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**VE320 – Summer 2021**

**Introduction to Semiconductor Devices**

Instructor: Yaping Dan (但亚平)  
yaping.dan@sjtu.edu.cn

Chapter 0. Course Information and Preview



# Outline

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- **Course Information**
- Preview

# Course Information

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- Time: Monday 10:00-11:40  
Wednesday 10:00-11:40  
Friday 10:00-11:40 (odd weeks)
- Instructor: Professor Dan, Yaping  
JI New Building Office 516  
Email: [yaping.dan@sjtu.edu.cn](mailto:yaping.dan@sjtu.edu.cn)
- Office Hour: 9am-10am Monday, Wednesday (online in our Feishu classroom)
- Teaching Assistants:
  - Zexi Li [lzx12138@sjtu.edu.cn](mailto:lzx12138@sjtu.edu.cn)
  - Another Two TA: to be determined.

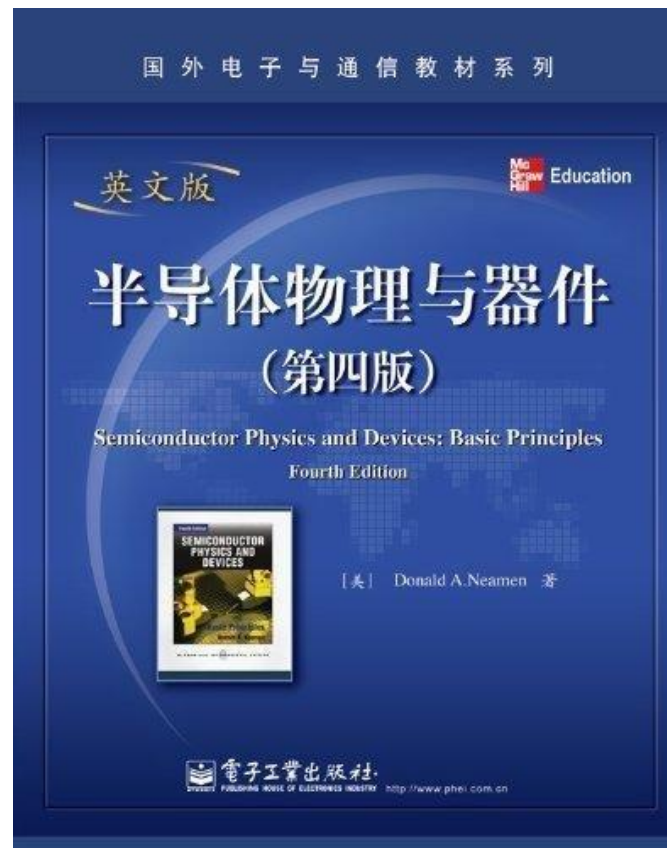
# Reference textbook

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Semiconductor Physics and Devices: Basic Principles 4<sup>th</sup> ed.

Donald A. Neamen

Publishing house of electronic industry



# Assignments, Quizzes

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- Assigned weekly on Friday, due on the following Friday.
- 13+ quizzes

Ve215, Vp240 or Vp260. If you do not meet this requirement, please see the instructor immediately after class.

# Grading Policy

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## Grading Policy

- Quizzes 5%
  - Assignments 5%
  - Midterm1 30%
  - Midterm2 30%
  - Final 30%
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- Fail, if the total grade is below 50.
  - Curve to be centered at B or B+ for the grades above 50.
  - Midterm and final exams will cover (but not limited to) the content of quizzes and assignments.

# Unethical Conducts

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- You are free to discuss homework with each other. But the work you submit must be your own.
- Any suspicious violation of the honor code will be reported to the honor council.
- Quizzes are open book, open discussion but no cheating
- Midterm and final exams are close-book.
- Standard cheating papers will be consulted with and published to all students, and distributed in the exams.

