Microfabrication (CHEM-E5115) exam May 22nd, 2018

Answer 5 out of 6 questions. If you answer all 6, the best one will be dropped out.

Cheat sheet (single A4) allowed. Must be returned with your answers.

Make sure your answers are coherent and consistent: a collection of facts is not an answer.

There is usually more than one way of doing things, so you have to argue for your choices.

Draw figures and graphs when appropriate.

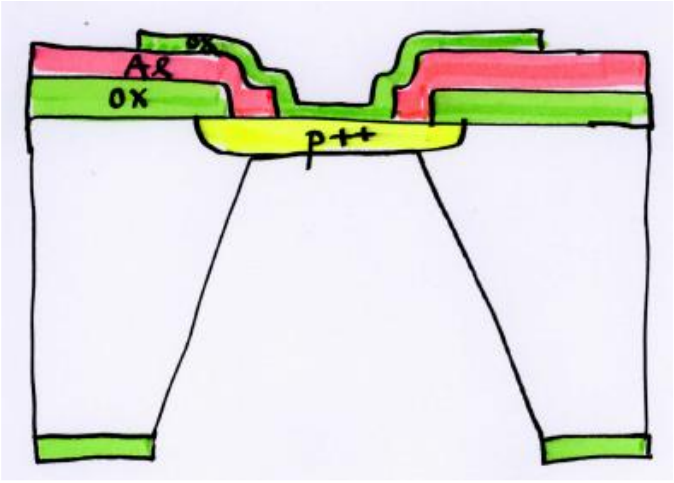
Note that some features in the drawings are because of drawing software only and do not represent actual microfabrication profiles.

Answer using pencil, or if you use pen, make sure to sketch your answer properly on a non-official paper before writing it down to official exam paper to avoid overwriting.

Start answer to each question from top of a new page. The first sheet contains pages 1-4, page 5 is the front page of the second sheet.

1. Give a short but concise description which deposition and patterning processes are used to make the metallizations listed below. For each case you must only discuss one process that you think is best suited for this application. (1 p. each).
   HINT: you should only spend 6 minutes for each!
   a) copper metallization for 32 nm CMOS
   b) aluminum metallization for 5 µm CMOS
   c) 50 µm wide, 5 µm thick gold lines for a microwave power source
   d) 3 µm wide, 500 nm thick doped polysilicon lines for a precision resistor
   e) 10 µm wide, 50 nm thick molybdenum lines for a heater resistor
   f) 50 nm wide, 50 nm thick silver lines for study of Ohm's law validity

2. Explain step-by-step the fabrication of the micro hot plate shown below. Additionally, give all film thicknesses, wafer thickness, bottom mask size, and hot plate size. 6 p.



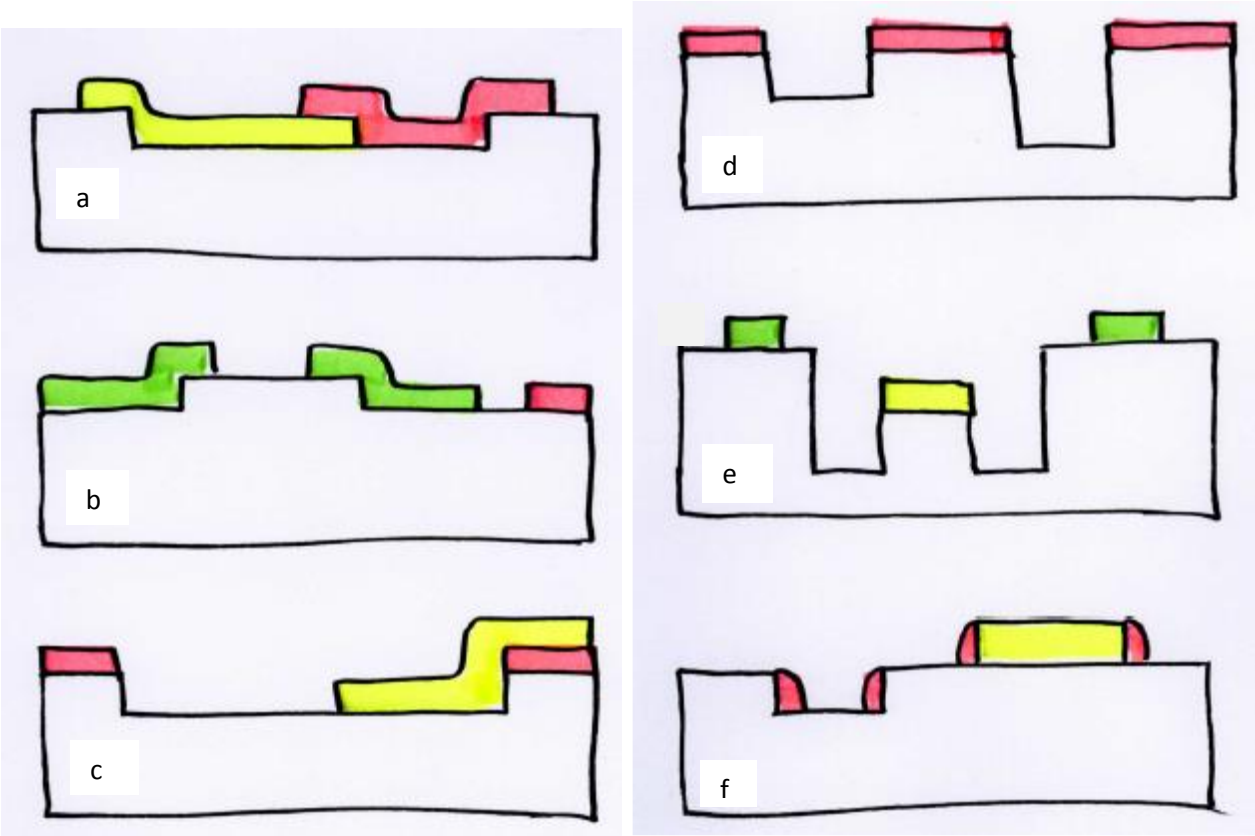
3. Deposition-lithography-etch:

Use the following expressions to make list of process steps for each of the figures a to f. 1 p. each.

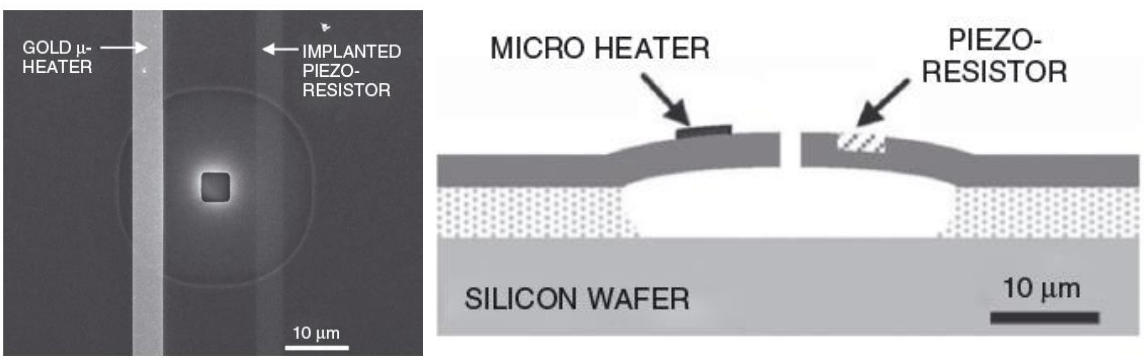
DEPOSIT RED/GREEN/YELLOW

LITHOGRAPHY TO DEFINE RED/GREEN/YELLOW/SILICON

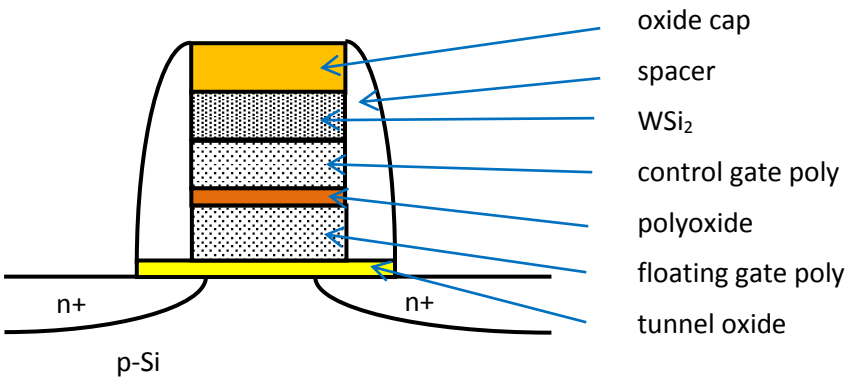
ETCH RED/GREEN/YELLOW/SILICON (+STRIP)



4. Explain step-by-step the fabrication of the resonator shown below. 6 p.



5. Explain step-by-step the fabrication process of the flash memory cell shown below (including film thickness estimates, process temperature guesses and spacer material). 6p.



6. Compare KOH and DRIE etching of silicon for MEMS applications. Hint: Make simple drawings to explain geometrical aspects (remember that geometry is just one topic to be discussed). 6 p.