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Energy Band & Charge Carrier Formulas

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List of 20 Energy Band & Charge Carrier Formulas

Energy Band & Charge Carrier

1) Carrier Lifetime

Open Calculator

fx $$T_a = \frac{1}{\alpha_r \cdot (p_0 + n_0)}$$

ex $$3.6E\hat{}\text{-}6s = \frac{1}{1.2e\text{-}6m^3/s \cdot (2.3e11/m^3 + 1.4e7/m^3)}$$

2) Concentration in Conduction Band

Open Calculator

fx $$n_0 = N_c \cdot f_E$$

ex $$1.4E\hat{}7/m^3 = 6.4e8/m^3 \cdot 0.022$$

3) Concentration of Holes in Valence Band

Open Calculator

fx $$p_0 = N_v \cdot (1 - f_E)$$

ex $$2.3E\hat{}11/m^3 = 2.4e11/m^3 \cdot (1 - 0.022)$$

4) Conduction Band Energy

Open Calculator

fx $$E_c = E_g + E_v$$

ex $$17.5eV = 0.198eV + 17.302eV$$

5) Distribution Coefficient

Open Calculator

fx $$k_d = \frac{C_{solid}}{C_L}$$

ex $$0.404 = \frac{1.01e15cm^{-1}}{2.5e15cm^{-1}}$$

6) Effective Density of State

Open Calculator

fx $$N_c = \frac{n_0}{f_E}$$

ex $$6.4E\hat{}8/m^3 = \frac{1.4e7/m^3}{0.022}$$

7) Effective Density State in Valence Band

Open Calculator

fx $$N_v = \frac{p_0}{1 - f_E}$$

ex $$2.4E\hat{}11/m^3 = \frac{2.3e11/m^3}{1 - 0.022}$$

8) Energy Gap

Open Calculator

fx $$E_g = E_c - E_v$$

ex $$0.198eV = 17.5eV - 17.302eV$$

9) Energy of Electron given Coulomb's Constant

Open Calculator

fx $$E_e = \frac{n^2 \cdot \pi^2 \cdot [hP]^2}{2 \cdot [Mass\text{-}e] \cdot L^2}$$

ex $$121.1842eV = \frac{(2)^2 \cdot \pi^2 \cdot [hP]^2}{2 \cdot [Mass\text{-}e] \cdot (7e\text{-}10)^2}$$

10) Excess Carrier Concentration

Open Calculator

fx $$\delta_n = g_{op} \cdot \tau_n$$

ex $$1E\hat{}14/m^3 = 2.9e19 \cdot 3.62e\text{-}6s$$

11) Fermi Function

Open Calculator

fx $$f_E = \frac{n_0}{N_c}$$

ex $$0.021875 = \frac{1.4e7/m^3}{6.4e8/m^3}$$

12) Intrinsic Carrier Concentration

Open Calculator

fx $$n_i = \sqrt{N_v \cdot N_c} \cdot \exp\left(-\frac{E_g}{2 \cdot [BoltZ] \cdot T}\right)$$

ex $$2.7E\hat{}8/m^3 = \sqrt{2.4e11/m^3 \cdot 6.4e8/m^3} \cdot \exp\left(-\frac{0.198eV}{2 \cdot [BoltZ] \cdot 300K}\right)$$

