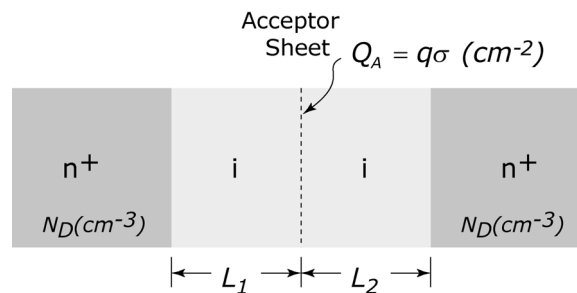

EE566 Solid State Devices

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Dept of Electrical Engineering
University of Notre Dame
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1st Mid-Term Exam

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Problem(20 Points)



Consider the GaAs structure shown in the figure above at 300K. A sheet of acceptors (of density $q\sigma/cm^2$) is placed in the intrinsic region of GaAs such that it is a distance L_1 from one heavily doped n^+ region, and L_2 from another. NEGLECT Gummel correction.

- Calculate the potential barrier V_0 for electrons to flow from one n^+ region to another at zero applied bias in terms of Q_A , L_1 , L_2 , N_D , and other material parameters of GaAs.
- Sketch the charge-field-band diagram for the zero-bias case where $L_1=100nm$ and $L_2=200nm$, $\sigma=5 \times 10^{11}/cm^2$, and $N_D=N_C$ for GaAs (assume non-degenerate relationship for carrier density and Fermi level). Make reasonable approximations to simplify your calculation. What is V_0 for this structure?
- We say that the diode “turns-on” when there is no barrier to electron flow. What is the turn-on voltage in each direction? What is their ratio? Sketch a typical I-V curve for the structure.
(Hint- Remember that the *total area* under the field is just the applied voltage).
- What is the *maximum* turn-on voltage in each direction? For what value of Q_A will we achieve the maximum turn-on voltages in each direction?

NOTE:

Sketches, sketches with proper LABELS!! (wherever the situation demands). State your approximations clearly, and use your intuition to cut down on the math.

Data: GaAs (300K):

$$| E_g = 1.424eV \mid \epsilon_s = 12.9\epsilon_0 \mid \epsilon_0 = 8.85 \times 10^{-14} F/cm^2 \mid N_C = 4.7 \times 10^{17}/cm^3 \mid N_V = 7 \times 10^{18}/cm^3 \mid$$