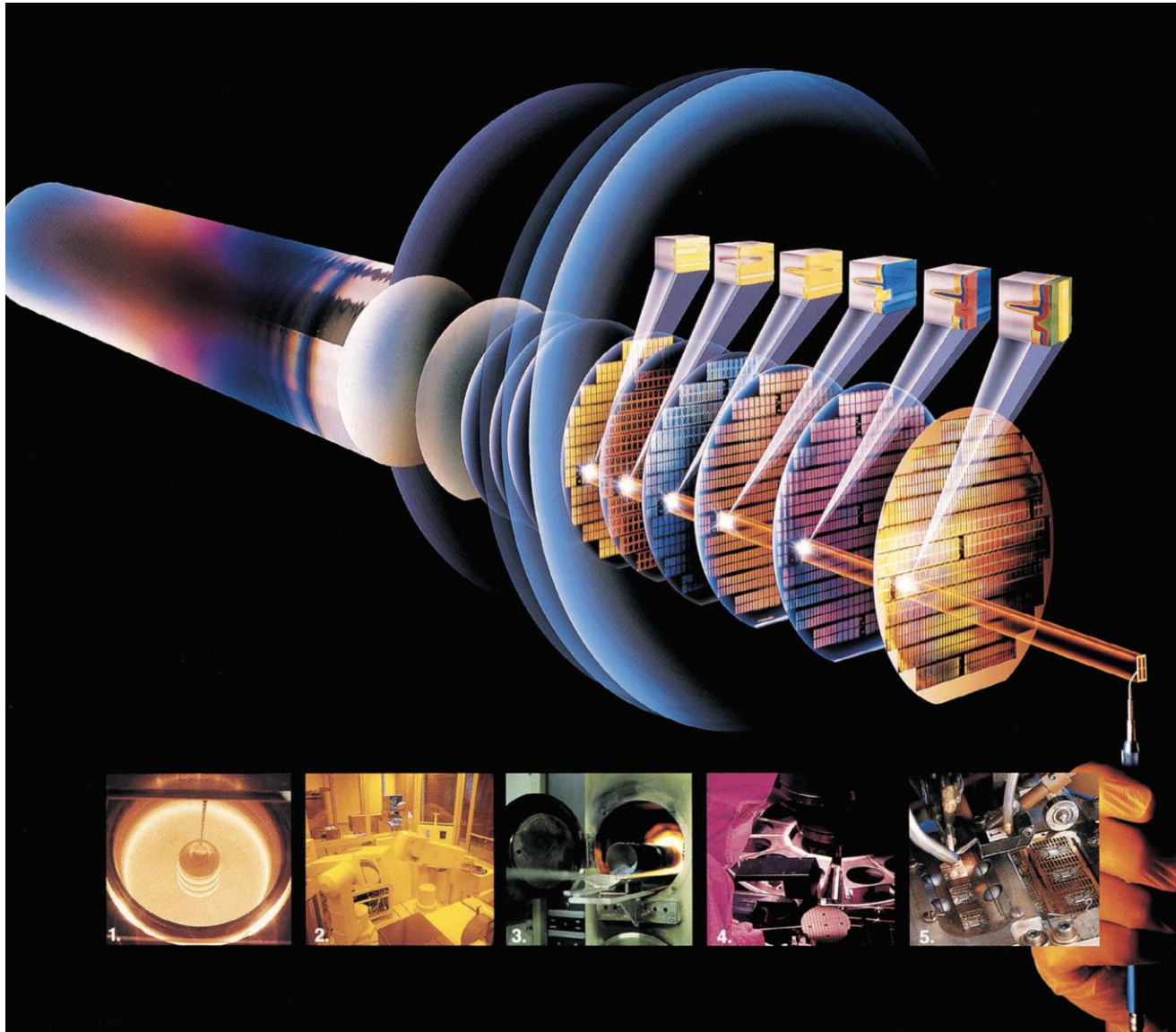
# Outline

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- Course Information
- **Preview**

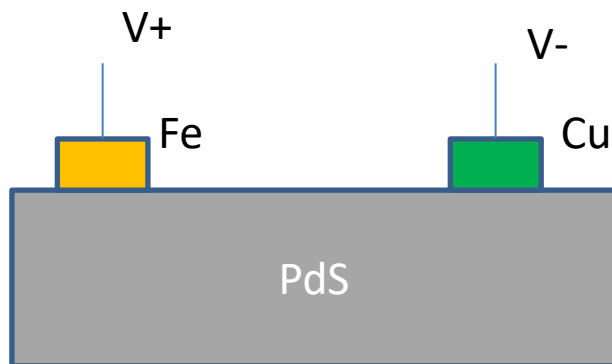


# Preview: Semiconductors and Integrated Circuits



# Preview: Semiconductors and Integrated Circuits

The first semiconductor device:



Braun in 1874



**Karl Ferdinand Braun**

Shared the 1909 Nobel Prize in Physics with [Guglielmo Marconi](#) "for their contributions to the development of wireless telegraphy"

# Preview: Semiconductors and Integrated Circuits

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Quantum Mechanics → Semiconductor Physics

(1900 - 1950s)

