts and the gelators were retained as per the minimum critical gelation concentrations for the every solvent directed metallogelation studies for each metallogels respectively. The gelation process mentioned in the experimental section has been adopted for every solvent-directed attempt. The 'inversion-vial' was performed for each case and the outcome of individual solvent-based experiments is collected in Fig. S7, and Fig. S8, for **Ni-SB,** and **Zn-SB** metallogels, respectively. The experimental outcome clearly confirms that DMF is the optimum solvent to achieve the stable **Ni-SB,** and **Zn-SB** metallogels under ambient experimental conditions.

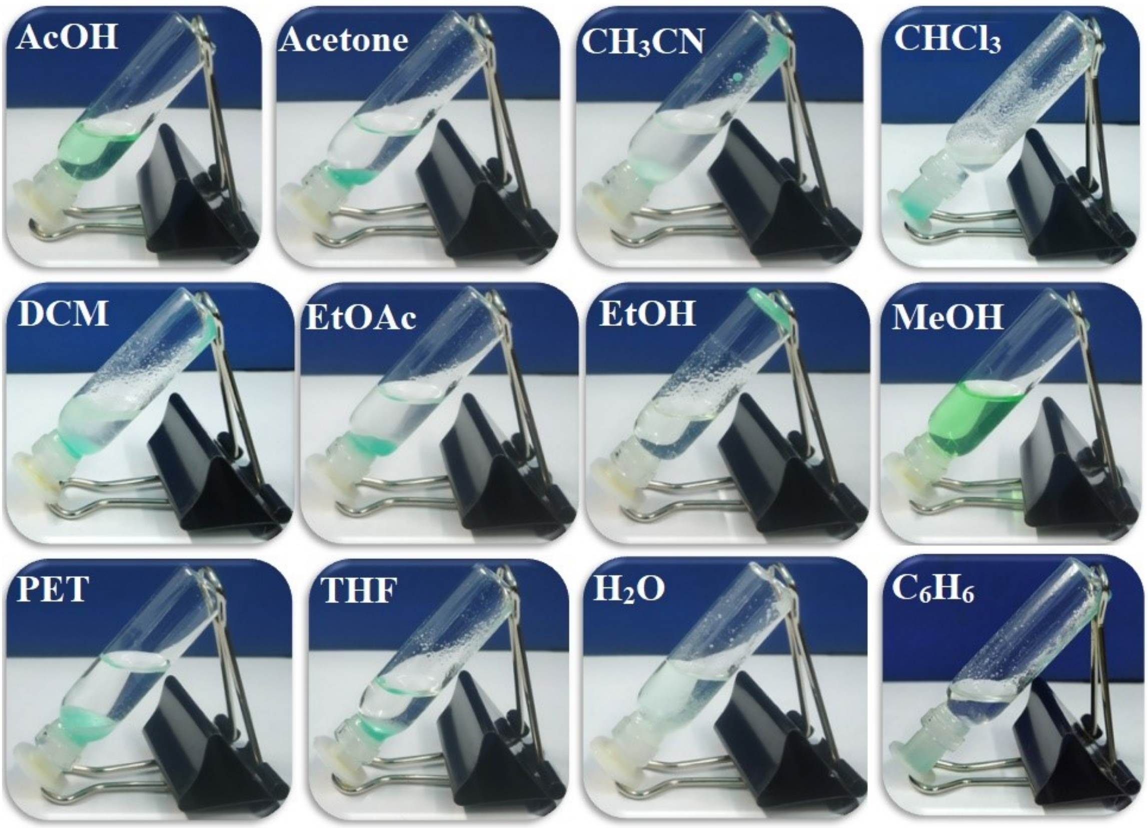

Fig. S5. Role of diverse solvents in forming stable metallogel of **Ni-SB**.

