Terminology in Integrated Circuits and Semiconductor Manufacturing

ATA 55th Annual Conference
Chicago, IL

Di Wu
Leidos

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A Little About Me

- Graduated from the University of Rochester with BS and MS in Electrical Engineering
- Worked as an Integrated Circuit Development Engineer at Delphi from 1995 to 2009
- Worked as a Freelance Chinese Language Teacher/Translator/Interpreter from 2004 to 2010
- Worked as a Chinese Linguist for Government Contractors in the DC Area since 2010

Definition of Semiconductor

A solid substance that has a conductivity between that of an insulator and that of most metals, either due to the addition of an impurity or because of temperature effects. Devices made of semiconductors, notably silicon, are essential components of most electronic circuits.

- Oxford Dictionary

Semiconductor Industry Overview

- $249 Billion Industry Today
- USA, South Korea, Japan, Taiwan, Singapore, and European Union
- The role of the industry as technology enabler. The semiconductor industry is widely recognized as a key driver for economic growth in its role as a multiple lever and technology enabler for the whole electronics value chain. In other words, from a worldwide base semiconductor market of $213 billion in 2004, the industry enables the generation of some $1,200 billion in electronic systems business and $5,000 billion in services, representing close to 10% of world GDP.

Semiconductor Industry Overview

2013 Top 20 Semiconductor Sales Leaders Forecast
($M, Including Foundries)

2013F Rank	2012 Rank	Company	Headquarters	2012 Tot Semi	1Q13 Tot Semi	2Q13 Tot Semi	3Q13 Tot Semi	4Q13F Tot Semi	2013F Tot Semi	2013F/2012 % Change
1	1	Intel	U.S.	49,114	11,555	11,785	12,366	12,615	48,321	-2%
2	2	Samsung	South Korea	32,251	7,946	7,769	8,805	9,070	33,590	4%
3	3	TSMC*	Taiwan	16,951	4,460	5,152	5,377	4,815	19,804	17%
4	4	Qualcomm**	U.S.	13,177	3,916	4,222	4,457	4,550	17,145	30%
5	8	SK Hynix	South Korea	9,057	2,577	3,521	3,692	3,250	13,040	44%
6	6	Toshiba	Japan	11,217	2,938	2,868	3,356	3,035	12,197	9%
7	5	TI	U.S.	12,081	2,718	2,872	3,064	2,820	11,474	-5%
8	10	Micron	U.S.	8,002	2,158	2,493	2,900	3,000	10,551	32%
9	9	ST	Europe	8,364	1,994	2,033	2,077	2,080	8,184	-2%
10	11	Broadcom**	U.S.	7,793	1,954	2,035	2,146	1,975	8,110	4%
11	7	Renesas	Japan	9,314	1,886	1,920	2,101	1,920	7,827	-16%
12	14	Infineon	Europe	4,928	1,208	1,327	1,390	1,340	5,265	7%
13	13	AMD**	U.S.	5,422	1,088	1,161	1,461	1,534	5,244	-3%
14	12	Sony	Japan	5,709	1,247	1,144	1,203	1,295	4,889	-14%
15	15	NXP	Europe	4,325	1,085	1,188	1,249	1,265	4,787	11%
16	22	MediaTek**	Taiwan	3,366	817	1,115	1,308	1,275	4,515	34%
17	17	GlobalFoundries*	U.S.	4,013	946	1,020	1,125	1,170	4,261	6%
18	19	Freescale	U.S.	3,803	925	987	1,030	1,000	3,942	4%
19	20	UMC*	Taiwan	3,730	898	1,016	1,060	945	3,919	5%
20	18	Nvidia**	U.S.	3,965	939	903	1,005	905	3,752	-5%
Top 20 Total				216,582	53,255	56,531	61,172	59,859	230,817	7%

*Foundry **Fabless

Source: IC Insights' Strategic Reviews Database

Semiconductor Industry Overview

2013F Top 20 Semiconductor Sales Leaders Ranked by Growth ($M, Including Foundries)

2013F Rank	Company	Headquarters	2012 Tot Semi	1Q13 Tot Semi	2Q13 Tot Semi	3Q13 Tot Semi	4Q13F Tot Semi	2013F Tot Semi	2013F/2012 % Change
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Source: IC Insights' Strategic Reviews Database

Semiconductor Industry Overview

Semiconductor Industry Overview

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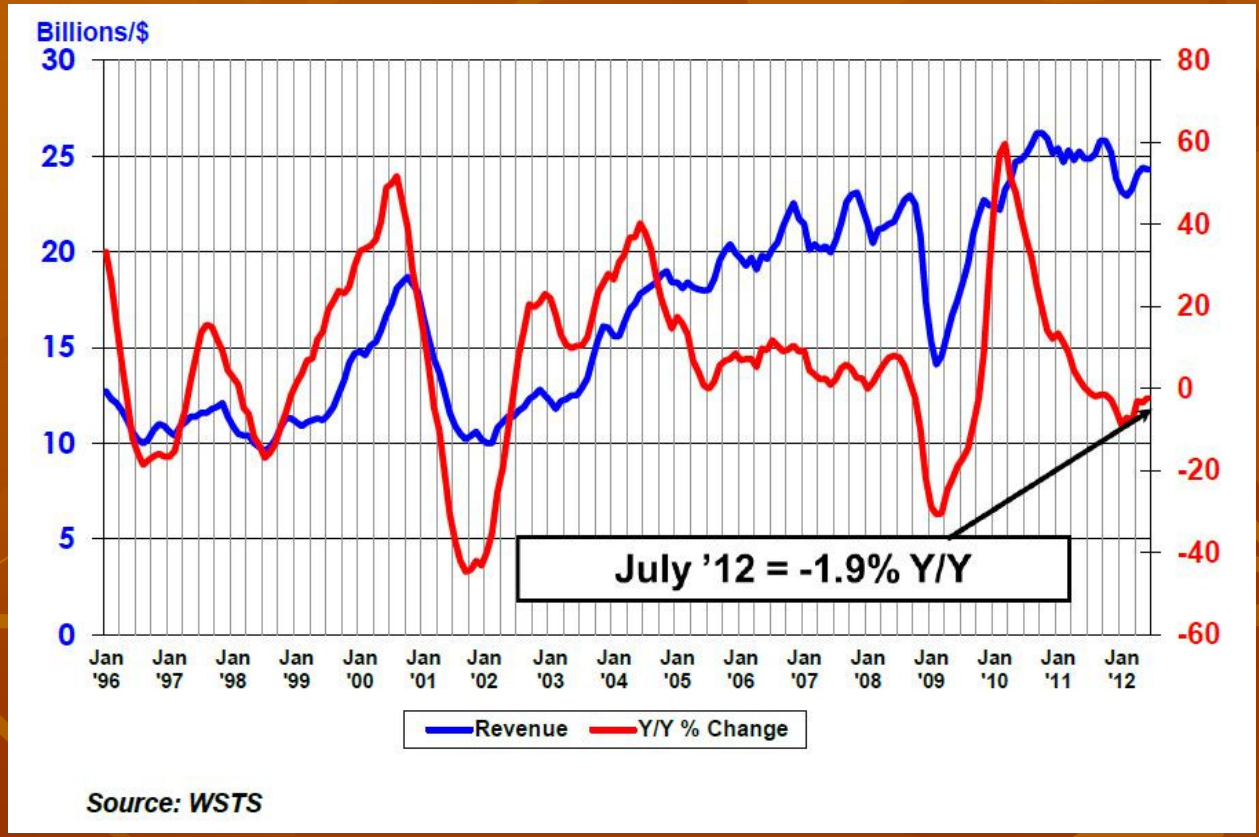
Semiconductor Industry Overview