13) Liquid Concentration

Open Calculator

fx $$C_L = \frac{C_{solid}}{k_d}$$

ex $$2.5E\hat{}15cm^{-1} = \frac{1.01e15cm^{-1}}{0.41}$$

14) Net Rate of Change in Conduction Band

Open Calculator

fx $$\alpha_r = \frac{TG}{n_i^2}$$

ex $$1.2E\hat{}\text{-}6m^3/s = \frac{8.7e10}{(2.7e8/m^3)^2}$$

15) Optical Generation Rate

Open Calculator

fx $$g_{op} = \frac{\delta_n}{\tau_n}$$

ex $$2.9E\hat{}19 = \frac{1.049e14/m^3}{3.62e\text{-}6s}$$

16) Photoelectron Energy

Open Calculator

fx $$E_{photo} = [hP] \cdot f$$

ex $$757.4472eV = [hP] \cdot 183.15PHz$$

17) Recombination Lifetime

Open Calculator

fx $\tau_n = (\alpha_r \cdot p_0)^{-1}$

ex $3.6E\hat{}\text{-}6s = (1.2e\text{-}6m^3/s \cdot 2.3e11/m^3)^{-1}$

18) Steady State Electron Concentration

Open Calculator

fx $n_{ss} = n_0 + \delta_n$

ex $1E\hat{}14/m^3 = 1.4e7/m^3 + 1.049e14/m^3$

19) Thermal Generation Rate

Open Calculator

fx $TG = \alpha_r \cdot (n_i^2)$

ex $8.7E\hat{}10 = 1.2e\text{-}6m^3/s \cdot \left(2.7e8/m^{3^2}\right)$

20) Valence Band Energy

Open Calculator

fx $E_v = E_c - E_g$

ex $17.302eV = 17.5eV - 0.198eV$

Variables Used

- C_L Impurity Concentration in Liquid *(1 per Centimeter)*
- C_{solid} Impurity Concentration in Solid *(1 per Centimeter)*
- E_c Conduction Band Energy *(Electron-Volt)*
- E_e Energy of Electron *(Electron-Volt)*
- E_g Energy Gap *(Electron-Volt)*
- E_{photo} Photoelectron Energy *(Electron-Volt)*
- E_v Valence Band Energy *(Electron-Volt)*
- f Frequency of Incident Light *(Petahertz)*
- f_E Fermi Function
- g_{op} Optical Generation Rate
- k_d Distribution Coefficient
- L Potential Well Length
- n Quantum Number
- n_0 Electron Concentration in Conduction Band *(1 per Cubic Meter)*
- N_c Effective Density of State in Conduction Band *(1 per Cubic Meter)*
- n_i Intrinsic Carrier Concentration *(1 per Cubic Meter)*
- n_{ss} Steady State Carrier Concentration *(1 per Cubic Meter)*
- N_v Effective Density of State in Valence Band *(1 per Cubic Meter)*
- p_0 Holes Concentration in Valance Band *(1 per Cubic Meter)*
- T Temperature *(Kelvin)*
- T_a Carrier Lifetime *(Second)*

- **TG** Thermal Generation
- α_r Proportionality for Recombination *(Cubic Meter per Second)*
- δ_n Excess Carrier Concentration *(1 per Cubic Meter)*
- τ_n Recombination Lifetime *(Second)*

Constants, Functions, Measurements used

- Constant: **pi**, 3.14159265358979323846264338327950288
  Archimedes' constant
- Constant: **[BoltZ]**, 1.38064852E-23 Joule/Kelvin
  Boltzmann constant
- Constant: **[Mass-e]**, 9.10938356E-31 Kilogram
  Mass of electron
- Constant: **[hP]**, 6.626070040E-34 Kilogram Meter² / Second
  Planck constant
- Function: **exp**, exp(Number)
  Exponential function
- Function: **sqrt**, sqrt(Number)
  Square root function
- Measurement: **Time** in Second (s)
  Time Unit Conversion
- Measurement: **Temperature** in Kelvin (K)
  Temperature Unit Conversion
- Measurement: **Energy** in Electron-Volt (eV)
  Energy Unit Conversion
- Measurement: **Frequency** in Petahertz (PHz)
  Frequency Unit Conversion
- Measurement: **Volumetric Flow Rate** in Cubic Meter per Second (m³/s)
  Volumetric Flow Rate Unit Conversion
- Measurement: **Carrier Concentration** in 1 per Cubic Meter (1/m³)
  Carrier Concentration Unit Conversion
- Measurement: **Reciprocal Length** in 1 per Centimeter (cm⁻¹)
  Reciprocal Length Unit Conversion

Check other formula lists

- **Electrons & Holes Formulas**
- **Energy Band & Charge Carrier Formulas**
- **Semiconductor Carriers Formulas**
- **SSD Junction Formulas**

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