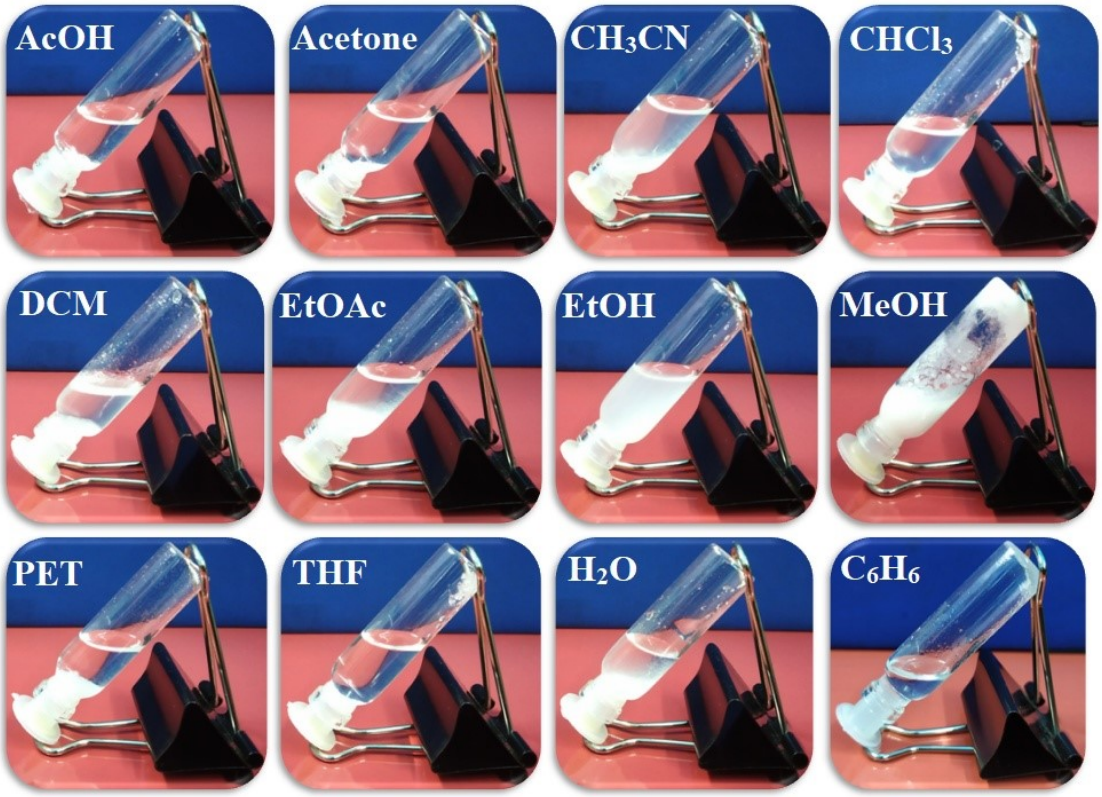

Fig. S6. Role of versatile solvents in forming stable metallogel of **Zn-SB**.

4. Infrared spectroscopic analyses.

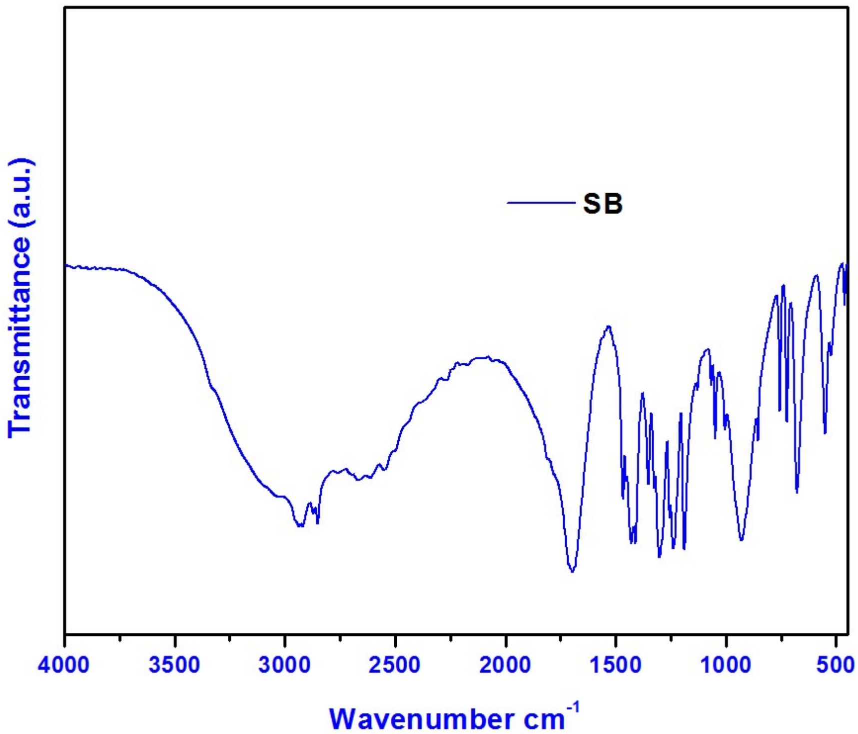

Fig. S7. IR spectra of pure sebacic acid.

5. Electrical Property Analysis

Thermionic Emission theory:

According to Thermionic Emission theory, the forward bias current density can be expressed as $J = J_0\left[exp\left(\frac{q\,V}{\eta\,K\,T}\right) - 1\right]$ (1)

J_0 = Saturation Current Density= $A^*T^2 exp\left(-\frac{q\Phi_B}{KT}\right)$ (2)

Where, q=Electronic Charge, V=Applied Voltage, η=Ideality Factor, K=Boltzman's Constant, T=Temperature in Kelvin scale, Φ_B= Barrier potential Height, A^*= Rechardson's constant and was considered as 1.2×10^6 A m^{-2} K^{-2}.

Cheung's method:

According to Cheung's model, when a series resistance is designed as a series combination of resistor and diode, then the voltage across the diode can be substituted as the voltage drop across the series combination of diode and resistor. Then equation (1) can be drafted as,

$$J = J_0\left[exp\left(\frac{q\,(V - I\,R_S)}{\eta\,K\,T}\right)\right]$$

(3)

Where, IR_S term indicates the voltage drop across the series resistance of the semiconductor diode. Inserting the value of saturation current density into equation (3), and differentiate with respect to lnJ, we get,

$$\frac{dV}{d\ln J} = A\,J\,R_S + \frac{\eta\,K\,T}{q}$$

(4)

Where, Rs=series resistance, q=Electronic Charge, η= Ideality Factor, K=Boltzman's Constant, T=Temperature in Kelvin scale

As stated in the Cheung model, the current density-reliant function H(J) can be written as,

$$H(J) = V - \frac{\eta\,K\,T}{q}\ln\left(\frac{J}{A^*T^2}\right) = A\,J\,R_S + \eta\,\Phi_B$$

(5)

Where, $\Phi_B =$ Barrier height, A^*= Rechardson's constant and was considered as 1.2×10^6 A m^{-2} K^{-2}