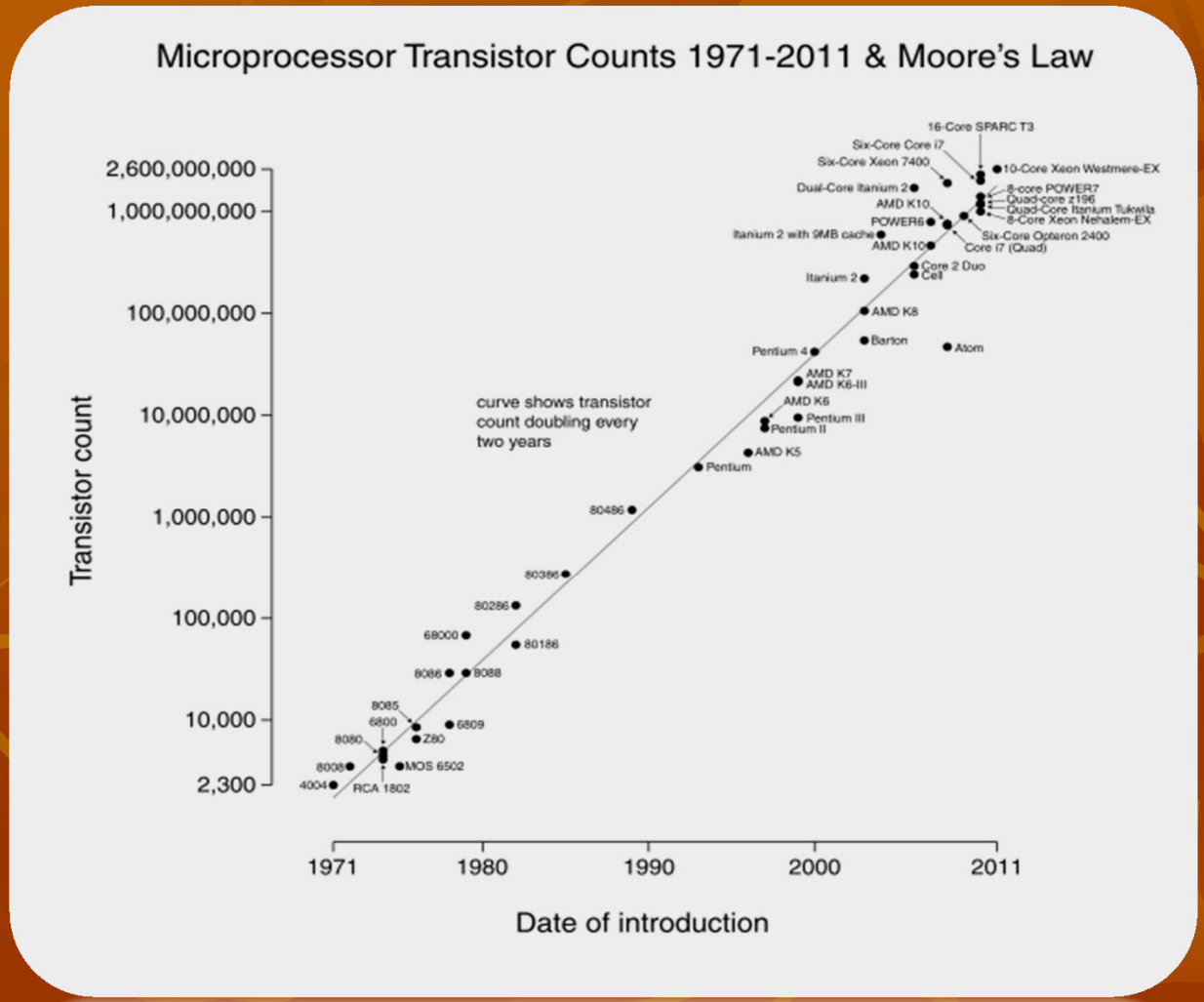
Semiconductor Industry Revenue



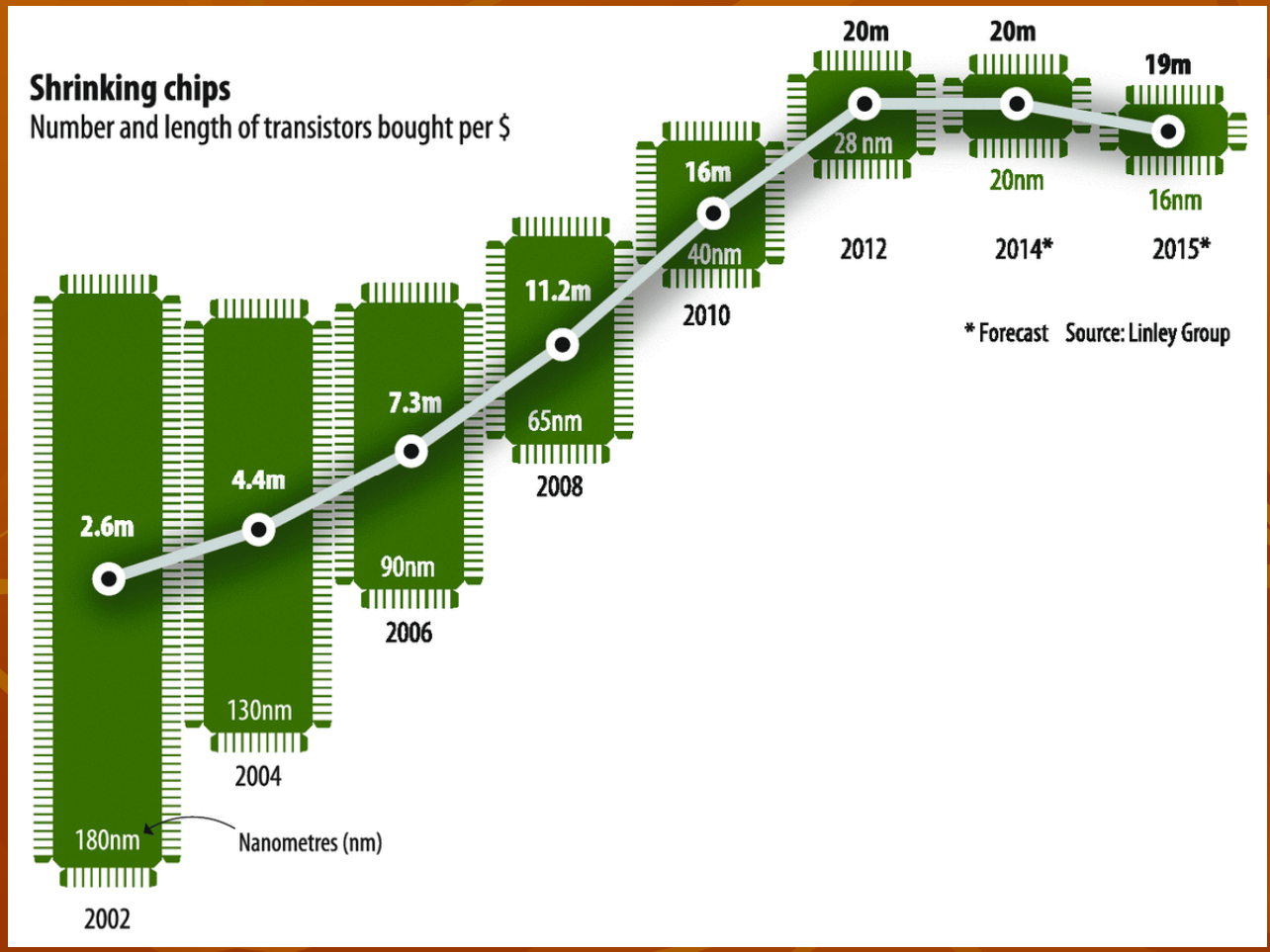
Moore's Law

- An observation named after Gordon E. Moore, co-founder of Intel, who described the trend in his 1965 paper.
- Over the history of computing hardware, the number of transistors in a dense integrated circuit doubles approximately every two years.

Moore's Law

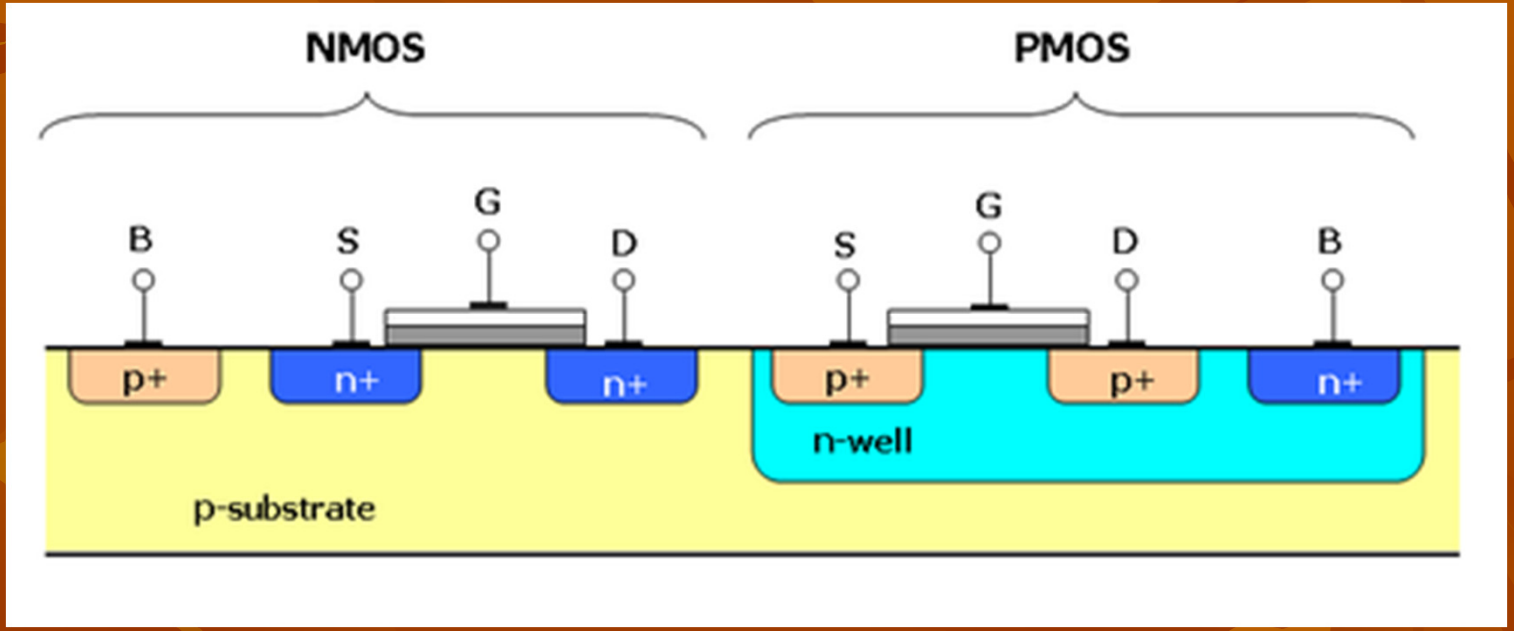

Microprocessor Transistor Counts 1971-2011 & Moore's Law
Transistor count
2,600,000,000
1,000,000,000
100,000,000
10,000,000
1,000,000
100,000
10,000
2,300
curve shows transistor count doubling every two years
16-Core SPARC T3
Six-Core Core i7
Six-Core Xeon 7400
10-Core Xeon Westmere-EX
Dual-Core Itanium 2
8-core POWER7
Quad-core z196
AMD K10
Quad-Core Itanium Tukwila
8-Core Xeon Nehalem-EX
POWER6
Itanium 2 with 9MB cache
Six-Core Opteron 2400
AMD K10
Core i7 (Quad)
Core 2 Duo
Cell
Itanium 2
AMD K8
Barton
Atom
Pentium 4
AMD K7
AMD K6-III
AMD K6
Pentium III
Pentium II
AMD K5
Pentium
80486
80386
80286
68000
80186
8086
8088
8085
6800
6809
8080
Z80
8008
MOS 6502
4004
RCA 1802
1971
1980
1990
2000
2011
Date of introduction