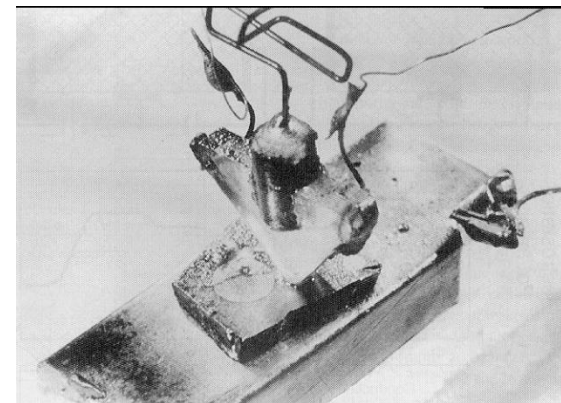
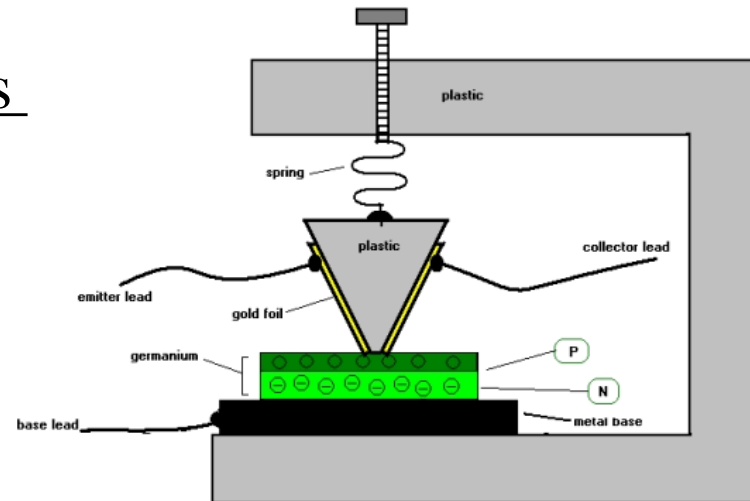
[Max Planck](#), [Niels Bohr](#), [Werner Heisenberg](#), [Louis de Broglie](#), [Arthur Compton](#), [Albert Einstein](#), [Erwin Schrödinger](#), [Max Born](#), [John von Neumann](#), [Paul Dirac](#), [Enrico Fermi](#), [Wolfgang Pauli](#), [Max von Laue](#), [Freeman Dyson](#), [David Hilbert](#), [Wilhelm Wien](#), [Satyendra Nath Bose](#), [Arnold Sommerfeld](#), and [others](#).

# Preview: Semiconductors and Integrated Circuits

## Explosion of integrated circuits



*John Bardeen, William Shockley, and Walter Brattain at Bell Labs, 1948*



First transistor Bell Labs, 1948  
Based on Ge (锗)



# Preview: Semiconductors and Integrated Circuits

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## Silicon Valley



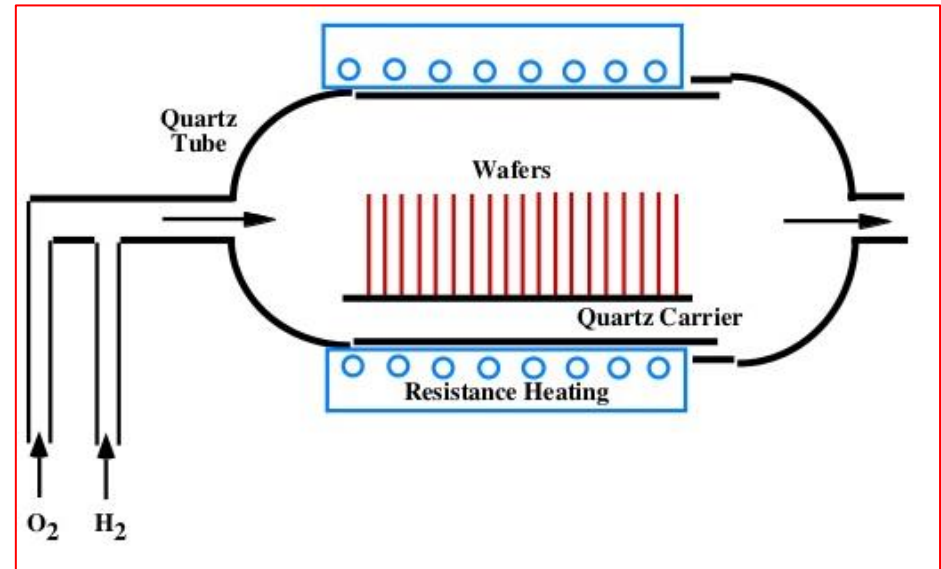
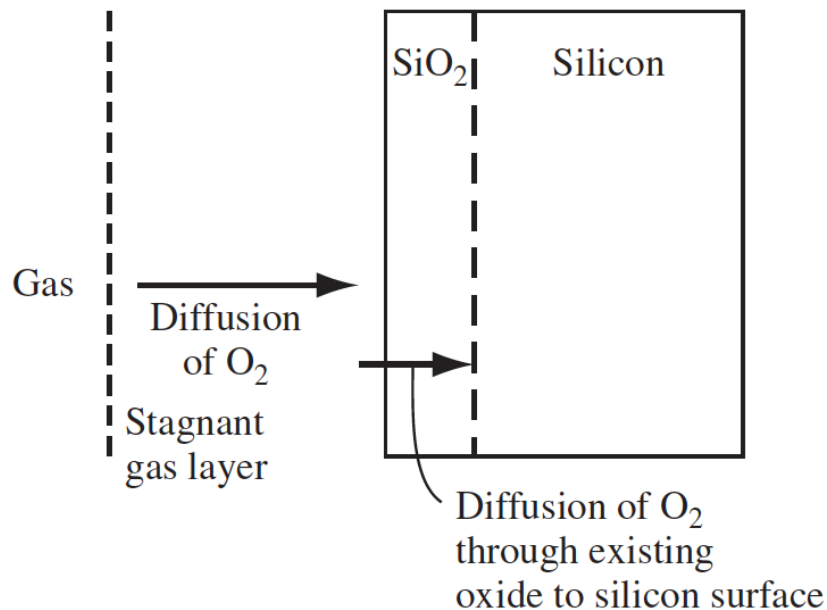
*Bell Lab, New Jersey*



