Lecture 4 ex 2

Sensor components
Borje Norlin

[110] direction gives $\pi_{44}^{l} \approx 70 \cdot 10^{-11}$

$$\frac{\Delta R}{R} \approx \pi_{44} (\sigma_l - \sigma_t) \approx 70 \cdot 10^{-11} \sigma_l = 3\%$$

$$\sigma_{max} = \frac{0{,}03}{70 \cdot 10^{-11}} = 4{,}29 \cdot 10^{+7} \text{ Pa}$$

$$\sigma_{max} = \frac{QLt}{2I} \qquad I = \frac{at^3}{12}$$

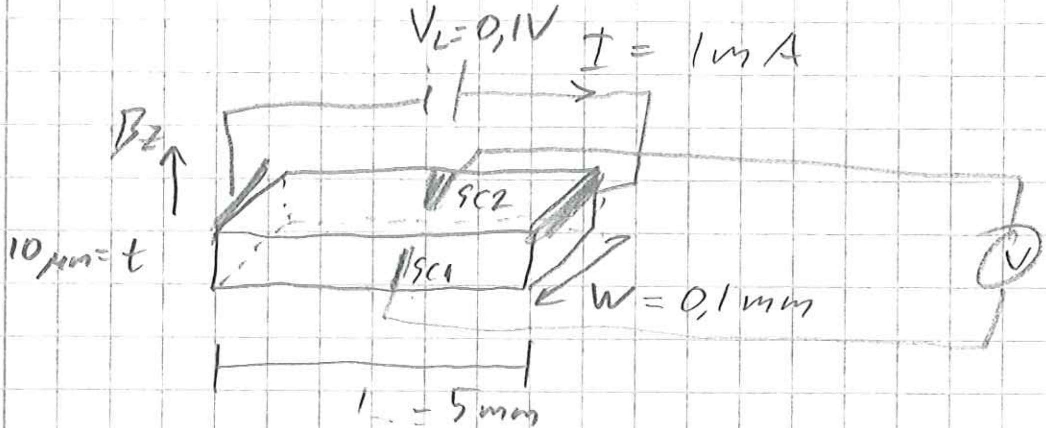
$$\sigma_{max} = \frac{QLt}{2} \cdot \frac{12}{at^3} = \frac{QL6}{at^2}$$

$$a = \frac{QL6}{\sigma_{max}} = \frac{10 \cdot 10^{-6} \cdot 1 \cdot 10^{-3} \cdot 6}{4{,}29 \cdot 10^{7} \cdot (3 \cdot 10^{-6})^2} = 155 \mu m$$

Answer: 155 µm beam width will result 3 % resistance change.

Lecture 5 ex 3

3 Hall structure



$= \sout{0{,}1V}$

$= V_{sc12} = -2mV$

$t = 10 \cdot 10^{-6}\ m = 1 \cdot 10^{-3}\ cm$

$B_z = 10 \cdot 10^{-5}\ Wb/cm^2$

Negative V_{sc12} gives: Electrons

$$R_H = V_{sc2} \cdot t \Big/ I \cdot B = \frac{-2 \cdot 10^{-3} \cdot 1 \cdot 10^{-3}}{1 \cdot 10^{-3} \cdot 10 \cdot 10^{-5}} = -20\ cm^3/C$$

$$R_H = \frac{r_n}{q n_0} \qquad n_0 = \frac{1}{1{,}602 \cdot 10^{-19} \cdot 20} = 3{,}121 \cdot 10^{17}\ cm^{-3}$$

assume $r \approx 1$ $\qquad n_0 = 3{,}121 \cdot 10^{17}\ cm^{-3}$

Answer:

carrier type is electrons,

5 A grating is fabricated by deep etching of grooves in silicon. The silicon wafer is 300 μm thick and the etched groves are 50 μm deep. Two test samples are fabricated; in the first the grooves are filed with Gold (Au), in the other the grooves are filled with Indium (In).

Sketch of grooves viewed from the side.

To investigate the filling quality, X-ray microscopy images are taken of the two gratings using 20 keV monochrome radiation. The result are two "Zebra-like" images showing brighter and darker stripes.

Calculate the relative intensities for the darker and the brighter stripes in the two images. (Images are often normalized to the intensity value "one" when no object is applied.)

Exam 2012-11-01 ex 5

$\alpha_{Si} = 10,397\ cm^{-1}$

$\alpha_{Au} = 1523,0\ cm^{-1}$

$\alpha_{In} = 149,4\ cm^{-1}$

$\phi_0 = 1$

$\alpha_{Si} x_{Si} = 10,397 \cdot 0,03 = 0,31190$

$\phi_{Si} = e^{-\alpha x} = e^{-0,31190} = 0,732$

Au:

$\alpha_{Au} \cdot x_{Au} = 1523,0 \cdot 0,005 = 7,615$

Remaining Si $\alpha_{Si} x_{rSi} = 10,397 \cdot 0,025 = 0,2599$

$\phi = e^{-\alpha_{Au} \cdot x_{Au}} \cdot e^{-\alpha_{Si} \cdot x_{rSi}} = e^{-(7,615 + 0,2599)} = 0,000380$

In:

$\alpha_{In} \cdot x_{In} = 149,4 \cdot 0,005 = 0,747$

Remaining Si, same as for Au 0,2599

$\phi = e^{-((\alpha x)_{In} + (\alpha x)_{Si})} = e^{-(0,747 + 0,2599)} = 0,365$

First image pattern

Only silicon : 0,732 intensity (white)

Au (gold) : 0,0004 intensity (black)

2:nd image pattern

Only silicon : 0,732 intensity (white)

In (indium) : 0,362 intensity (gray)