

ECSE-2210 Microelectronics Technology
Fall 2005 Homework - 8

Reading list: Chapters 14 (pages 477 – 487). Hand in your solutions in class.

1. Assume that an ideal Schottky barrier is formed on n-type Si having $N_D = 10^{16} \text{ cm}^{-3}$. The metal work function is 4.5 eV, and the Si electron affinity is 4 eV.
 - (a) Draw equilibrium band diagrams such as in Fig 14.2 to scale. What is the barrier height qV_{bi} (where V_{bi} is called the built-in voltage) for electron flow from the semiconductor to metal ($S \rightarrow M$)? What is the barrier height (Φ_B) for electron flow from the metal to semiconductor ($M \rightarrow S$)? What is the depletion layer width formed in the semiconductor? What is the maximum electric field \mathcal{E}_0 in the depletion layer?
 - (b) Draw the forward- and reverse-bias diagrams, as in Fig 14.3 to scale, for $V_A = 0.1 \text{ V}$ and $V_A = -3 \text{ V}$ respectively. What are the barrier heights for electron flows from $S \rightarrow M$ and $M \rightarrow S$ for each case now? Note that this junction will behave like a $p^+ - n$ rectifying junction.
2. Suppose for the above case, we used a metal with a work function of 4.0 eV. Now, draw the band diagram at equilibrium. Is the metal-semiconductor contact ohmic or rectifying? Explain.
3. Explain why MS diodes switch very rapidly from the forward bias “on state” to reverse bias “off state” (where as p-n diodes do not!).