Lecture 38
Lithography: Introduction
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Reading:
Chapter 7, Fabrication Engineering at the Micro- and Nanoscale, 4th edition, Campbell

What is Lithography?
• In the art world, lithography is a two-century-old printing technology used to make prints and posters.
• In the semiconductor world, lithography is the printing technology used to mass-produce chips like microprocessors, memory and flash that are at the heart of electronic devices.

Defining Lithography
li · thog · ra · phy, n. [<Gr. lithos, stone + graphia, to write]
1. a printing technique based on the production of a three-dimensional relief image on a substrate (writing on stones).

Motivation (Why care about lithography?)
• Why is lithography so important?
  – 50% of the cost of making a modern chip (integrated circuit) is litho cost
  – Improvements in chip cost and performance (Moore’s Law) have historically been gated by lithography capability
• Chip companies, governments, and universities continue to invest large sums in lithography R&D
  – The hope is to keep Moore’s Law going

Why Size Matters
• We cram more transistors onto a chip by making each transistor smaller
  – Lithography improvements must enable the printing of smaller features without significantly increasing the cost of making the chip

A Note on “Small”
Patterns printed with lithography to make transistors are as small as 20 nm today, and still getting smaller!
Subtractive Patterning

- 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

Lithography – The Basics

- Ingredients of a Lithography System
  - A master pattern to be reproduced called a photomask
  - A photosensitive film called a photoresist
  - A special camera (called a stepper or a scanner) that projects an image of the photomask into the photoresist
  - A tool for processing the photoresist (coating, baking, developing) called a track

Lithography Sequence

- Wafer Coat PEB Develop Expose Metrology Prebake
- Track and Stepper/Scanner combined into a "photocell"

Example Lithography Tools

- From Nikon Corp.
- From ASML

Example Tracks

- TEL Lithius Plus (from Tokyo Electron)
- SVG 88 (Silicon Valley Group)

Lecture 38: What have we Learned?

- Give two important reasons why lithography is one of the most critical technologies in semiconductor manufacturing?
- What are the basic steps in a lithography sequence?
- What are the ingredients (tools and materials) of a lithography process?