

2006 Qual Exam Questions

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1. Consider a semiconductor with a bandgap of 0.5 eV. Draw the energy band diagram of the semiconductor if it is intrinsically doped. Indicate the workfunction of the semiconductor in the band diagram.
2. If a metal with a workfunction that is the same as the semiconductor is brought in contact with the semiconductor, draw the energy band diagram again.
3. If the workfunction of the metal is smaller, draw the band diagram.
4. If the workfunction of the metal is larger, draw the band diagram.
5. Now, focus on the case in which the workfunction of the metal is larger. Assume we make a MOSFET with the source and drain with the metal directly in contact with the semiconductor. Draw the I_d vs V_{ds} curve (with different V_{gs}) for this transistor. Explain the features of the IV curve and contrast this with a conventional MOSFET.
6. How can you improve the IV characteristics of this transistor? What is the physics behind your solution?
7. Now, draw the I_d vs V_{gs} curve (at high V_{ds}) of the unmodified transistor. Explain the features of the IV curve and contrast this with a conventional MOSFET.
8. Can we use this ambipolar transistor in conventional CMOS circuit families? Which circuit types will not work with the ambipolar transistors?
9. Draw the circuit diagram of a 2-input CMOS NAND gate. Will this circuit work if the transistor is made of the ambipolar transistor above?