Solution #0   EE/MSE 484

Problem 1:

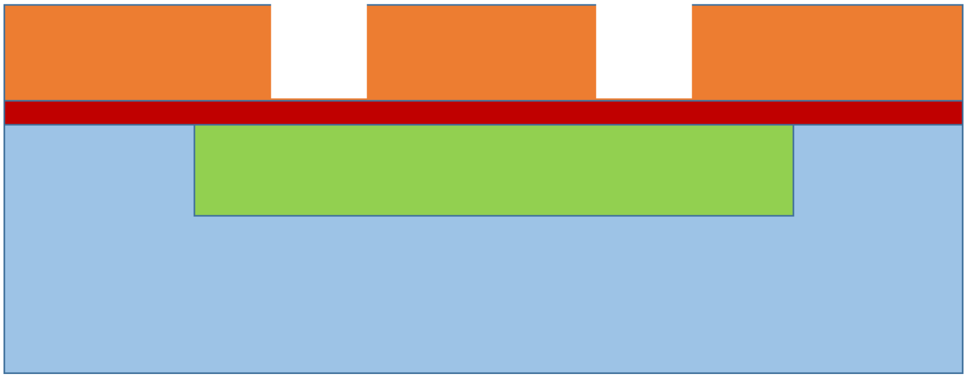
Step 1: In the n type substrate, Grow thermal oxide;

Step 2: Deposit, expose and develop photoresist; Use mask #1 to pattern the photoresist;

Step 3: Conduct n type implantion using phosphorus;

Step 4: Strip photoresist. Drive in the implanted phosphorus;

Step 4: Deposit, expose and develop photoresist; Use mask #2 to pattern the photoresist;



Step 5: Conduct p type implantion with boron;

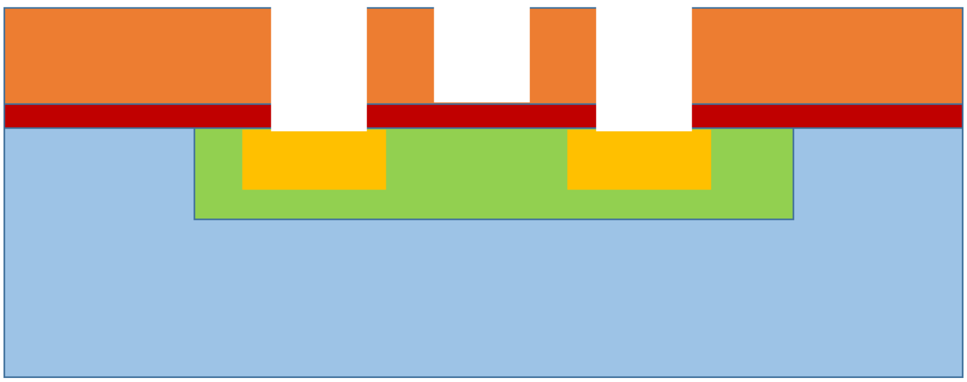
Step 6: Strip photoresist. Drive in the implanted boron;

Step 7: Stipe oxide and grow a new thermal oxide;

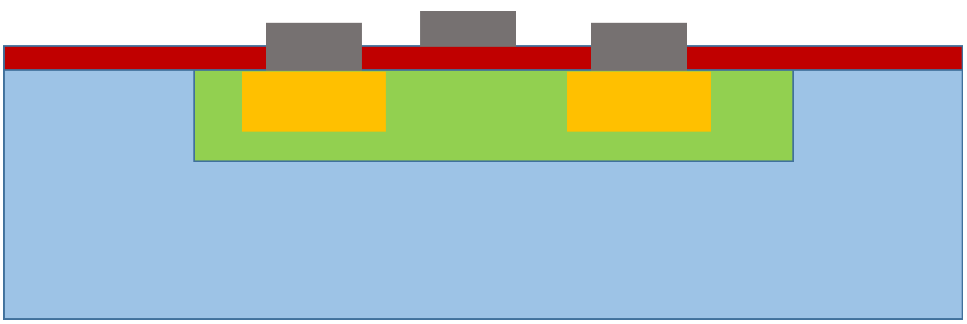
Step 8: Deposit, expose and develop photoresist; Use mask #2 to pattern the photoresist;

