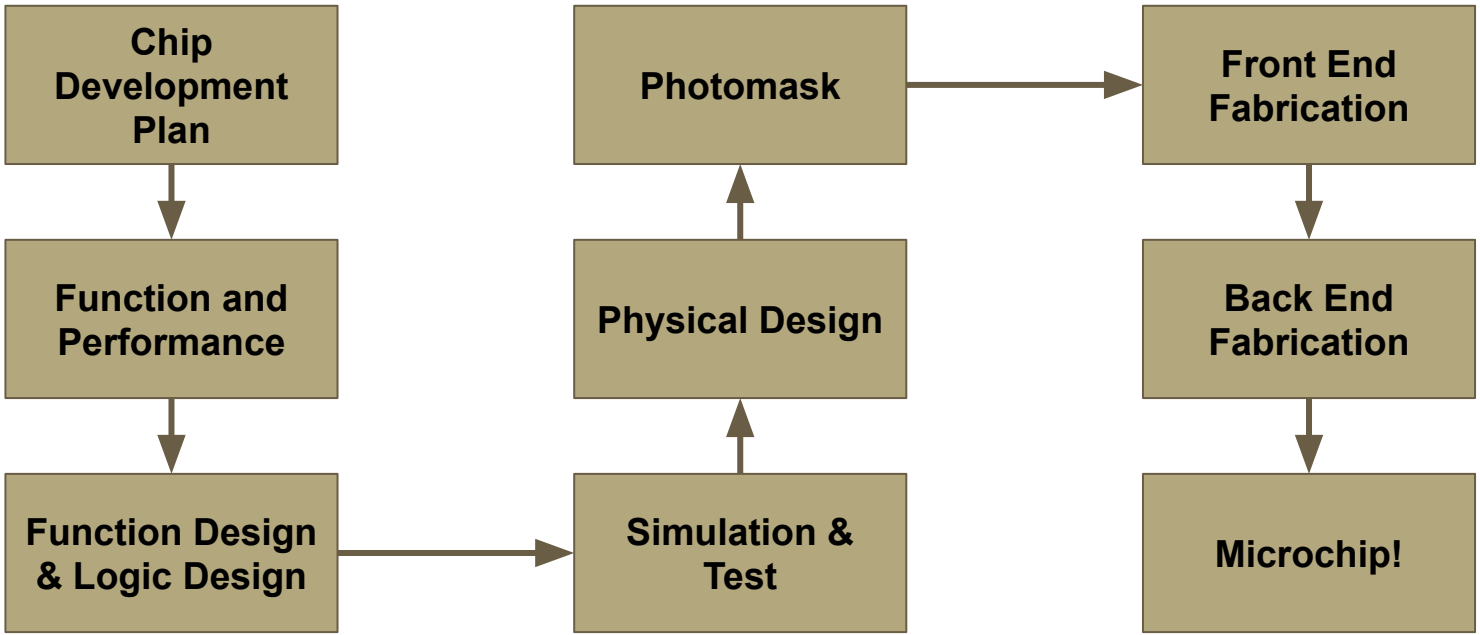
Bits of Architecture

Semiconductor Manufacturing

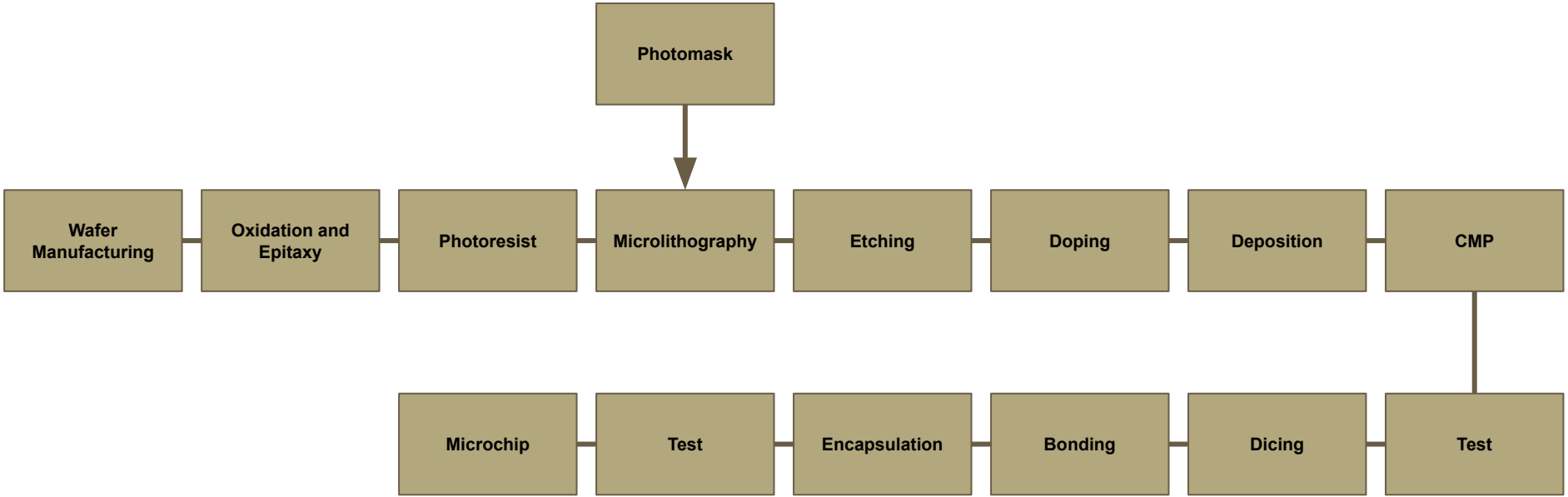
How Do You Make a Chip?