The Shrinking Transistors

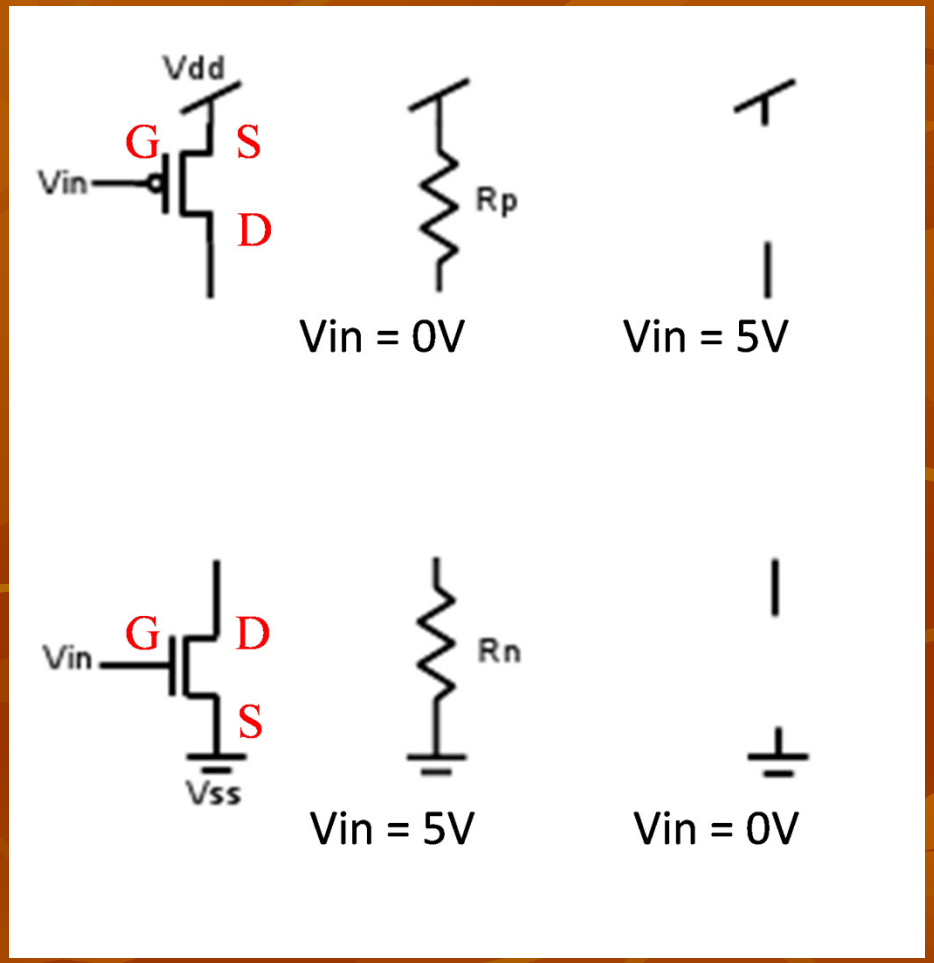


Transistor Basics

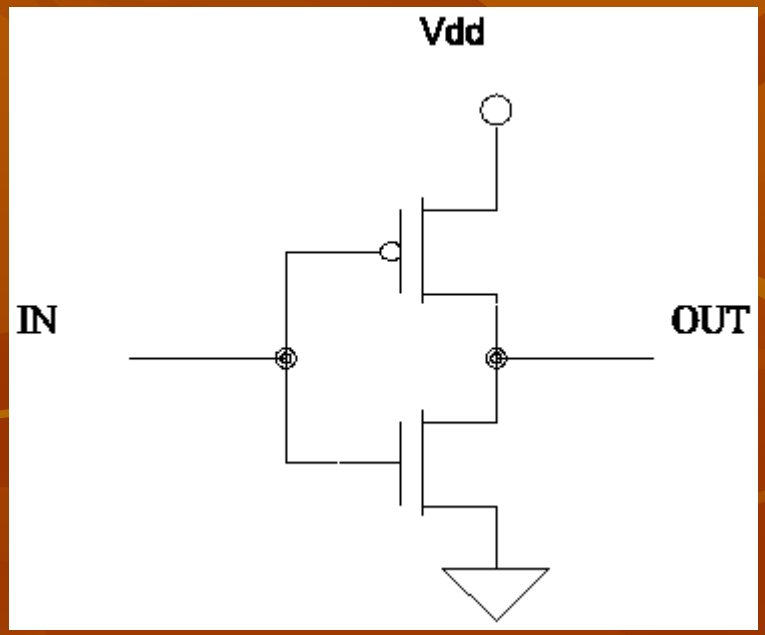
MOSFET – Metal Oxide Field Effect Transistor