Step 9: Etch away the exposed oxide;

Step 10: Deposit, expose and develop photoresist; Use mask #3 to pattern the photoresist;

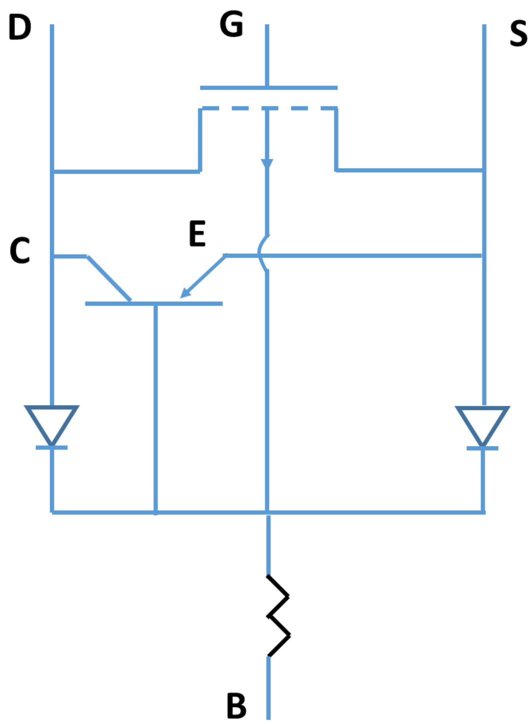


Step 11: Deposit metal and then lift off metal on top of photoresist



Problem 2:

In structure, we have two diodes, one PNP bipolar transistor and one PMOS. The effective circuit is shown below:



Problem 3:

(a) Since Na>Nd, this region should be p type. The hole concentration is:

$$p = \frac{N_A - N_D + \sqrt{(N_A - N_D)^2 + 4n_i^2}}{2}, n = n_i^2/p$$

The result is $p = 2 * 10^{18} cm^{-3}, n = 50 cm^{-3}$

The mobility is determined by the total doping which is

$$N_T = N_A + N_D = 4 * 10^{18} cm^{-3}$$

Based on the plot in the notes we have mobility are

$$\mu_p \sim 100 cm^2/Vs, \qquad \mu_n \sim 180 cm^2/Vs$$

(b) Resistivity is

$$\rho = \frac{1}{\sigma} = \frac{1}{q(p\mu_p + n\mu_n)} \sim \frac{1}{1.6 * 10^{-19} * 2 * 10^{18} * 100} = 0.031\Omega * cm^{-1}$$

(c) Resistance is

$$R = \frac{\rho L}{S} = \frac{\rho L}{wt} = 0.031 * \frac{2000}{50 * 40 * 10^{-7}} = 313 k\Omega$$

Problem 4:

For the p side, $N_T = N_A + N_D \sim 5*10^{18}$ cm^{-3} the mobility for electron is about μ_n = 150 cm^2/Vs. The diffusivity for the electron is $D_n = \frac{kT}{q}\mu_n = 3.9 cm^2/s$

For the n side, $N_T = N_D = 2*10^{17}$ cm^{-3} the mobility for hole is about μ_p = 260 cm^2/Vs. The diffusivity for the electron is $D_p = \frac{kT}{q}\mu_p = 6.7cm^2/s$

The reversed saturation current is

$$I_s = qAn_i^2\left[\frac{D_n}{N_AW_p} + \frac{D_p}{N_DW_n}\right]$$

$$= 1.6 * 10^{-19} * 0.5 * 10^{-8} * 10^{20} * \left[\frac{3.9}{2 * 10^{18} * 50 * 10^{-7}} + \frac{6.7}{2 * 10^{17} * 20 * 10^{-7}}\right]A$$

$$= 1.34 * 10^{-18}A$$