High School Summer Intern Program

University of California, Berkeley

EECS/ERL

Characterization of Boron Diffusion from Boron+ Source Wafers

Summer 2003

Bonny McKeon

High School Senior

Bishop Union High School

Bishop, California

Microlab

Outline

Introduction

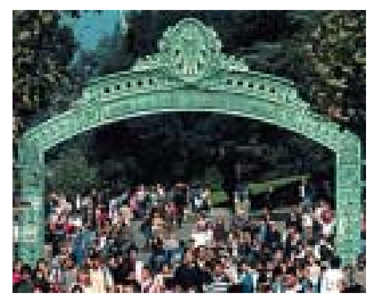
- **Why I came to the Microlab**

Assignment

- **Cleanliness is Paramount**

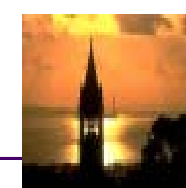
Project

- **Objective**
- **Experimental**
- **Analysis**
- **Conclusion**



What I have learned

Acknowledgements



Why I came to the Microlab

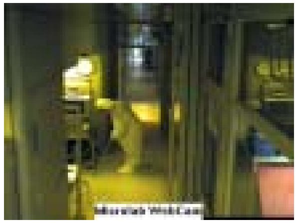
- **My last summer to do something impressive**
- **Nothing seemed interesting**
- **Mom happened upon website**
- **Denied at first**
- **Visited Microlab**
- **Good opportunity to learn about engineering**

Cleanliness is Paramount

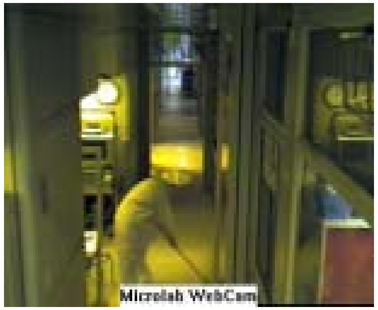
• Hundreds of steps to complete one design

• At micron level, fabricated devices can malfunction from dirt and organics

• Many precautions are therefore taken to insure cleanliness

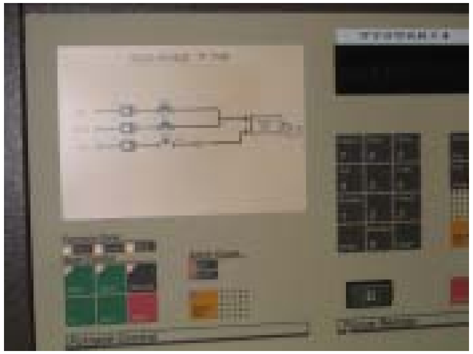


- Lab members must gown-up
- Adhesive mats are placed through-out lab



- Lab surfaces must stay clean
- Air is constantly filtered
- De-ionized water used