High-Level Processes (I.C. Design + Fabrication)

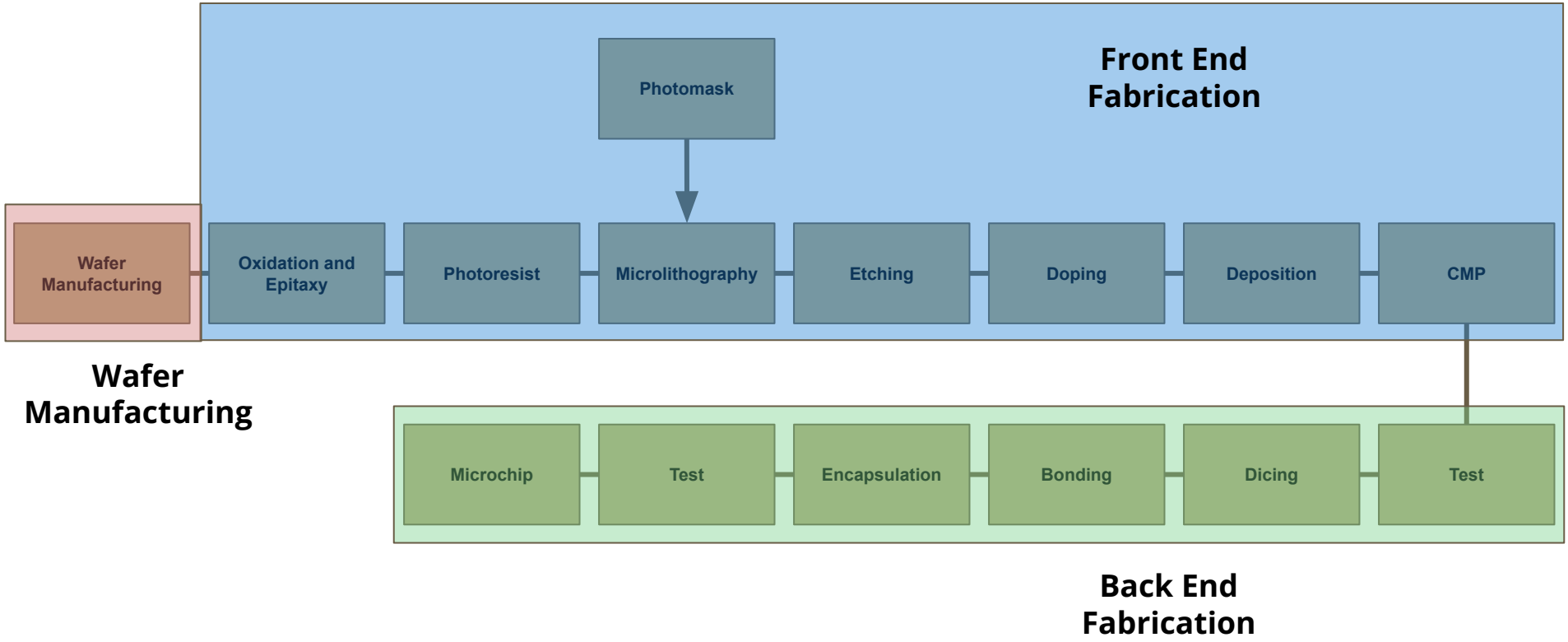


Under the Hood...

Making a Microchip



Making a Microchip



Wafer Manufacturing

The Foundation of Microchips

- Starts with a silicon ingot
- Lowered in ~100% pure molten silicon and gradually withdrawn
  - Silicon atoms attach to the seed, creating a large rod of silicon
- Wafer Preparation
  - Cropping, grinding, and slicing
  - Lapping
  - Etching
  - Polishing
  - Cleaning

Front End Fabrication

Front End Fabrication (Part 1/3)

- **Epitaxy**
  - Deposit an overlayer of crystal (epitaxial film) on the substrate (in a defined orientation w.r.t. the substrate)
- **Oxidation**
  - Growth of silicon dioxide (an electrical insulator) on the wafer

Front End Fabrication (Part 2/3)

- **Photolithography**
  - Our **Photoresist** and **Microlithography** stages
  - **Photomask**
    - A copy of the circuit pattern drawn on a quartz plate
    - The “stencil” for creating I.C.
  - Apply **photoresist** to wafer + expose to light through our **photomask**
    - Protects parts of the wafer from later stages
- **Etching**
  - Removes silicon, silicon oxide, polysilicon, or metals
- **Doping**
  - Increasing conductivity of the silicon via ion implantation or diffusion

Front End Fabrication (Part 3/3)

- **Deposition**
  - Deposition of silicon nitride, silicon dioxide, silicon, or metal onto wafers
- **Chemical Mechanical Planarization (CMP)**
  - Application of an abrasive chemical slurry
  - Polishing + removal of excess material

Back End Fabrication

Back End Fabrication (Part 1/2)

- **Testing**
  - Electrical test of chips on wafer (and marking of chips for rejection)
- **Grinding + Dicing**
  - Back of wafer is thinned (for assembling and packaging)
  - Wafer is cut in individual dies
- **Wire Bonding**
  - Connect the IC to the substrate using fine gold or copper wires

Back End Fabrication (Part 2/2)

- **Packaging + Assembly (Encapsulation)**
  - Encapsulate the semiconductor in a supporting case
- **Final Test**
  - Verify everything still works :^)
    - Functionality, performance, power, etc.

- **Then we have our chip!**