H1 Litho, etching, silicon

Return in MC by March 10, 10 pm. Exercise session March 12, 9.15 am.

Q1. a) Calculate an estimate for silicon lattice constant from atomic mass and density.

b) Silicon atom density is $5 \cdot 10^{22}$ cm^{-3}. If boron dopant concentration is 10^{15} cm^{-3}, how far are the boron atoms from each other ?

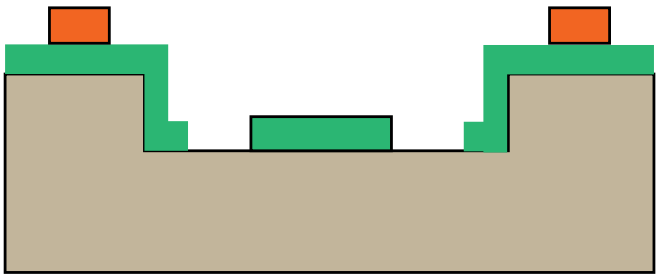
c) Consider an olympic swimming pool filled with golf balls, and one squash ball. If golf balls represent silicon atoms, and the squash ball represents a phosphorous atom, what would be the resistivity of a silicon piece with similar doping level? Hint: This is an order of magnitude question and you should make rough approximations as needed.

Q2. 100 mm diameter silicon wafer has 1 µm lines fabricated on it. The photomask is made of soda lime glass with a coefficient of thermal expansion CTE of 10 ppm (10 × 10-6 /˚C). How accurately must the temperature in the patterning process be controlled in order to keep distortions from thermal expansion over 100 mm wafer below 0.3 µm ? Silicon CTE is 2.5 × 10-6 /˚C.

Q3. Find out (from the scientific literature) typical deposition rates and film thicknesses for the following thin film deposition processes:

-evaporation of aluminum
-sputtering of tungsten
-CVD of tungsten
-PECVD of oxide
-electroplated copper
-ALD of aluminum oxide
Remember to include also the citations!

Q4. **a)** Explain step-by-step the fabrication process of the device shown below.



b) Explain step-by-step two different processes that result in this device!