Microfabrication CHEM-E5115

Exam Feb 22, 2024, 13-16 o'clock

Answer 5 out of 6 questions. All questions are 6 point max.

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

You have to argue for your choices: there is usually more than one way of doing things, and therefore you have to give reasons for doing things your way.

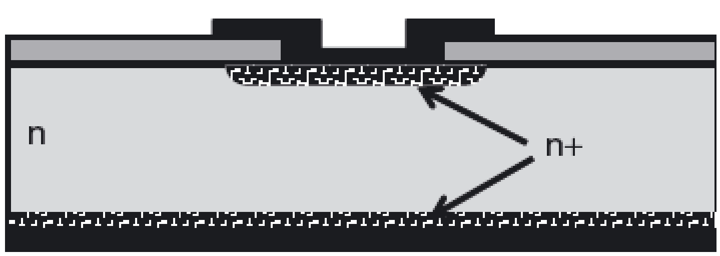
Draw figures and graphs when appropriate.

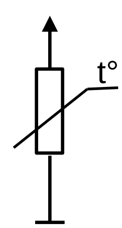
When asked to explain a fabrication process step-by-step, it means that you have to list the **MAIN** steps in the very order they are made.

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

Not all process steps are shown in the figures, but you have to explain also those steps that are not pictured!

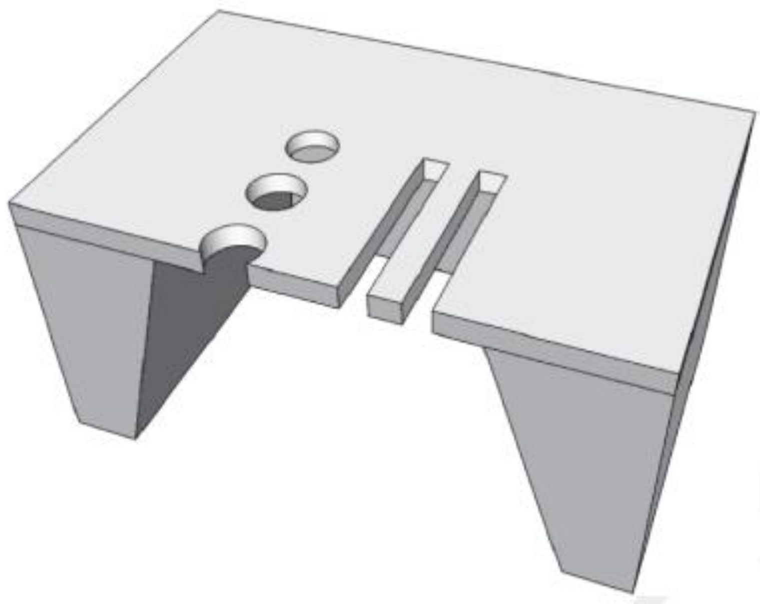
1. Explain step-by-step the process flow to fabricate the spreading resistance thermometer shown below (***drawing is not in scale***)**.** Additionally, identify all materials used and give your estimates of wafer, film and structure dimensions. Thermal diffusion is used for doping. 6 points.





2. a) KOH etching of silicon. 3 points.

2. b) Explain step-by-step the fabrication process of the device shown below. The width and the spacing of the trenches is 10 µm and the diameter of the holes is 20 µm. Everything that is visible in the figure is silicon. 3 points.



3. Explain the key similarities and differences between these concepts. 1 point each.

a) evaporation and sputtering

b) bulk wafer and epi-wafer

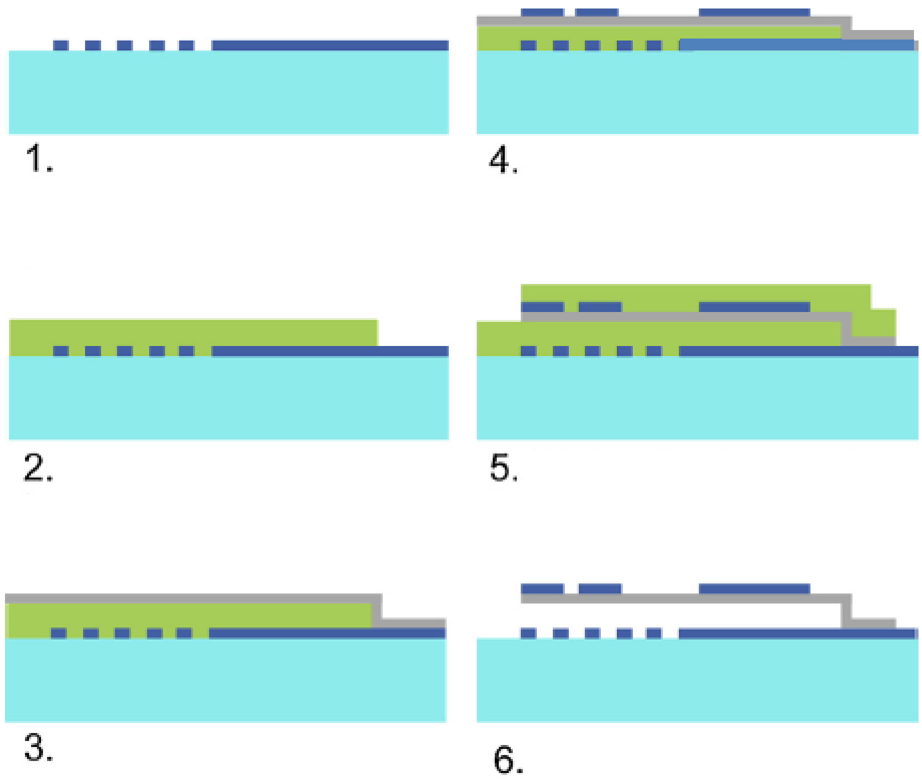
c) photomask and etch mask

d) CVD and ALD

e) polishing (CMP) and grinding

f) anodic bonding and fusion bonding

4. Explain step-by-step the fabrication process for the thermal radiation sensor shown below. Dark blue= metal, green=sacrificial material; gray=structural material. Propose real materials for these and also estimate dimensions and thicknesses of structures! 6 points.



5. Lithography. 6 points.

6. Continue the following sentences. Write short but informative sentences. 1 point each.

Examples:

ALD is great because *it provides highly conformal film* ➔ *0.5 points*

ALD is great because *it provides highly conformal film and high deposition rate* ➔ *0 points.*

ALD is great because *it allows sub-nm thickness control and good uniformity* ➔*1 point.*

ALD is great because *it results in high quality thin film.* ➔ *0 points.*

a) Compared to thermal diffusion, ion implantation…
b) Compared to bulk silicon MOSFET, thin film MOSFET…
c) Compared to 1 µm linewidth CMOS, 65 nm CMOS…
d) Compared to polysilicon gate, $TiSi_2$…
e) Compared to aluminum metallization, copper metallization…
f) Compared to 5 nm CMOS, 3 nm CMOS…