*Original site at California*

# Preview: Fabrication of Integrated Circuits

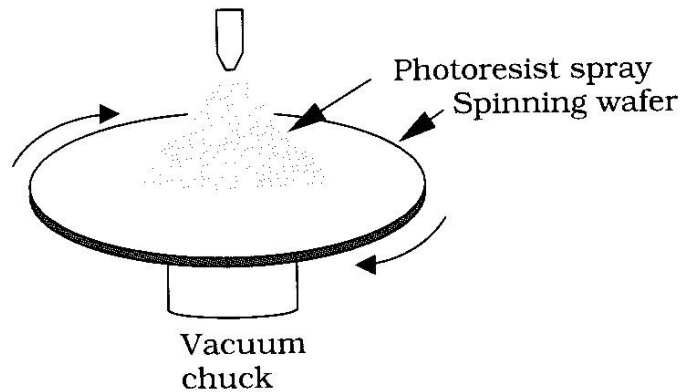
## Thermal oxidation



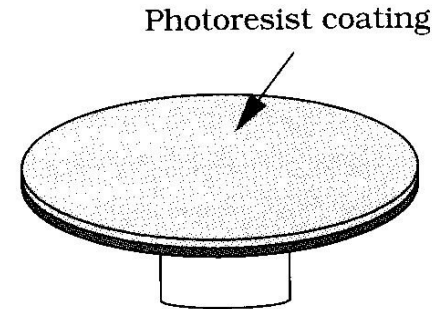
SiO<sub>2</sub>: high quality electrical insulator