Semiconductor Basics



Semiconductor Basics
CMOS – Complementary MOS

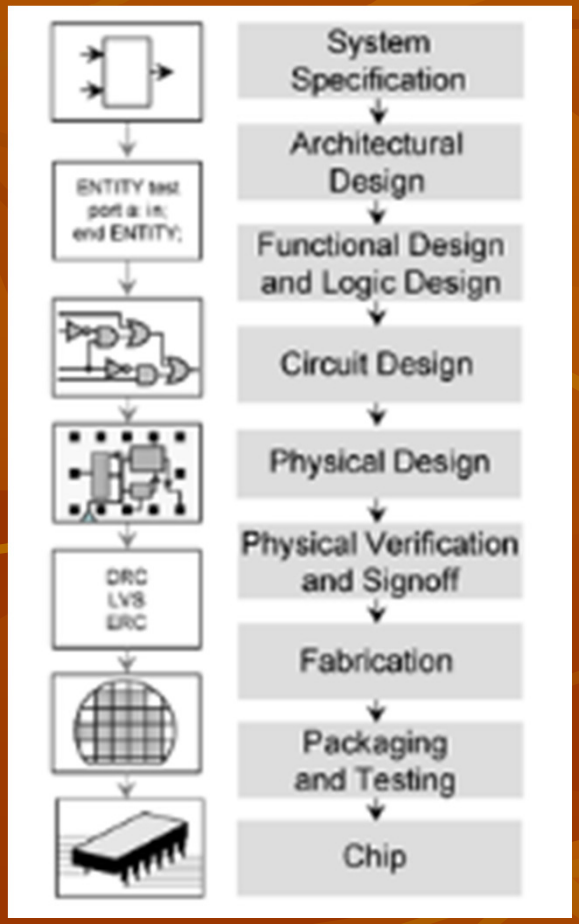


Definition of Integrated Circuit

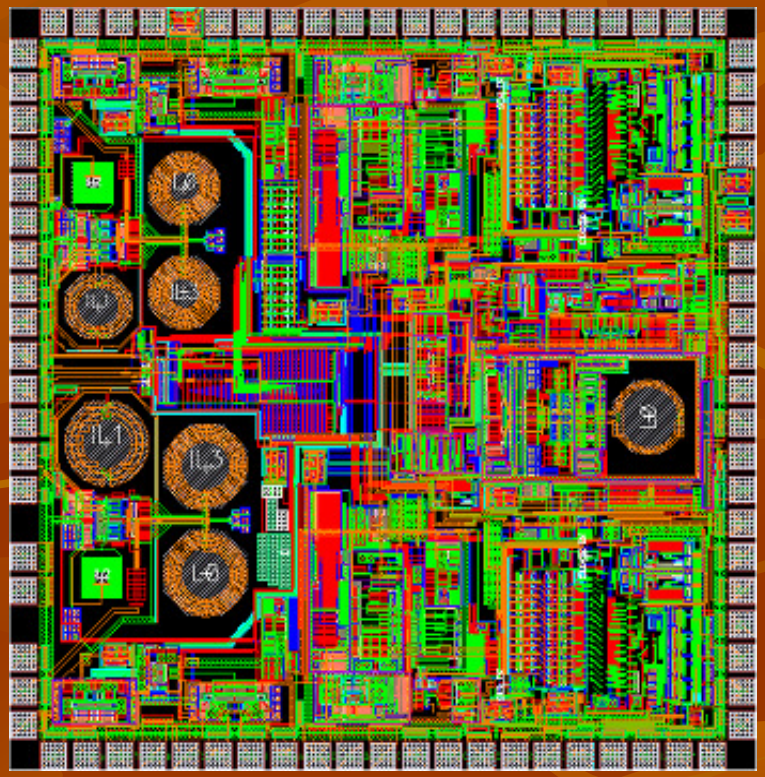
- Integrated circuit (IC), also called microelectronic circuit or chip, an assembly of electronic components, fabricated as a single unit, in which miniaturized active devices (e.g., transistors and diodes) and passive devices (e.g., capacitors and resistors) and their interconnections are built up on a thin substrate of semiconductor material (typically silicon). The resulting circuit is thus a small monolithic “chip,” which may be as small as a few square centimetres or only a few square millimetres. The individual circuit components are generally microscopic in size.

