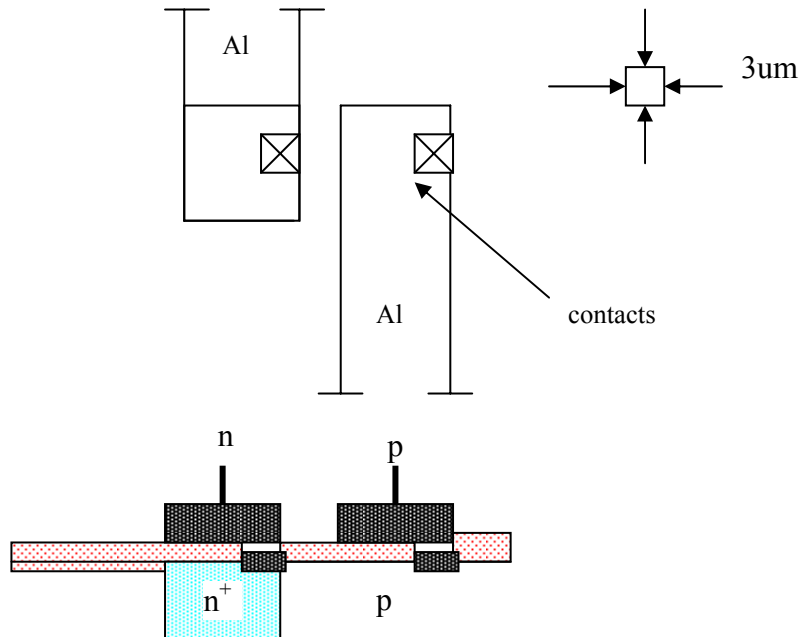


ECSE-2210 Microelectronics Technology
Class Activity 33 – Solution

1. The mask set for a simple rectangular p-n junction diode is shown below. The diode is formed in a p-type substrate.
 - a. How many masks are required to fabricate the structure as shown?
 Three: One for n-diffusion, one for contact holes, and one for patterning metal.
 - b. Draw a picture of the layout for the diode, which results when a worst-case misalignment of $3\ \mu\text{m}$ occurs in x-direction on each mask level. Assume that the contact level is aligned to the diffusion level and the metal over layer can shift also.
 The contact hole can shift to the edge of the diffused region. The metal over layer can shift also.



- c. What will happen if the contact hole is $6\ \mu\text{m} \times 6\ \mu\text{m}$ square? Will the device work?
 There is a chance the device may not work since the contact will short the n and p regions.
2. For NMOS fabrication, the substrate should be (n-type, **p-type**: choose one). For CMOS, the substrate should be (**n-type**, p-type, does not matter: choose one).

3. Two n^+ -diffused lines are running parallel in a substrate doped with 10^{15} cm^{-3} boron atoms. The substrate is biased to -5 V , and both lines are connected to $+5 \text{ V}$. Calculate the minimum spacing needed between the lines to prevent their depletion regions from merging. This explains why the minimum spacing between two diffused lines is larger than the spacing between two metal and poly-lines.

Minimum spacing should be any alignment tolerance plus twice the depletion layer width. The depletion layer width is W for each junction at the applied voltage $V_A = 10 \text{ V}$ between n and p regions.

4. Explain why we need field oxide in CMOS (see figure 2.10).
Field oxide is used to isolate different MOS devices. Otherwise, the devices can get shorted when a metal line is placed over the field oxide region.
5. What is the purpose of boron implantation in figure 2.12a? What is the purpose of arsenic implantation in figure 2.12b?
Implantation is used for defining source/drain regions of respective MOS devices.
6. N-well in CMOS should be connected to the **positive** part of the power supply and the p-type substrate should be connected to the **negative** part of the power supply. One has to make these junctions reverse biased so that different devices are electrically isolated.