Characterization Of Boron Diffusion From Boron+ Source Wafers



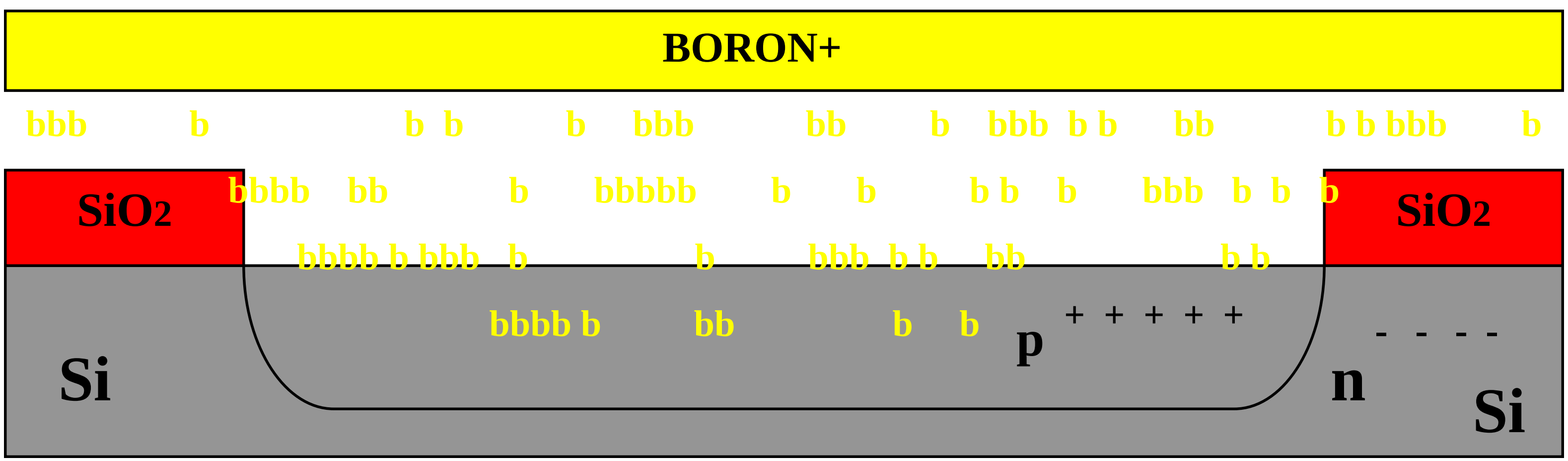
Theory

Diffusion Theory

- Method used to introduce impurities into silicon

Applications

- Etch stop for MEMS
- Junction formation for devices



Experimental

I. Sample Preparation

II. Boron+ Diffusion

III. Oxide Removal and Measurements

IV. Measurement Summary

Sample Preparation

I. Check out 25, 4" N-type test wafers

II. Scribe: 1-25

III. Clean:

$H_2SO_4 + H_2O_2$	10 minutes
Rise	5 minutes
10:1 H_2O: HF dip	30 seconds
Rinse	5 minutes

Boron+ Diffusion

I. Load recipe in furnace computer for Tystar14

II. Open furnace, load wafers into boat: back-to-back, facing source wafers (white ceramic)

III. Start program; run for determined time

IV. Unload wafers

Oxide Removal and Measurements

I. **Oxidize in steam for 30 minutes at 900°C in Tystar3 to dilute boron glass**

II. **Measure oxide (glass) thickness using Nanospec**

III. **Remove glass:**

  Dip in 5:1 H_2O:HF for 30 seconds

  Rinse

  Repeat 3 times

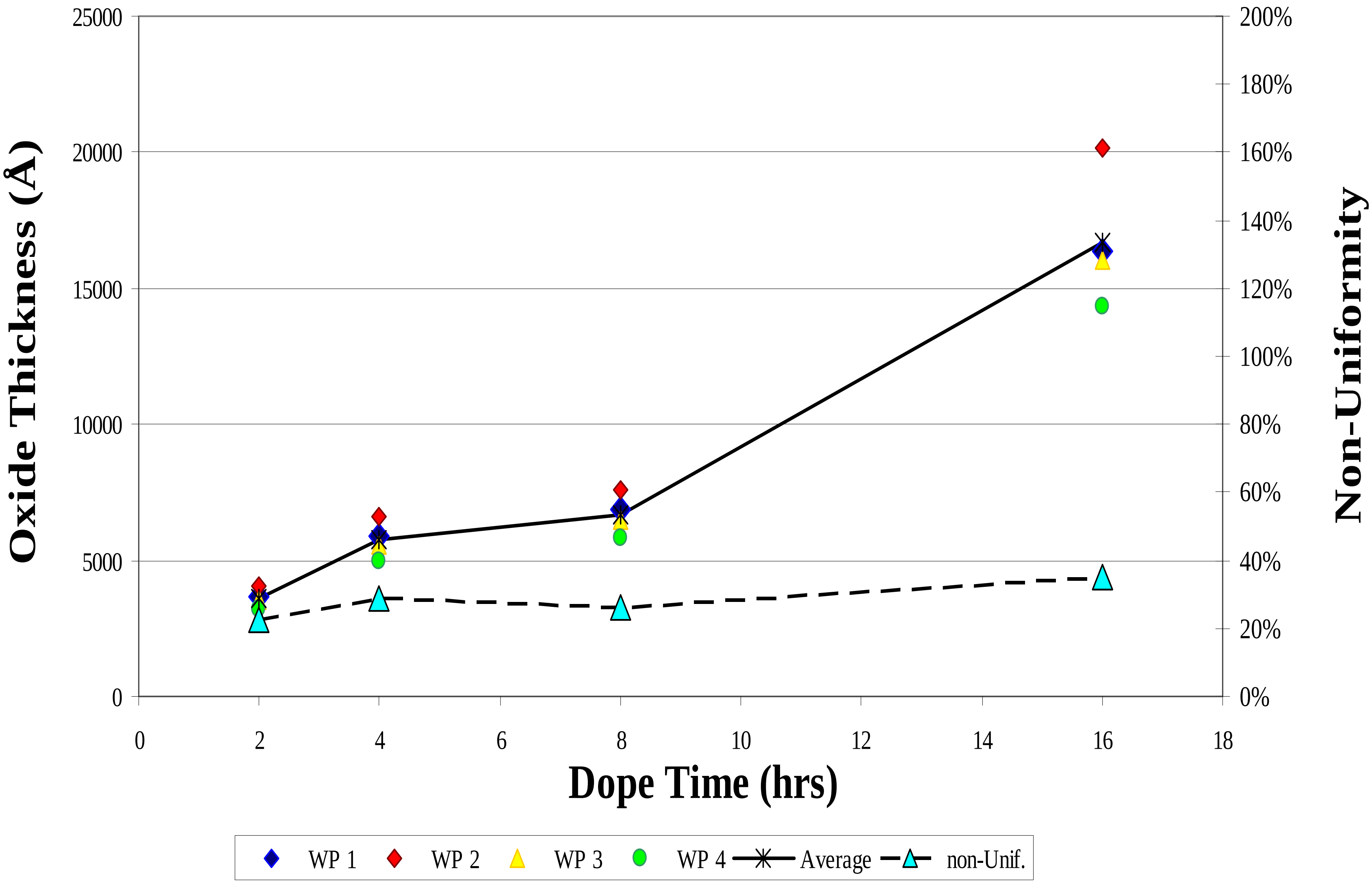
IV. **Measure sheet resistivity on 4-point probe**