# Preview: Fabrication of Integrated Circuits

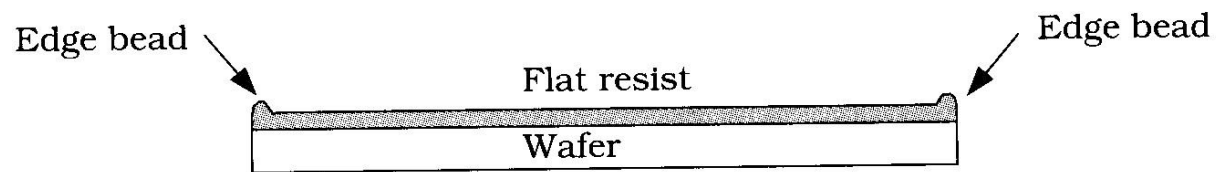
## Photolithography



(a) Resist application



(b) Coated wafer

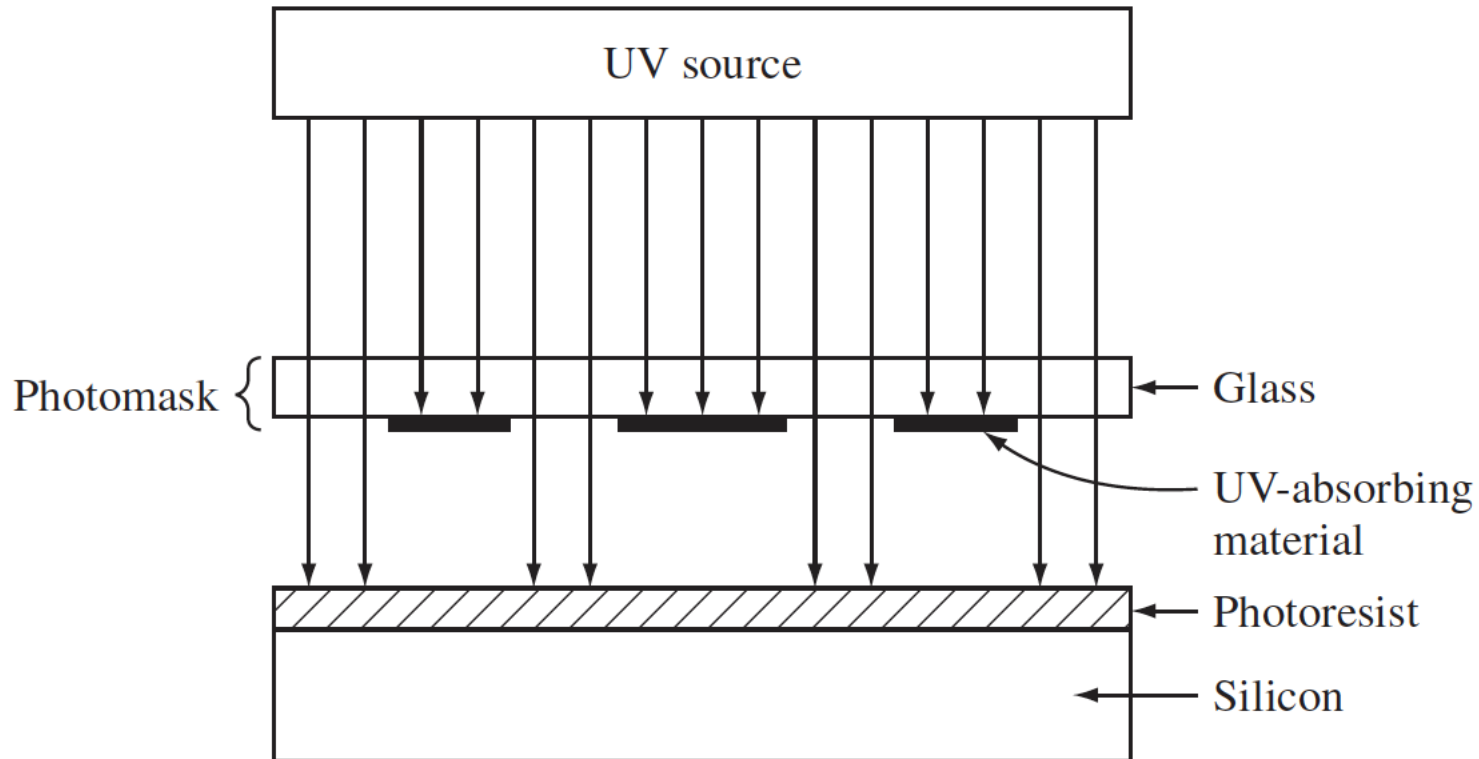


(c) Beading

# Preview: Fabrication of Integrated Circuits

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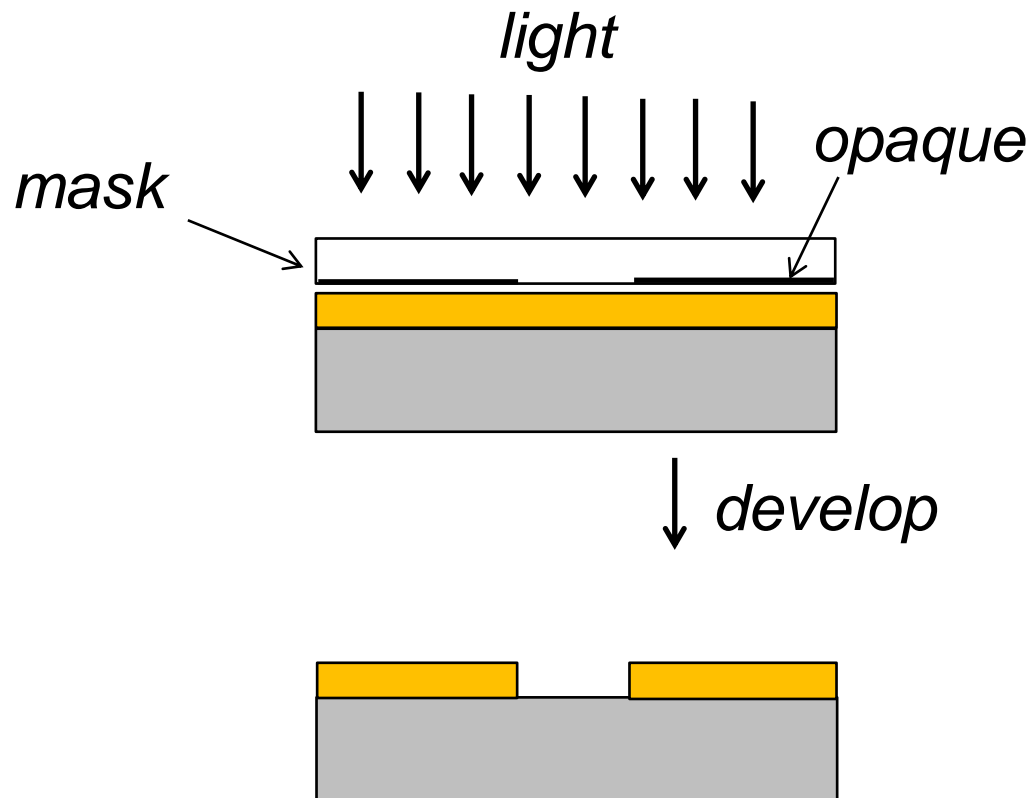
## Photolithography



