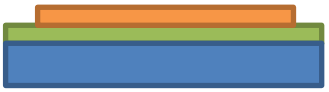
Microfabrication Lab Demo

CHEM-E5115

Lab Demo1, 2019
Return to MyCourses by March 31st.

Introduction

The idea of this lab demo is to show cleanroom processes in real life, and to answer the question "What steps 'lithography' really include?" After the lab demo, student should know how the wafers are handled in cleanroom, how the process equipment really looks like and what is the speed of 11 step process.



The objective is to fabricate simple devices shown in the figure on the right. The device includes metal wires with different dimensions and contact pads for the wires. The process flow for this device is explained below.

Pre-processing

a. Substrate: pre-cleaned <100> Si wafer
b. Thermal oxidation
c. Aluminum sputtering

Process Flow in Cleanroom: assistant with students

Wafer HMDS Priming in oven 21min (Started by assistant before students enter)

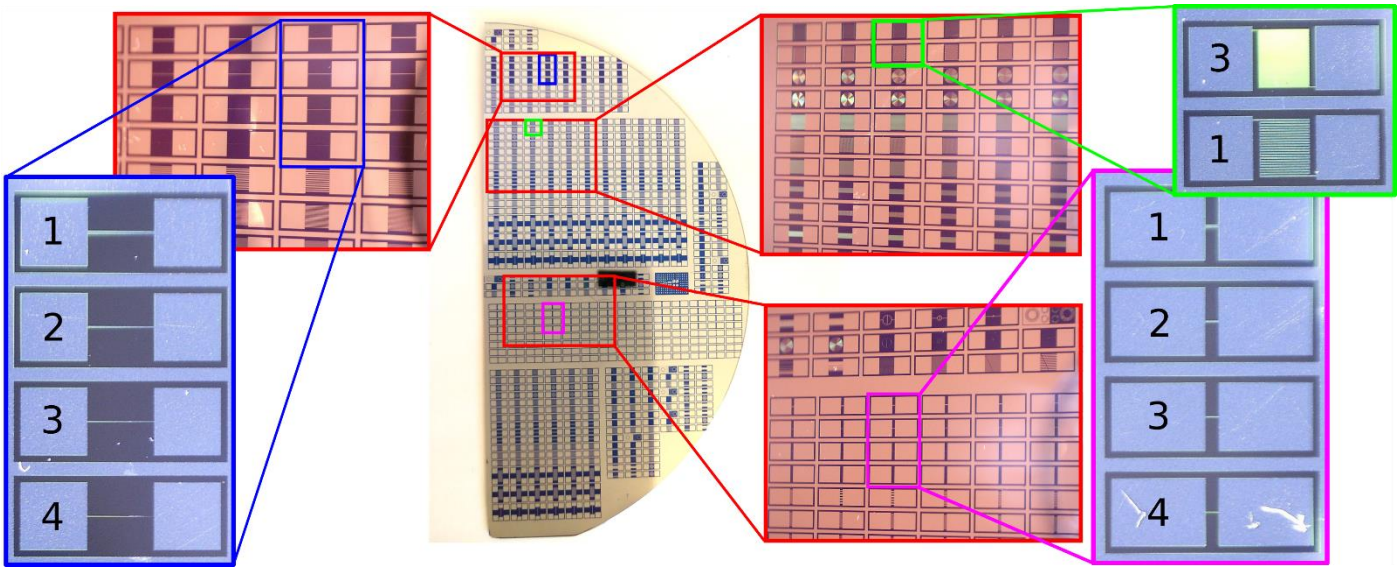
1. Photoresist AZ5214 spinning on wafer (Recipe 1)
2. Photoresist soft bake 90˚C for 1min
3. ϴ Mask alignment and UV exposure 3s ϴ (Chromium Mask: MB2-Microbridges 2001)
4. Photoresist developing in tank 45-60s
5. Rinsing in DI-tank and drying with single wafer dryer
6. ϴ Check the results with microscope ϴ
7. Hard bake 120˚C for 2min
8. Aluminum wet etching H_3PO_4 /HNO_3 2 minutes in 50˚C (turn on the heater at least 15min earlier)
9. Rinse 3 minutes in bubbler bath (automatical timer when your start the bubbler)
10. Photoresist stripping with acetone 5min, rinsing with Isopropanol and DI-water
11. ϴ Profilometer and ellipsometer measurements ϴ (Ellipsometry for blank wafer)
12. Take the wafer out of the cleanroom

Group work by students without assistant

(Detailed instructions can be found from measurement table)

13. Resistance measurement of the wires (Multimeter)
14. Measure the resistance in 200°C
15. Annealing 450˚C for 20min
16. Re-measure the resistance after cooling down (in room temperature)

Measurements



Profilometer measurement

Wire	Al Thickness (nm)		Wire width (µm)	
Length	**1.0mm**	**0.2mm**	**1.0mm**	**0.2mm**
1				
2				
3				
4				

Ellipsometer measurement

Measurement	Oxide thickness (nm)	
1, 2		
3, 4		
5, 6		

Electrical resistance measurement

Wire	Before annealing RT (Ω)		During annealing 200 °C (Ω)		After annealing RT (Ω)	
	1.0mm long	0.2mm long	1.0mm long	0.2mm long	1.0mm long	0.2mm long
1						
2						
3						
4						
Serpent 1						
Serpent 3						

Questions (4p total)

1) Calculate the aluminum thin film resistivity of as deposited samples. Compare it to literature values (remember to include reference!). Use resistance measured **before** annealing. **(1p)**

NOTE: remember compatible units, e.g. Ωm vs. μΩcm

2) Calculate the length of serpent wires. Use your measured data. **(1p)**

NOTE: Serpent wires 1 and 3 have the same width as wires number 1 and 3, respectively.

3) Why is electrical resistance higher during annealing? How does annealing affect the electrical resistance? What happens to metal during annealing? Why is resistance lower after annealing? Recalculate resistivity! Compare "before" and "after" resistivities! **(1p)**

4) What is the wavelength we used for exposing the resist AZ5214 and why this is important? (We used Süss Microtec mask aligner MA-6 for exposure.) What would be different if we had evaporated the aluminum film? If you measure Al sheet resistance, and film thickness is non-uniform, how do you know resistivity? What would be different if we used plasma etching of Al film instead of wet etching? **(1p)**