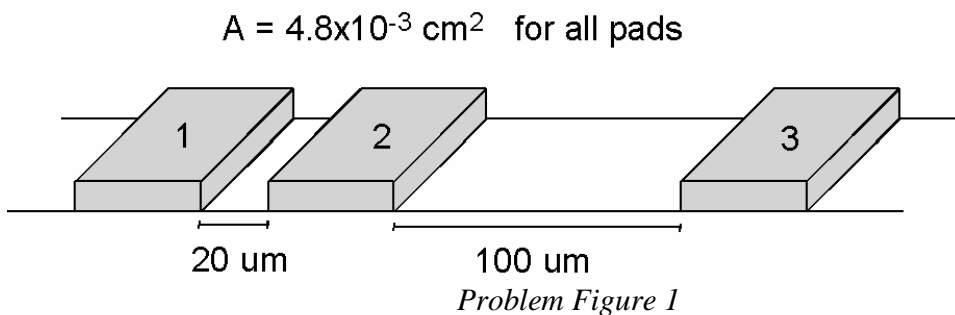


ECEn 452 – Semiconductor Devices Lab  
Week 5: “Contact Resistance”  
Objectives

**Prelab Questions**

1. How does the distance between pads affect the measured resistance?
2. How does the probe station measure resistance?
3. Three metal pads are deposited on a semiconductor surface, as shown in Problem Figure 1. With an applied voltage of 1V between Pad 1 and Pad 2, 30 mA of current flow through the semiconductor. The same voltage is applied between Pad 2 and Pad 3, causing 15 mA of current to flow. Calculate the specific contact resistance of the semiconductor.



**Objectives**

1. TLM Measurements:

Using the HP4145 Parameter Analyzer and the probe station, you will test the contact resistance of all your metal samples from the previous lab. You will utilize the TLM method by measuring the total resistance between adjoining metal pads that are spaced at varying distances. Notice that each column has pads that are constant in surface area but varying in distance spaced apart.

The HP4145 applies a voltage between the two probes and then measures the current flow. From the graph displayed on the 4145, you can then calculate the resistance ( $R_{\text{pad1}} + R_{\text{semi}} + R_{\text{pad2}}$ ) between the two pads. Determine this resistance versus pad spacing for all your samples. Several different pad sizes are available for your TLM pattern. The wider pads should have less “fringing” effect and should yield more accurate results. Compare the resistances between the thinner pads and the wider ones. There are also pads that are longer and thus have more surface area. Investigate how this dimension affects your resistance calculations. Remember that although larger surface area will decrease the *total* resistance proportionately, the *contact* resistance (which is measured in  $\text{cm}^{-2}$ ) should remain the same. Verify that this is true in your calculations for contact resistance.

The basic TLM pattern and intended spacing is shown in the figure at the end of the objectives as it is laid out on your wafer, all dimensions are in microns. However, the actual spacing between your metal pads probably has an additional few microns because of over-etching of the metals.

## 2. Determining Contact Resistance:

Make plots of your resistance vs. pad spacing measurements from Objective 1 to determine contact resistance. Be sure to do this for each of the annealed samples. Ideally, the contact resistance will be independent of the pad size and spacing, but dependent on annealing conditions. Is this true in your measurements? What annealing conditions gave you the lowest contact resistance?

## 3. Silicon Surfaces:

When you have completed your electrical measurements, etch the annealed metal from your samples with either aluminum or nickel etch. Examine the wafers under a microscope to see if you can see any changes to the surfaces. Are there any indications of alloy formation between the metal and the semiconductor?

