

THE UNIVERSITY OF TEXAS AT AUSTIN WHAT STARTS HERE CHANGES THE WORLD

CHE323/CHE384
Chemical Processes for Micro- and Nanofabrication

Lecture 1 Semiconductor Overview

Chris A. Mack
Adjunct Associate Professor

Reading:
Chapter 1, *Fabrication Engineering at the Micro- and Nanoscale*, 4th edition, Campbell

© Chris Mack, 2013 1

THE UNIVERSITY OF TEXAS AT AUSTIN WHAT STARTS HERE CHANGES THE WORLD

What is a Semiconductor?

- A material whose conductivity can be varied by many orders of magnitude
 - Temperature
 - Light
 - Doping
 - Electric Field } Can be applied locally
- Can be made into a switch
 - Current-controlled switch (e.g., bipolar transistor)
 - Voltage-controlled switch (e.g., MOSFET)

© Chris Mack, 2013 2

THE UNIVERSITY OF TEXAS AT AUSTIN WHAT STARTS HERE CHANGES THE WORLD

Semiconductor Processing

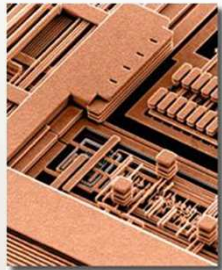
- Creating small, interconnected 3D structures of insulators, semiconductors, and conductors (called patterning)
 - Allows manipulation of local electric field and current
- Selectively doping semiconductor regions to create p-n junctions and other electrical components
 - Allows manipulation of local charge carrier concentration

© Chris Mack, 2013 3

THE UNIVERSITY OF TEXAS AT AUSTIN WHAT STARTS HERE CHANGES THE WORLD

Patterning

- Subtractive patterning
 - Deposition
 - Lithography
 - Etch
- Additive patterning
 - Lift-off
 - Damascene



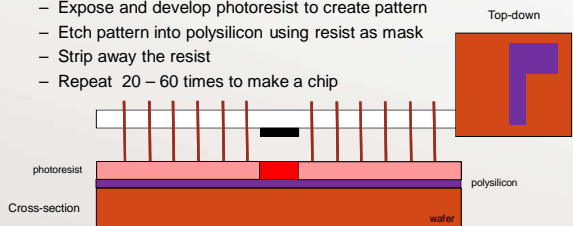
From IBM website

© Chris Mack, 2013 4

THE UNIVERSITY OF TEXAS AT AUSTIN WHAT STARTS HERE CHANGES THE WORLD

Patterning Example

- Patterning Sequence (example)
 - Deposit polysilicon (for example) on wafer
 - Deposit photoresist layer on top of polysilicon
 - Expose and develop photoresist to create pattern
 - Etch pattern into polysilicon using resist as mask
 - Strip away the resist
 - Repeat 20 – 60 times to make a chip



© Chris Mack, 2013 5

THE UNIVERSITY OF TEXAS AT AUSTIN WHAT STARTS HERE CHANGES THE WORLD

Patterning Techniques

- Deposition Techniques
 - Physical Vapor Deposition (PVD)
 - Sputtering
 - Evaporation
 - Chemical Vapor Deposition (CVD)
 - Oxidation
- Etch techniques
 - Dry (plasma, reactive ion etching)
 - Wet
- Patterning is used to make wires, insulators, and regions of selective doping

© Chris Mack, 2013 6

THE UNIVERSITY OF TEXAS
AT AUSTIN

WHAT STARTS HERE CHANGES THE WORLD

Localized Doping

- Patterning
- Ion implantation
- Annealing (diffusion)

B ions accelerated to hundreds of keV

© Chris Mack, 2013 7

THE UNIVERSITY OF TEXAS
AT AUSTIN

WHAT STARTS HERE CHANGES THE WORLD

We are making...

- Transistors
- Chips
- Wafers

© Chris Mack, 2013 (this is mass production!) 8

THE UNIVERSITY OF TEXAS
AT AUSTIN

WHAT STARTS HERE CHANGES THE WORLD

Lecture 1: What have we learned?

- Define “semiconductor”
- What are the two important ways to locally change the conductivity of a semiconductor?
- What is patterning?
- Draw a basic diagram outlining the steps of a subtractive patterning process
- Define “ion implantation”
- Why is annealing required after ion implantation?

© Chris Mack, 2013 9