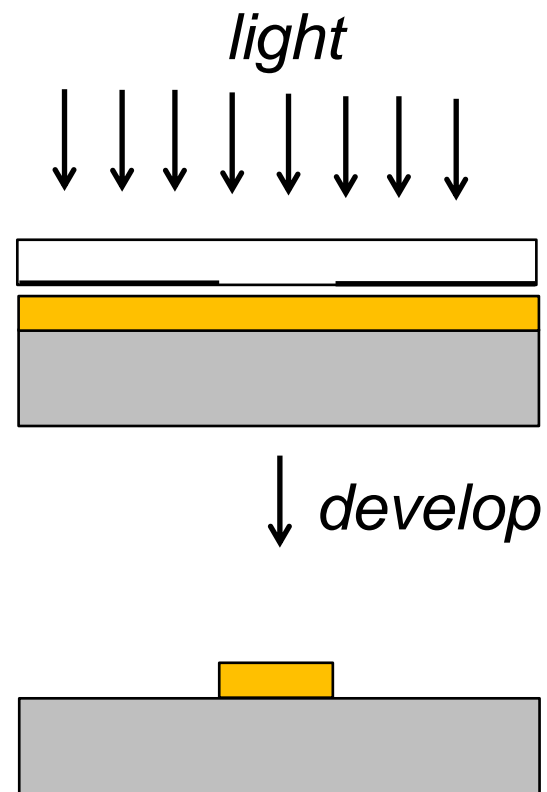


# Preview: Fabrication of Integrated Circuits

## Photolithography



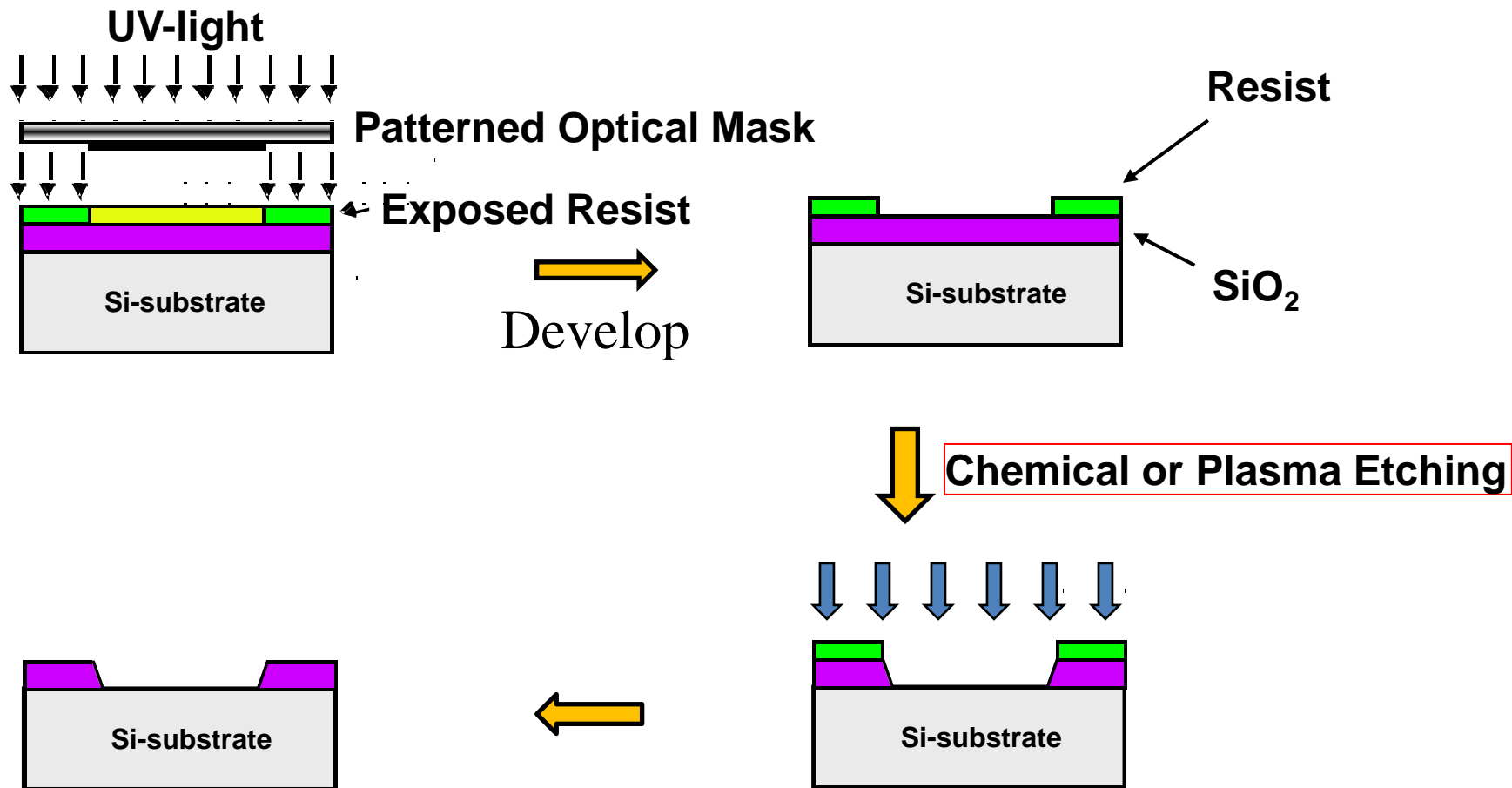
*positive*



*negative*

