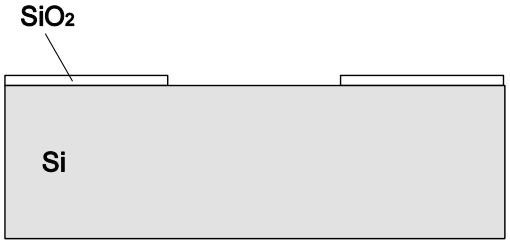
Tentamen
Mikrosensorer

Institutionen för Mätteknik och Industriell Elektroteknik
130604 kl. 8.00-13.00
Allowed material: calculator, ruler
All papers turned in must be signed
The test consists of 20 short questions and a larger final task

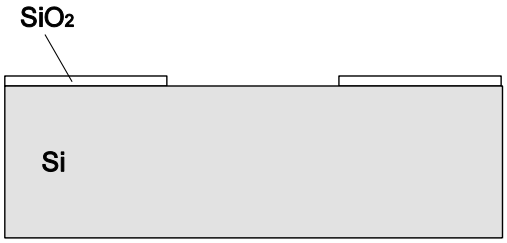
1. So what's the big deal about microsensors?
How can you answer to that? Write at least four advantages of microsensors compared to traditional sensors.

2. When doping silicon, there are two main methods. Describe the two different ways.

3. Below is a silicon wafer with an opening in the masking layer. You are etching the silicon with an isotropic etch. Draw in the picture how the etch profile looks like after a short time and after a long time.



Short after etch start



Long time after etch start

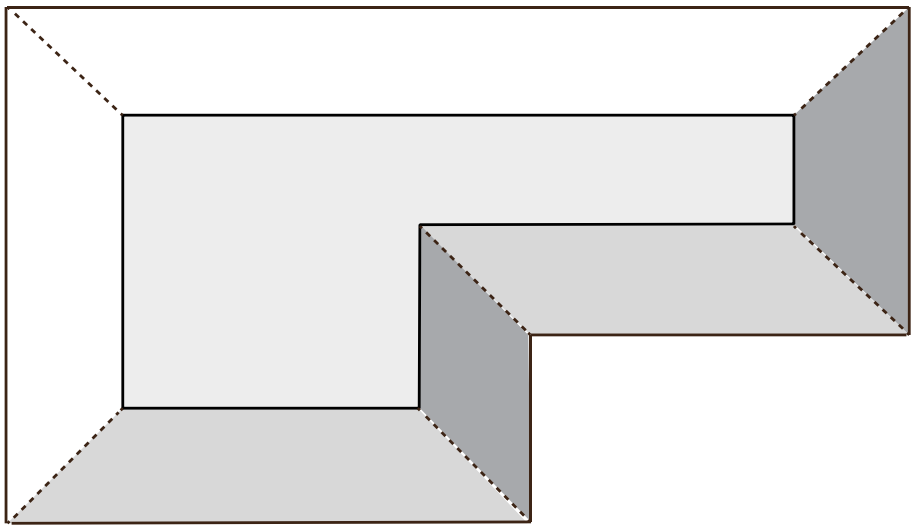
4. Very often our sensor must be shielded against the environment. Describe two methods to make a hermetic (gastight) seal in a microsensor.

5. Doped silicon can be used as piezoresistive sensor elements. Argue for and against the use of piezoresistive sensor elements.

6. Describe two methods of making electrical contacts to a microsensor.

7.

You have made the following structure in <100> silicon with standard anisotropic etching. The structure is protruding from the wafer. Draw in the picture how the original mask looked like.



8. We have an n-type piezoresistive element placed in the <110> orientation on a (100) - silicon wafer. The original resistance is 100Ω.
   Then we apply a stress on the resistor. The longitudinal stress is σ_L =30MPa, and the transversal stress σ_T = 18MPa.
   The resistor has the piezoresistive coefficients:
   π_{11} = -100
   π_{12} = +50
   π_{44} = -12
   What is the resulting resistance?

9. Temperature sensors are a large field in microsensors. The Seebeck effect is one phenomena suitable for making such a sensor in microscale on silicon. Describe how to design such a sensor to make it a viable alternative.

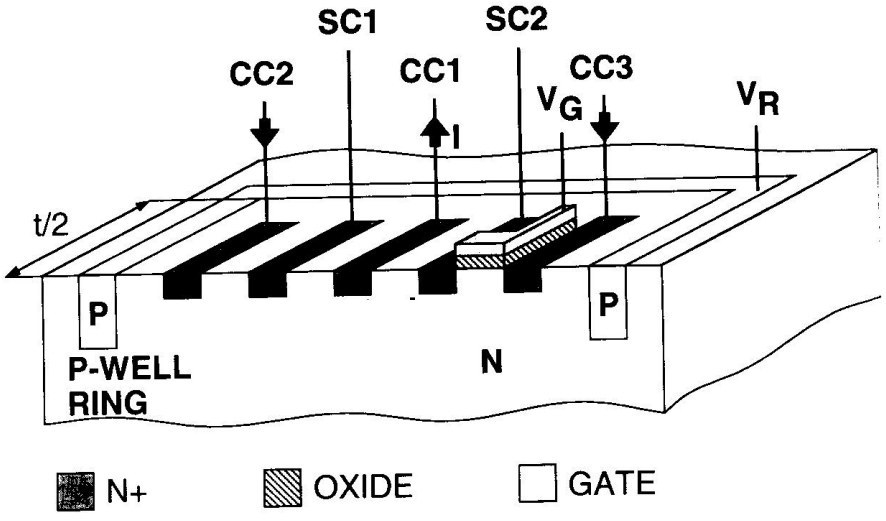
10. What is the advantages/disadvantages with contact lithography compared to proximity litography

11. Temperature sensors may be used for sensing other parameters. One such sensor is the pirani gate. What does it sense and how does it work?

12. Semiconductor thermo resistors show different temperature dependency depending on in which temperature region we are measuring. What is happening in the three different regions?

13. One commonly used photosensor is the P-I-N photodiode. How does it work

14. The image show a semiconductor sensor. What is the name of the device and what does is it sensitive for?



15. Describe the principle of the PTAT sensor (Proportional To Absolute Temperature).

16. Chemical sensors is the fastest growing field in microsensors today. What is the main advantages of downscaling of chemical sensors?

17. Describe the principle of an electrochemical Biosensor

18. In the field of biosensors there are so called calorimetric sensors.
    What is the main principle of those?

19. Most sensors belong to several sensor categories. Describe how you can use a magnetic sensor for biosensing applications.

20. You have made an accelerometer with four piezoresistive elements. The resistors are measured to 93Ω ± 0,5Ω. You connect the resistors in a wheatstone bridge and connect the amplifier. Before you start to measure you check the resistors one last time to see if everything is alright. This time your multimeter show 70Ω instead of the 93Ω you measured just moments ago. Why?