ECE 340 Homework XVI Spring 2003

Due: Monday, May 5, 2003

1. On a semi-insulating GaAs substrate a lightly n-type doped GaAs is epitaxially grown, and an MESFET with a gate length of 3 μm is fabricated. (In practice, ion implantation instead of epitaxial growth is used to realize MESFET devices to reduce the cost.) The epitaxial layer is 0.6 μm thick and has a doping concentration of $4x10^{16}/cm^3$. Assume that the Schottky barrier is 0.8V and gate width is 100 μm. Given $n_i = 2x10^6/cm^3$, $\mu_n = 6000\ cm^2/V\text{-}s$ at room temperature, and the relative dielectric constant for GaAs is 13.2. (a) Determine the drain voltage, V_D, required to pinch off the channel for $V_G = -1$ V and (b) estimate the channel current for $V_D = 0.1$ V and $V_G = -1$ V and (c) estimate the saturation current for $V_G = -1$ V where V_G is the gate voltage, and (d) estimate the saturation current for $V_G = -5$ V.

2. Refer to Fig. 1-13. Assuming the lattice constant varies linearly with composition x for a ternary alloy, what composition of InxGa1-xP is lattice-matched to GaAs? What is the bandgap energy of the $In_xGa_{1-x}P$ layer? Also, assume that a p-n junction is made in the corresponding lattice-matched epitaxial layer to form a light emitting diode and isotropic light emits. In general, about half of the photons go toward the substrate side. If the $In_xGa_{1-x}P$ diode can be grafted from its original GaAs substrate onto different substrates, which substrate among GaSb, InP, GaP and SiC is considered to be transparent? Namely, which substrate would not considerably absorb the light emitted from the p-n junction toward the substrate?

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ECE 340 Homework XVII Spring 2003

Due: Wednesday, May 7, 2003

1. A symmetric p-n junction of area 5cm x 5cm has rectifying I-V characteristics such that $I=I_{th}[\exp(qV/kT) -1]$, where $I_{th} = 12$ nA. Assume that the minority carrier diffusion lengths $L_n=L_p=2$ μm in each side of the junction, and the depletion width is 1 μm. Upon solar illumination in a clear day an optical generation rate of $2x10^{18}$ EHP/cm^3 is obtained uniformly at least one diffusion length deep into each side of the neutral region as well as within the depletion region. (a) Calculate the short-circuit current and the open-circuit voltage for this illuminated junction. (b) Plot the I-V curve for this solar cell. Repeat part (a) when some clouds block the sun and the optical generation rate reduces to a half.