# Preview: Fabrication of Integrated Circuits

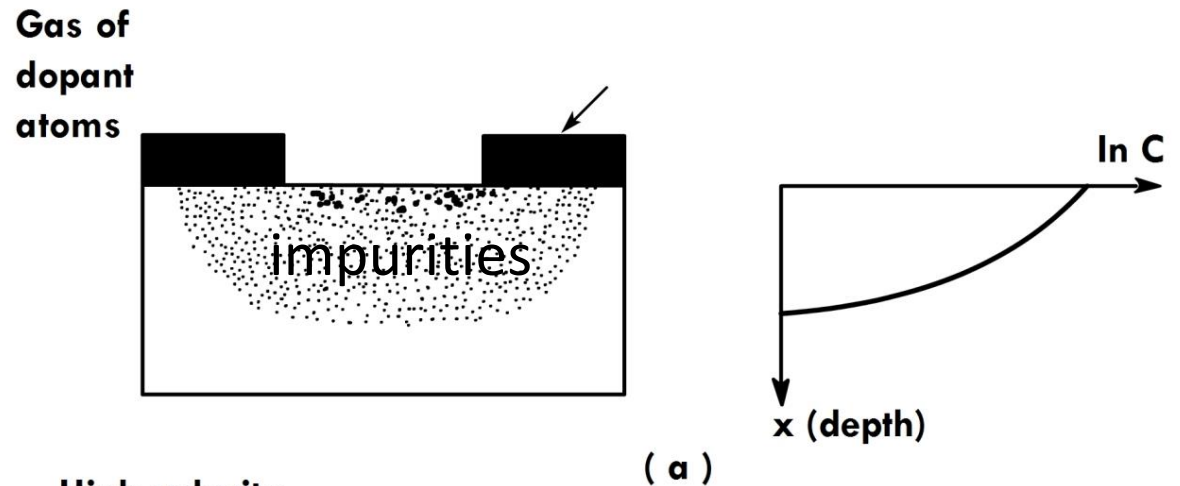
## Etching



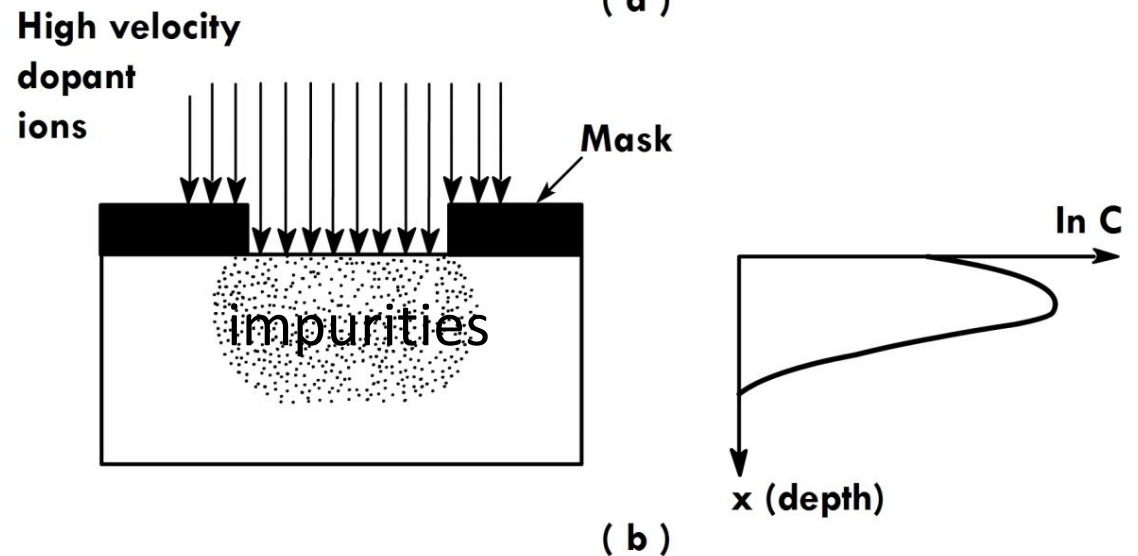
# Preview: Fabrication of Integrated Circuits