  - Encyclopedia Britannica

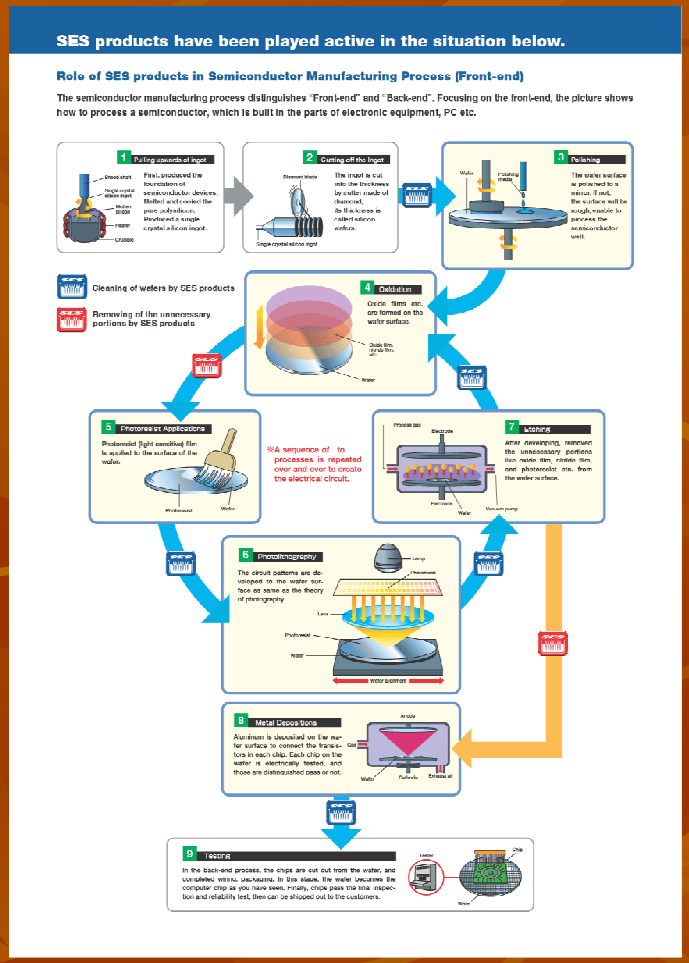
IC Design Cycle



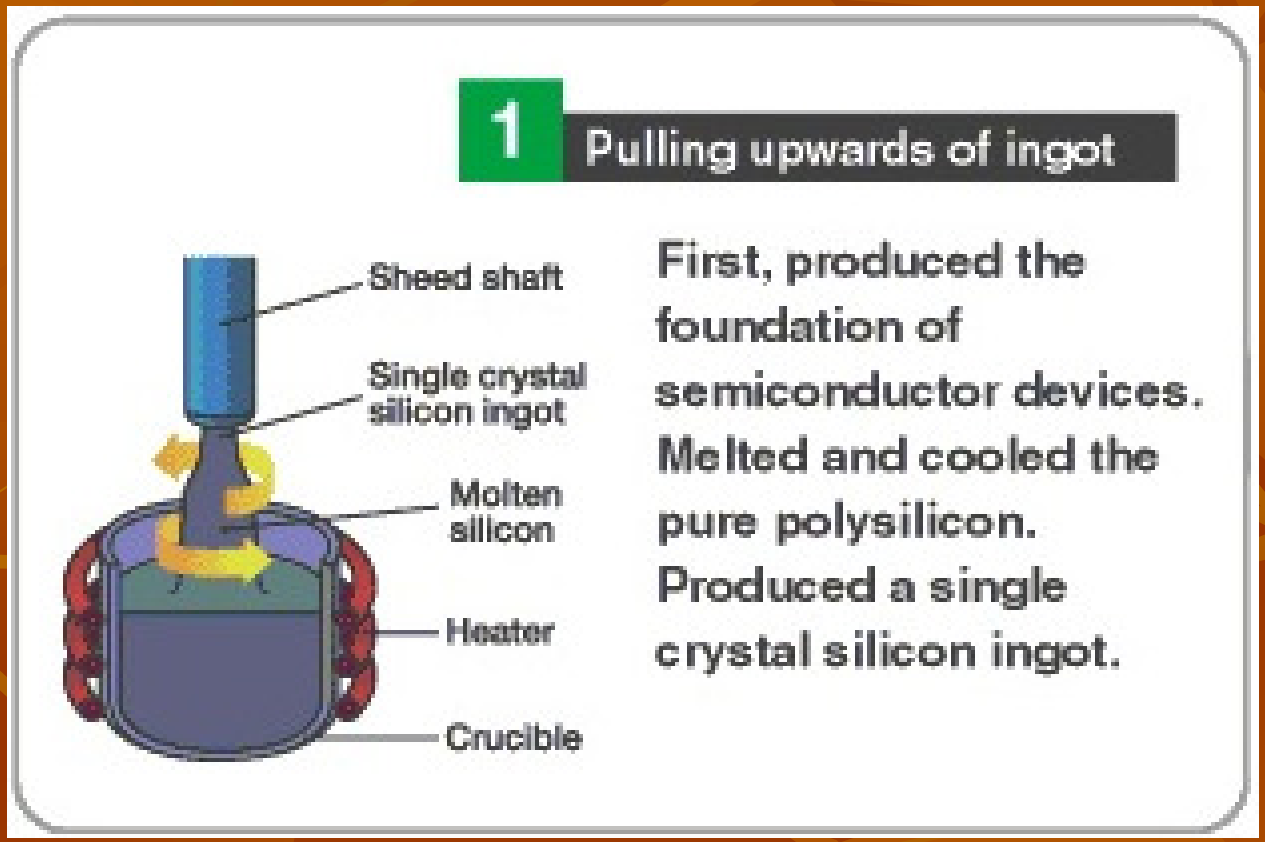
2 Channel GPS Dual Receiver



Semiconductor Manufacturing Cycle

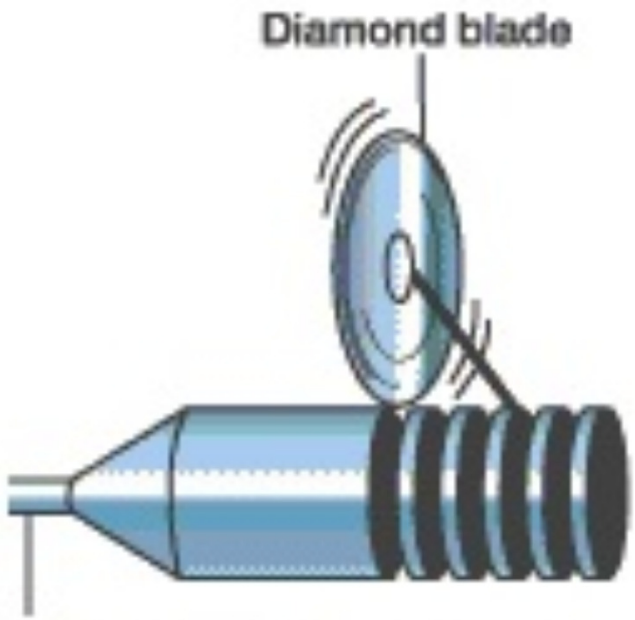


