Quick Start Micro Training LLC
Very Quick Start™ Microelectronics Course

7-Hour Narrated E Learning Course (Also Webinar or In-Person Class)

SAMPLE SLIDES FROM COURSE

Dr. Ted Dellin
Quick Start Micro Training LLC, www.quickstartmicro.com
(retired) Chief Scientist, Microsystems Ctr., Sandia National Labs.
dellin@ieee.org, 1-505-401-8707

Outline of Class

- **Introduction**
  (1. Introduction, 2. Background Review)
- **Special Properties of Semiconductors**
  (3. Semis are Special 4. Electrons & holes, 5. n & p type 6. Currents, 7. pn Junctions, 8. External voltage on pn Junction)
- **MOS Transistor & CMOS IC**
  (9. MOS capacitor, 10. MOS transistor, 11. ICs & scaling
- **Making an IC**
  (12. Overview, 13. Design & Test, 14. Unit Processes 15. Front End Process, 16. Back End Process, 17. Packaging)

Engineering Semiconductor Properties Leads to Useful Devices

Semiconductors Have Electronic Special Properties

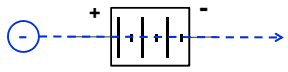
We Can Engineer (Control) Those Properties
During Design & Manufacturing — *By Applying Voltages During Device Operation*

2 Basic Building Blocks of Electronic & Optoelectronics
Junctions (Semi/Semi, Semi/Metal) — *MOS Capacitor*

Very Useful Devices
Rectifiers, Transistors, ICs, Photodetectors, Solar Cells, LEDs, Lasers

A Voltage Source (e.g., Battery) Supplies Energy

Battery of Voltage, V

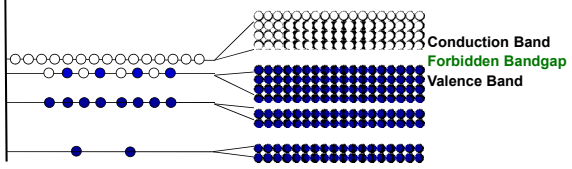


- **Charges gain energy going through a battery**
  - **Electrons gain energy from + to – side of battery**
- **Energy Gained = Amount of Charge x Voltage**
  - ***An electron going through a 1V battery gains 1 eV (electron Volt, 1.6E-19 Joules)***

Single Energy Levels of Atoms Become Bands (Ranges of Energy) in Crystals

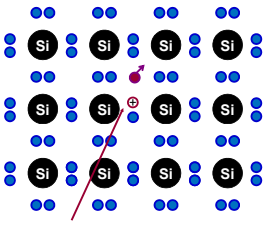
Electron's Energy

Isolated Si Atom **Si Crystal**



Single Energy Levels ***Levels in Bands of Energy***

The Positively Charged "Hole"



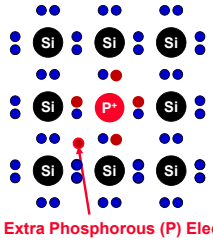
"Hole" (Missing Valence Electron)

- **The site of the missing valence electron is called a "hole"**
- **There is a charge of +1 at the hole**
  - ***14 + protons surrounded by only 13 – electrons***
- **<u>The hole can move through the crystal</u>**
  - ***An electron from an adjacent atom can fill an existing hole and in the process create a new hole at the adjacent atom***

Sample Slides

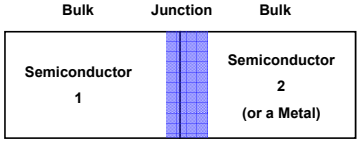
Replacing a Silicon Atom With Phosphorus Makes Silicon n Type (Excess Electrons)

n Type (Excess Electron) Si
P substitutionally replaces Si in the lattice. P's 5th valence electron is free to move about crystal.



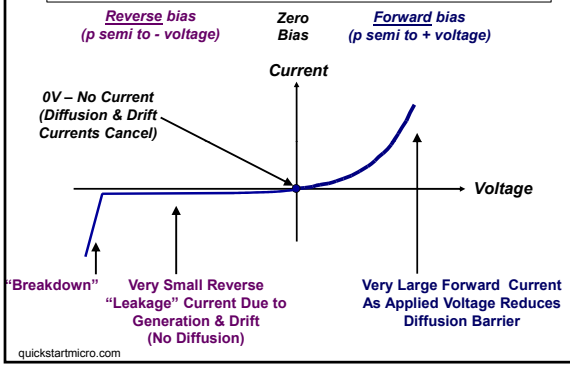
- *Si Valence Electron*
- *P Valence Electron*

A "Junction" Is Formed Whenever Two Different Semiconductors Are Joined

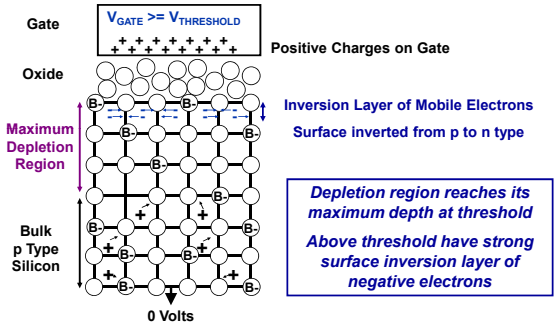


- "Bulk" regions of the semiconductors remained essentially unchanged
- Inside the junction many interesting effects can occur
  - E.g., built-in voltage and electric field and diffusion barriers