## Doping

Thermal diffusion

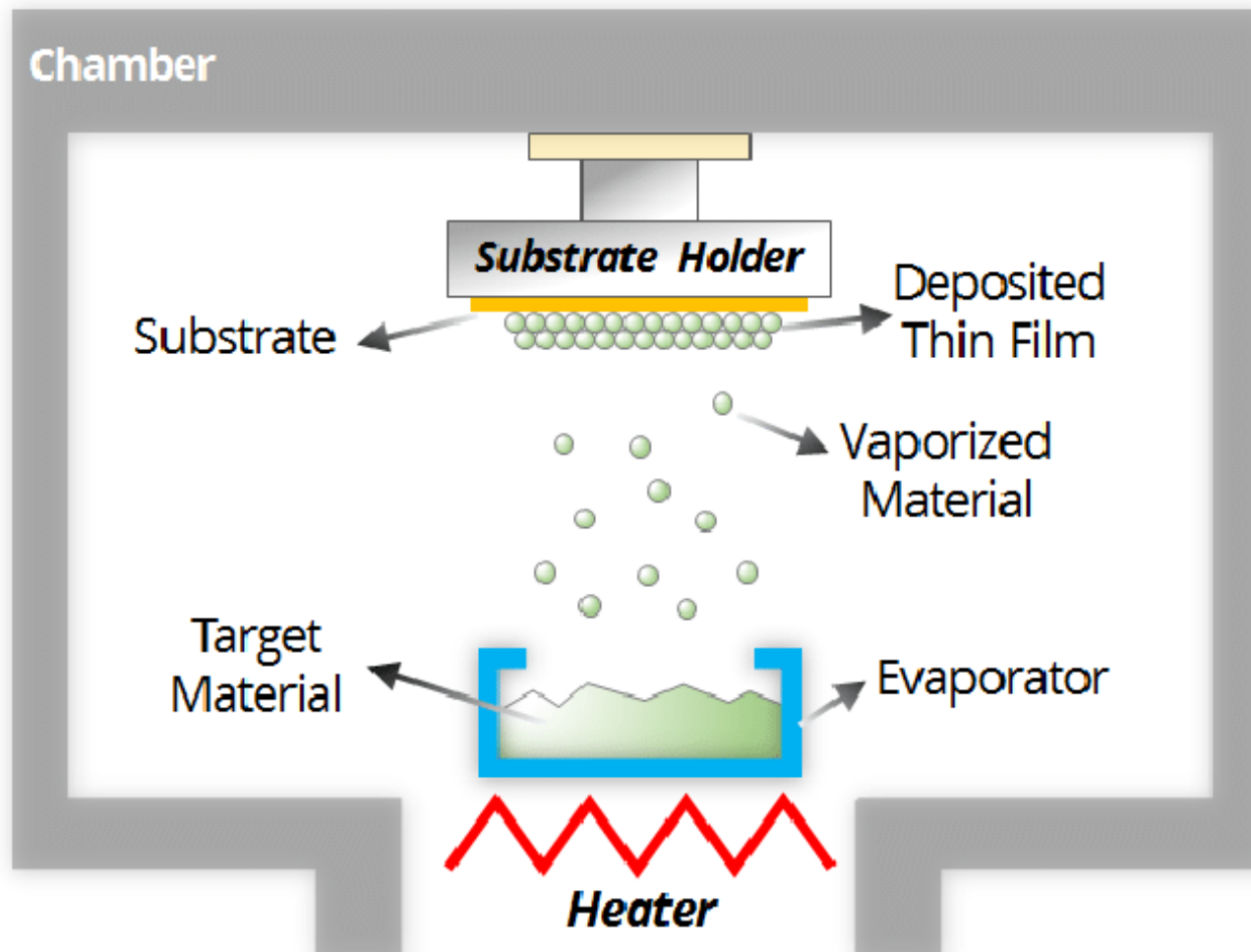


Ion implantation



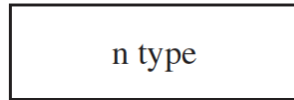
# Preview: Fabrication of Integrated Circuits

## Metallization (metal deposition)

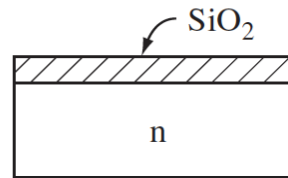


# Preview: Fabrication of Integrated Circuits

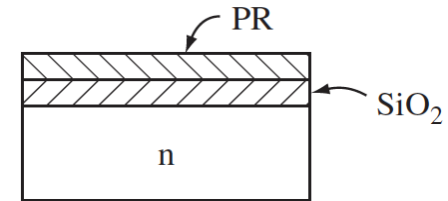
## Simple Fabrication Process



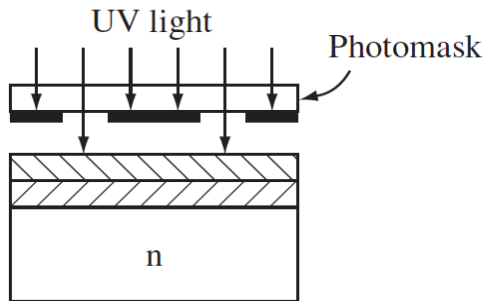
1. Start with  
n-type substrate



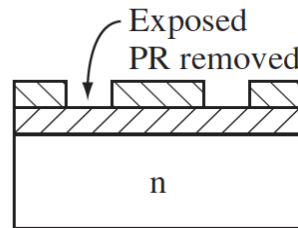
2. Oxidize surface



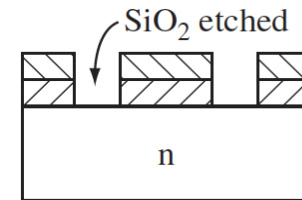
3. Apply photoresist  
over  $\text{SiO}_2$



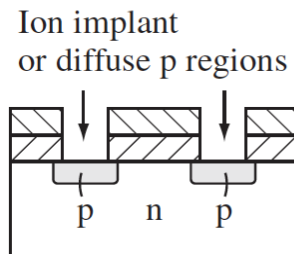
3. Expose photoresist  
through photomask



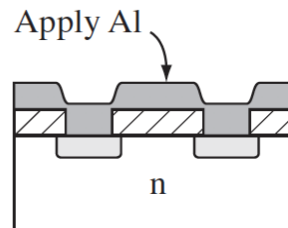
4. Remove exposed  
photoresist



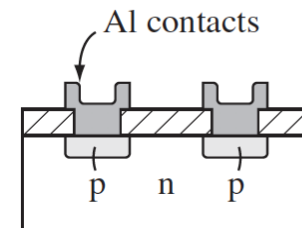
5. Etch exposed  $\text{SiO}_2$



6. Ion implant or  
diffuse boron  
into silicon



7. Remove PR and  
sputter Al on  
surface



8. Apply PR, photomask,  
and etch to form Al  
contacts over p regions