520.495/580.495 Microfabrication Laboratory

Laboratory Assignment (Lab 1a)

Instrumentation and Measurements

Objectives: Familiarize the students with often used instruments in the laboratory:

I) The thin film and surface profilometer (Datek).

II) The optical microscope (Optiphot 66)

These two pieces of equipment will be useful in inspecting and characterizing the microstructures that you will fabricate throughout the course.

I. Prelab Work:

Do a search on the web and write a short report (less than 1000 words):

1. Who are the principle manufacturers of inspection microscopes and surface profilometers?
2. How much does a typical microscope and surface profilometer cost (used and new)?
3. What are the principles of operation of surface profilometers?
4. Provide two other different ways of measuring surface topography. Describe their principles.

II. Lab Work:

Warning: Laboratory equipment is delicate, so be careful when you use it. Take your time to setup and do the measurement, keep good notes of what you have done, and when in doubt consult the manuals or the instructors.

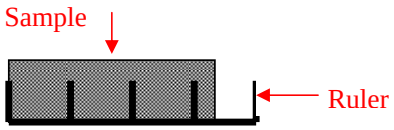
Samples: The test samples are on two wafer holders and they are color coded. The "blue" coded wafer holder contains "left-over" dies from a previous year pressure sensor class project. The "green" coded holder contains a wafer from a microelectrode/ microsensor class project. Gold is used for metallization.

Task #1: Sample inspection and measurements using the microscope.

PART A: Use the optical microscope to visually inspect the two samples. Use different magnification to obtain different views. Become familiar with the focus and position adjustment knobs.

Use the calibrated eyepiece to measure the distance between the fingers in one of the structures (interdigitated sensors) on the "green" sample. Make a simple drawing for one of the structures on the "green" sample and chose three of the dimensions to measure.

The calibrated eyepiece has a ruler with marking in it. First line up the ruler to the edge of the feature you want to measure.



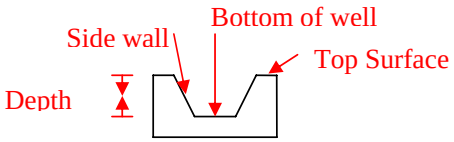
Each of the marking on the ruler is 100 units. In the drawing the feature is 300 units + some amount less than 100. Use the long line that is controlled by the knob on the calibrated eyepiece to measure the remaining length. First, turn the knob until the line is overlapping the last ruler marking that falls on the feature. Check the number on the knob. Turn the knob until the line is at the edge of the object that you want to measure. Check the number again. Add or subtract the numbers depending on the direction you turned the knob. Add this to the measurement you took using the ruler. In this example add the number to 300. Make a simple drawing for one of the structures on the "green" sample and mark the important dimensions.

Repeat this five times on three different features on the wafer, noting in your lab-book in each case the feature that you picked.

Calculation: Once you have obtained a measure for each of the features in units, you will need to convert this measure to microns. The conversion factors are posted on the base of the microscope. Each objective has its own conversion factor. For the 5X objective, the conversion factor is 0.54 units per micron, but for 20X objective, the factor is 2.1 units per micrometer.

PART B: Measure the depth of the etched wells in the backside of the pressure sensor on the "blue" sample.

You are measuring the depth of a well in a structure with a cross-section that looks like this:



If you look at the edge of the well you will see three sections: the top surface, the side wall (solid black), and the bottom of the well (very bumpy). The method that you will use to measure the depth of this well depends on the fact that for a given objective the focal length is constant. That is, when you focus on a surface the distance between the objective and the surface is a constant. To perform this measurement, first focus on one of the surfaces and note the number on the fine adjust knob for the focus. Then using only the fine adjustment, focus on the upper surface and again note the number. (You need to record the number of revolutions that have been made as well as the numbers. You may want your lab partner to help you with this since you can't watch through the oculars and look at the knob at the same time.)

Task #2: Taking a profile of the surface using the profilometer.

The profilometer is a very delicate instrument so use extra caution when working with it. In particular, the lever must be forward when loading and unloading the samples.

Use the profilometer to measure the thickness of the gold layer on the "green" sample. First initiate a baseline scan on the wafer next to the desired location by setting the instrument into manual mode and then pressing start. Use up or down arrows on the instrument to level the base so that the baseline doesn't drift off the paper. Repeat until you get a good baseline -multiple scans may be necessary-, deposit the tip over the desired area and do an automatic scan.

III. Postlab Work:

1. What are the microscope measurement variations (errors) among different measurements and different operators? Give examples from your lab-book.
2. What are the things that might affect the precision of your measurements?
3. What do you think is the most difficult part of this measurement method and is there anything you can do to make it easier?
4. What is the working range and resolution of profilometer?

Original lab procedure prepared by A.G. Andreou, Fall 1998; contributions by Jennifer Blain, Fall 2002 and Huy Vo, Fall 2004, revised by H. Vo, T. Yeh and M. Ho, Fall 2007.

Comment [M1]: Time needs to change.