Measurement Summary

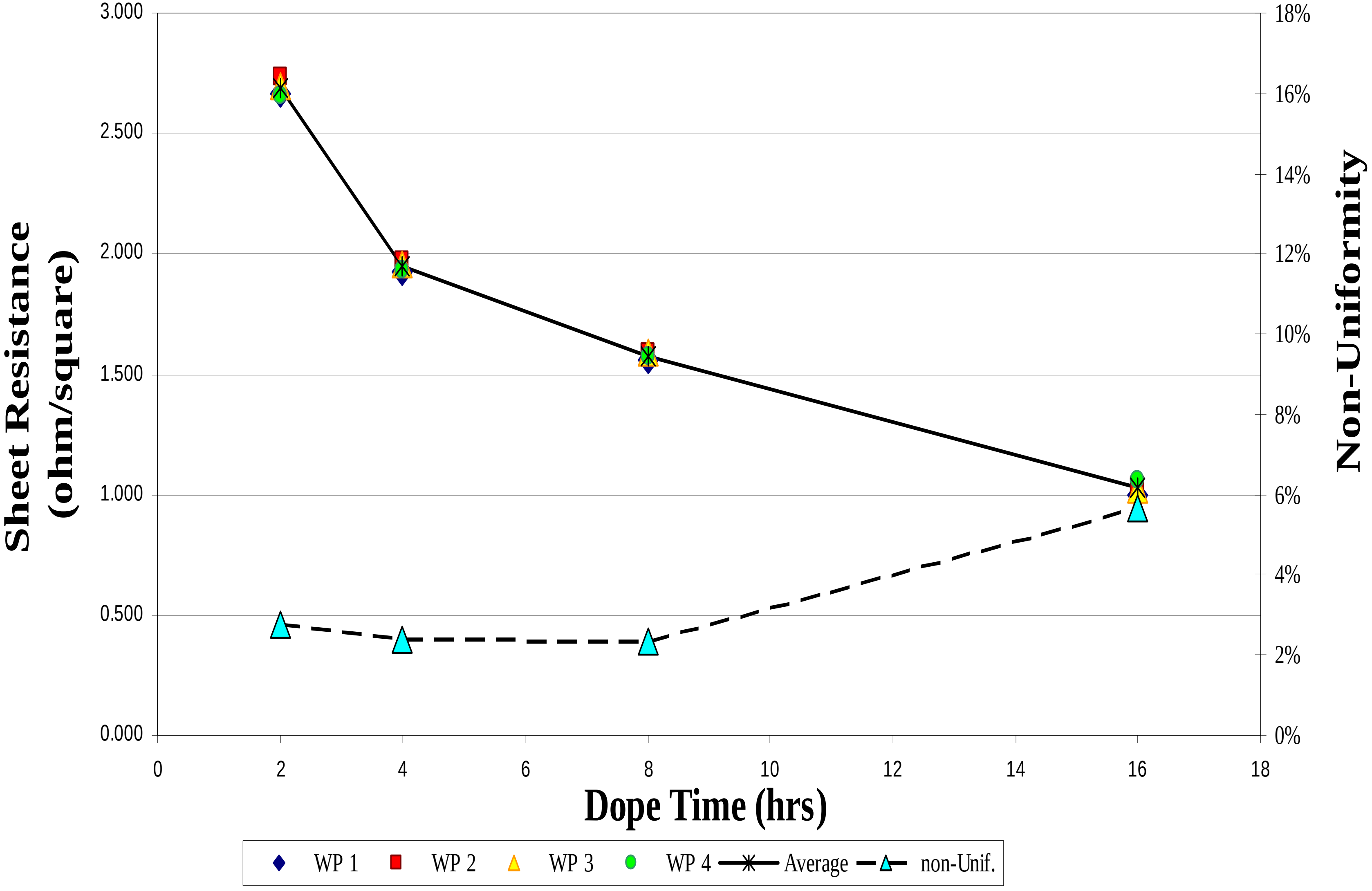
	Oxide Thickness (Å)					
Dope Time (hrs)	WP 1	WP 2	WP 3	WP 4	Average	non-Unif.
2	3663	4034	3504	3222	3606	22.54%
4	5915	6609	5592	4960	5769	28.58%
8	6877	7620	6448	5853	6700	26.38%
16	16355	20170	16008	14341	16718	34.87%