Current Through Junction Vs. Externally Applied Voltage ("IV Curve")

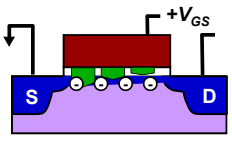


$V_{GATE} >= V_{THRESHOLD}$ *Inversion: Conductive Channel Formed*



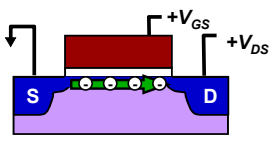
"Only Two Things" Division of Labor in MOS Transistor

1. Gate: Mobile Charges



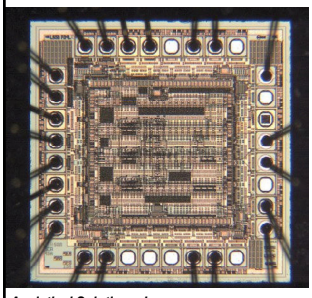
- A Gate Voltage, $V_G > V_{THRESHOLD}$ creates a surface layer of mobile charges ("inversion")

2. Drain: Average Motion of Those Charges In One Direction



- Drain Voltage produces an electric field which moves electrons from source to drain

Transistors + Electrical Interconnection = Integrated Circuit (IC)



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- IC contains:
  - *Lots of transistors*
  - *Electrical wiring between transistors and the outside world*
- The layout of the transistors plus interconnection determine the function of the IC
  - *Digital IC*
  - *Analog IC*
  - *Memory*

Sample Slides

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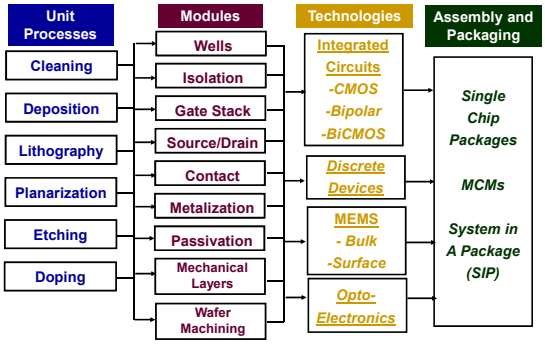
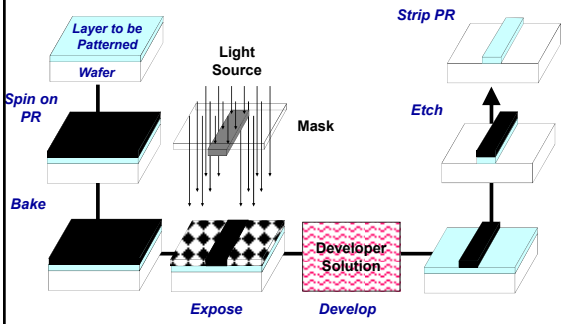
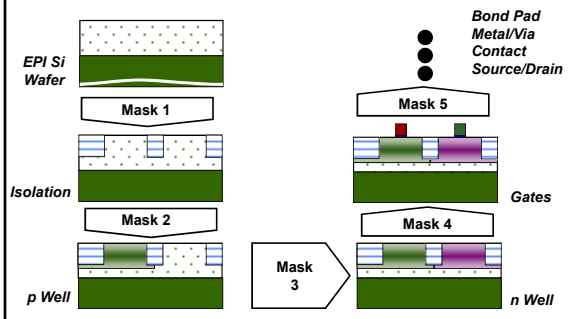
Overview of the Hierarchy In Making Semiconductor Devices



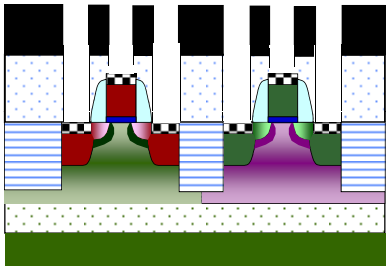
Pattern Definition Using Positive Photoresist (PR)



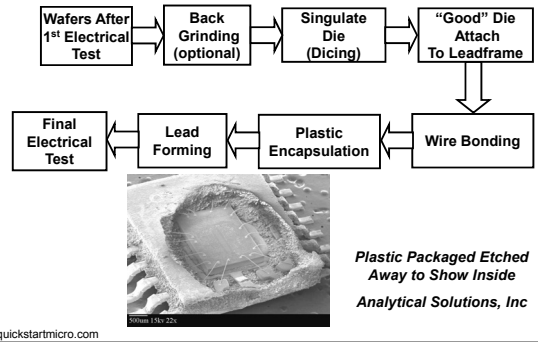
Complex Integrated Circuits Are Built Up One Feature At a Time



Mask 9: Pattern Contact Openings (Vias)



Major Steps In Conventional Wire Bond, Plastic Packaging



Plastic Packaged Etched Away to Show Inside

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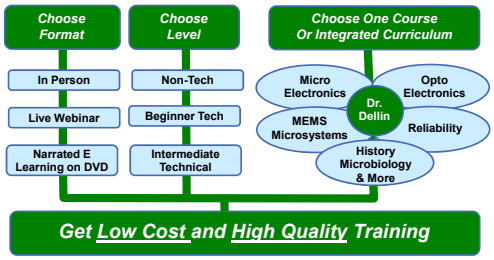
The Best and Most Affordable Semiconductor Training



More Information, Prices, … quickstartmicro.com
Or Dr. Ted Dellin, 1-505-401-8707

Sample Slides