Pulling Upward of Ingots



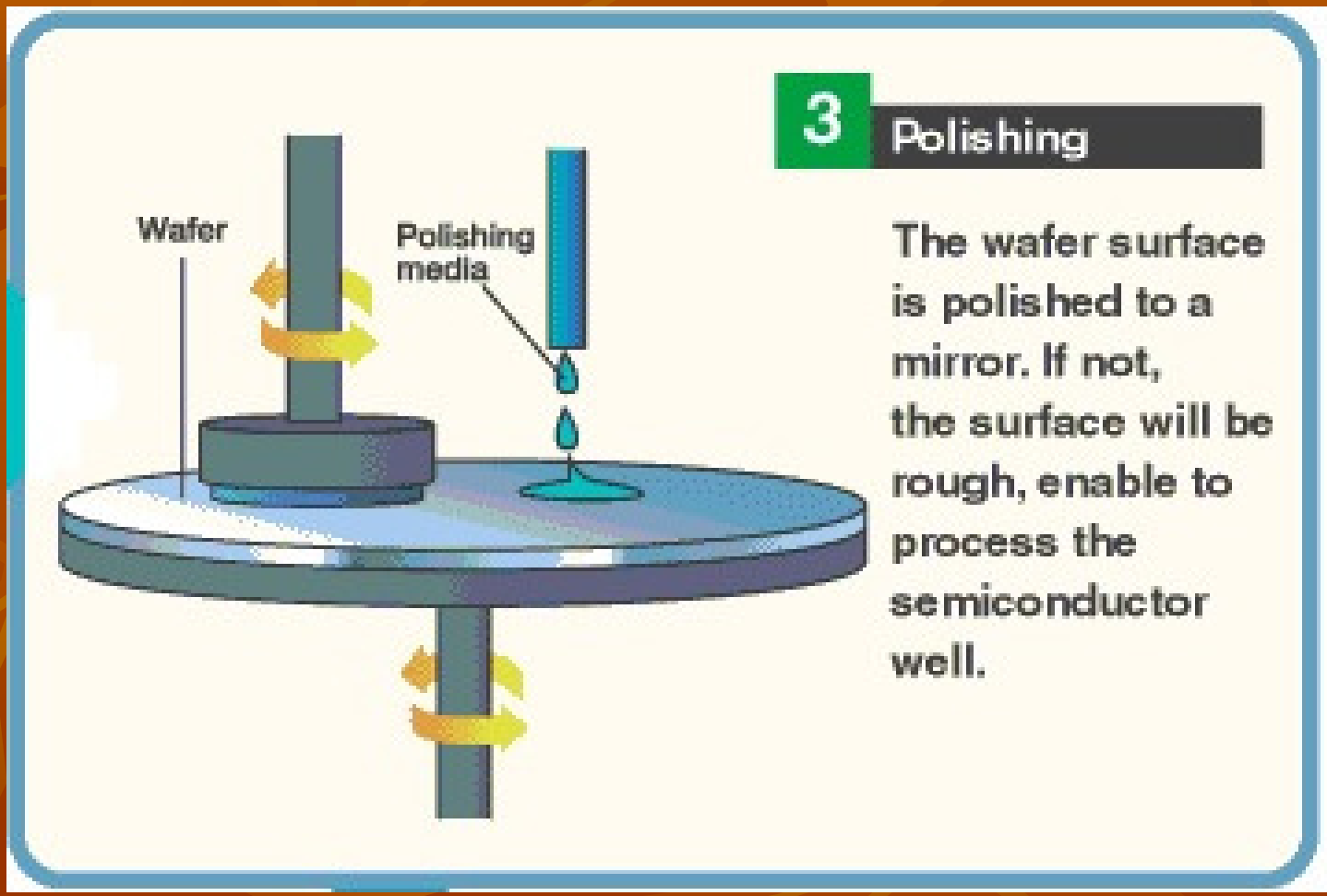
Cutting Off the Ingot

2 Cutting off the Ingot

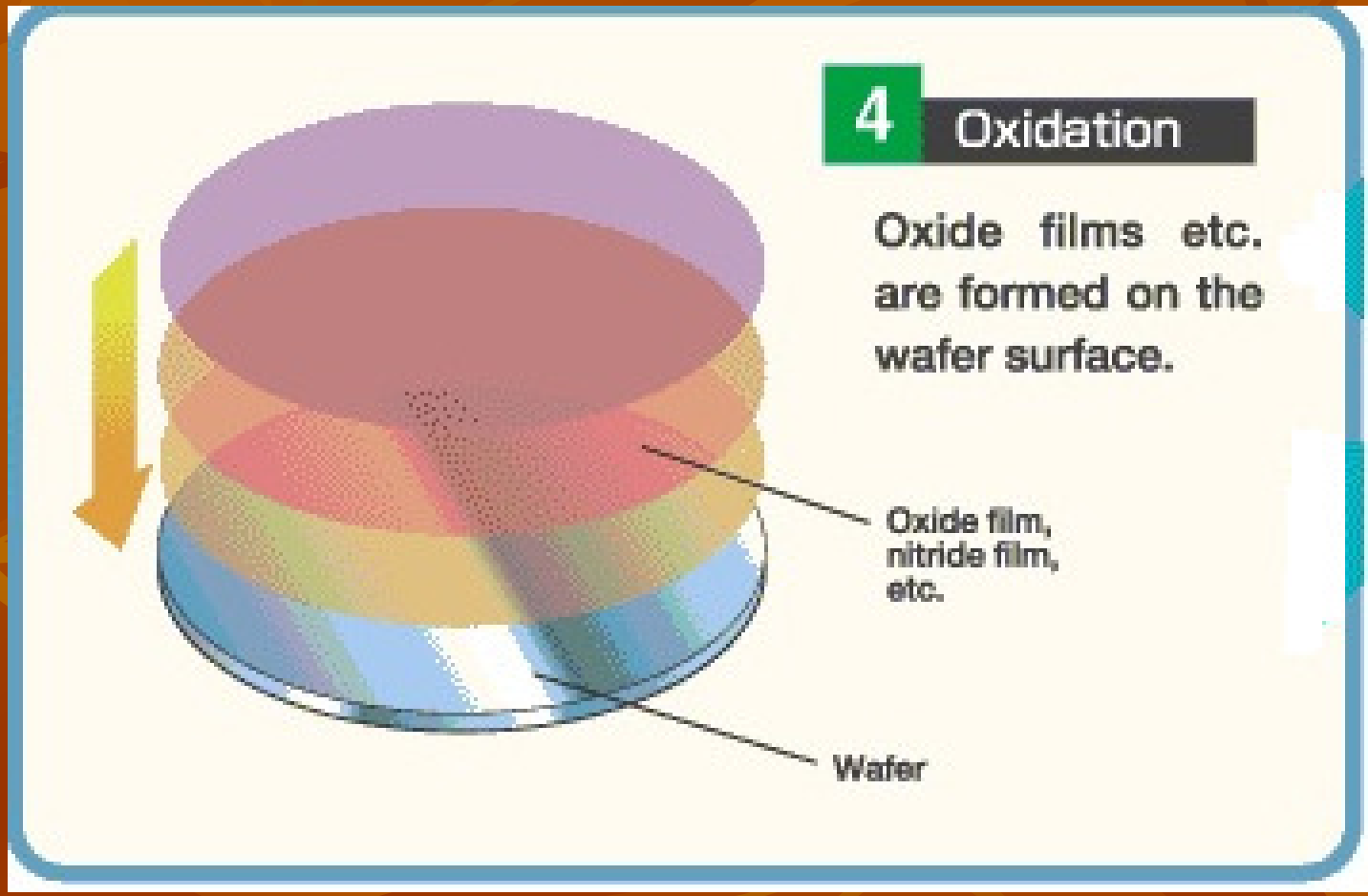


The ingot is cut into the thickness by cutter made of diamond, its thickness is called silicon wafers.