	Sheet Resistance (ohm/square)					
Dope Time (hrs)	WP 1	WP 2	WP 3	WP 4	Average	non-Unif.
2	2.664	2.734	2.700	2.660	2.690	2.75%
4	1.921	1.968	1.955	1.936	1.945	2.41%
8	1.556	1.593	1.587	1.571	1.577	2.33%
16	1.000	1.038	1.021	1.058	1.029	5.67%

Tystar14 Oxide Thickness Chart



Tystar14 Sheet Resistance Chart



Conclusion

Our results indicate:

- **Growth of oxide thickness will increase with dope time**
- **Resistivity decreases as time elapses (Less voltage is required to run device as the concentration of dopant increases)**
- **Sheet resistance does not change linearly with diffusion time (If wafer stayed in twice as long, resistance will not be twice as low**

What I Have Learned

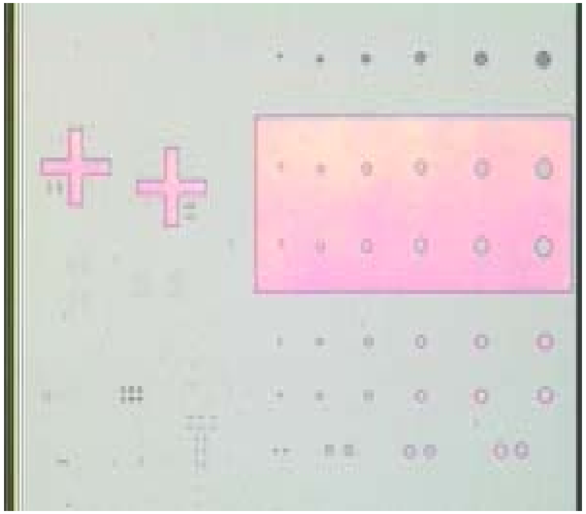
- **Wafer fabrication is a costly and tedious job, requiring hundreds of steps, where the wafers are easily susceptible to contamination**

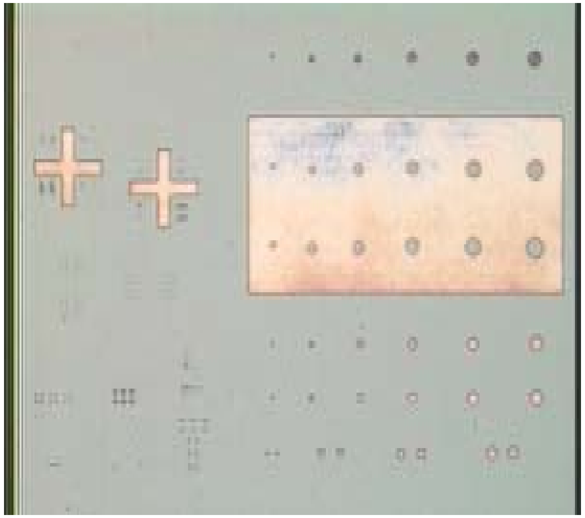
- **The importance of lab cleanliness is imperative, though often overlooked**

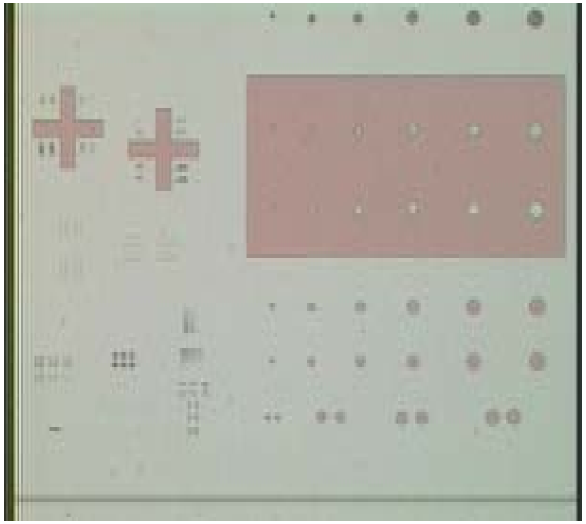
- **Doping can change the conductivity and resistivity of a wafer**

~Photolithography~

When transferring a pattern from a mask to the wafers' surface, the amount of energy from the u.v. light determines how much photoresist will be removed.







Acknowledgements

Marilyn Kushner for taking me throughout the lab and showing me the importance of lab cleanliness

Jimmy Chang, this project would still be a foreign language if it were not for your knowledge, patience, and guidance

Kim Chan for teaching me the basics of photolithography

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Mom- thanks for pushing me to take an opportunity such as this one