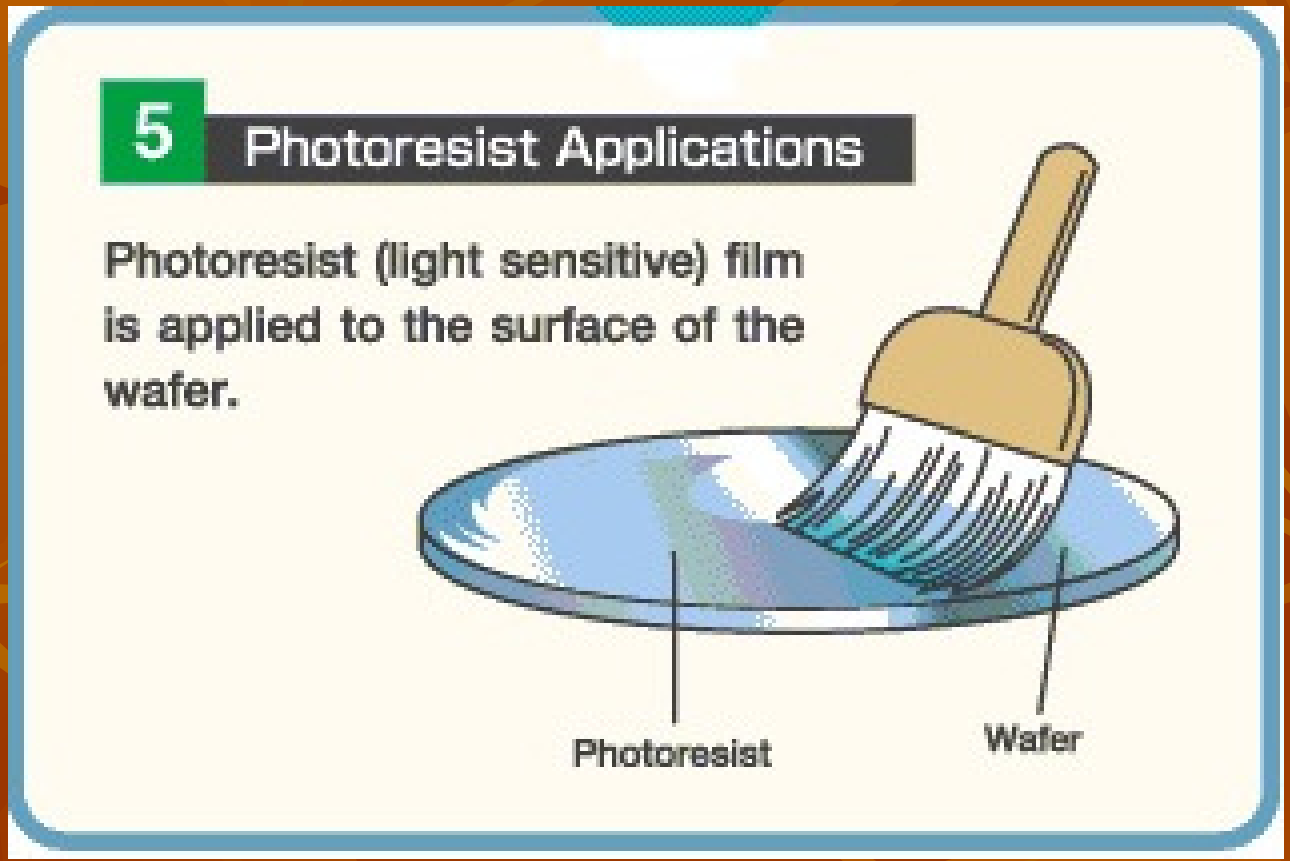
Polishing


3 Polishing
Wafer
Polishing media
The wafer surface is polished to a mirror. If not, the surface will be rough, enable to process the semiconductor well.

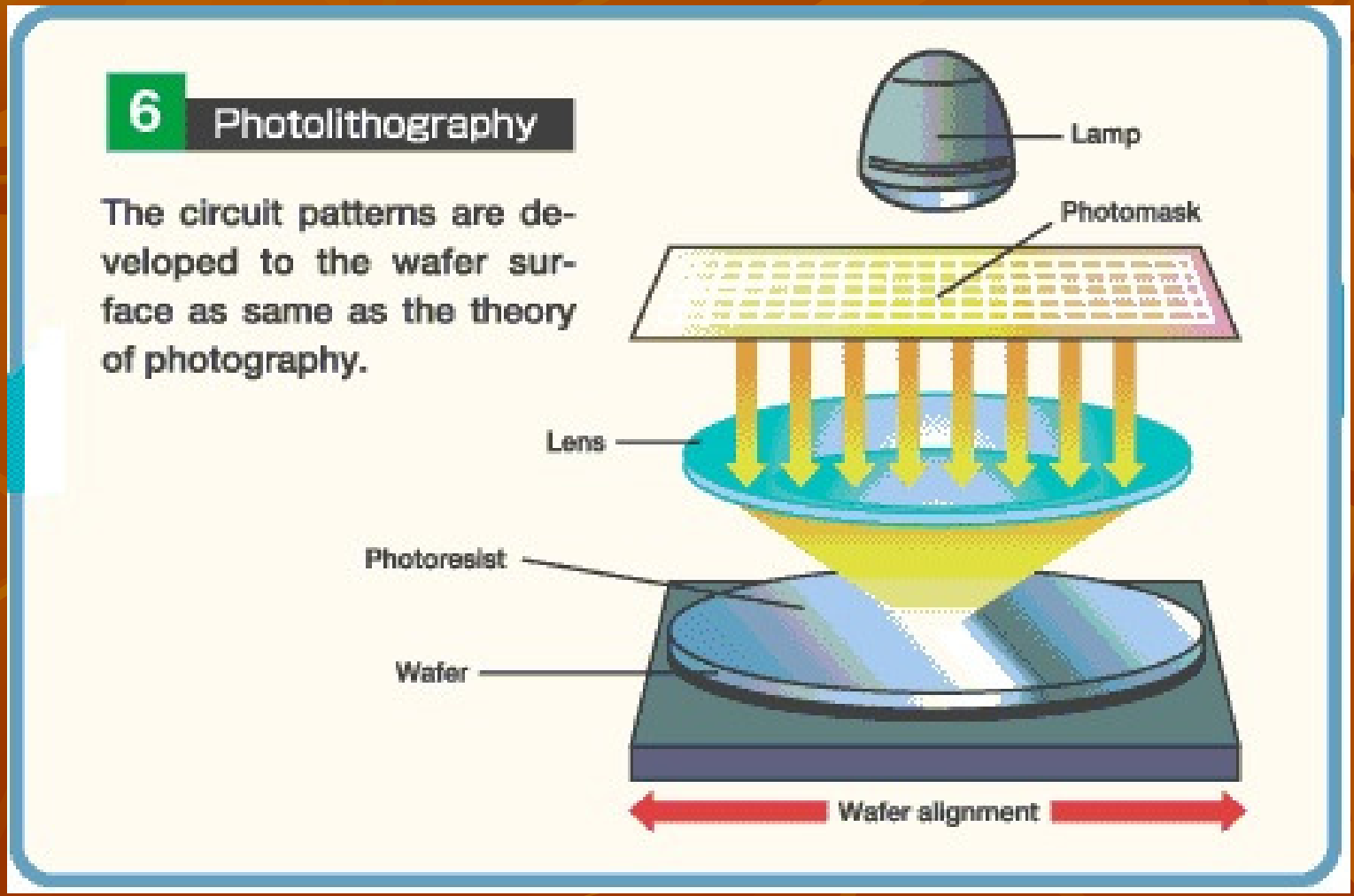
Oxidation


4 Oxidation
Oxide films etc. are formed on the wafer surface.
Oxide film, nitride film, etc.
Wafer

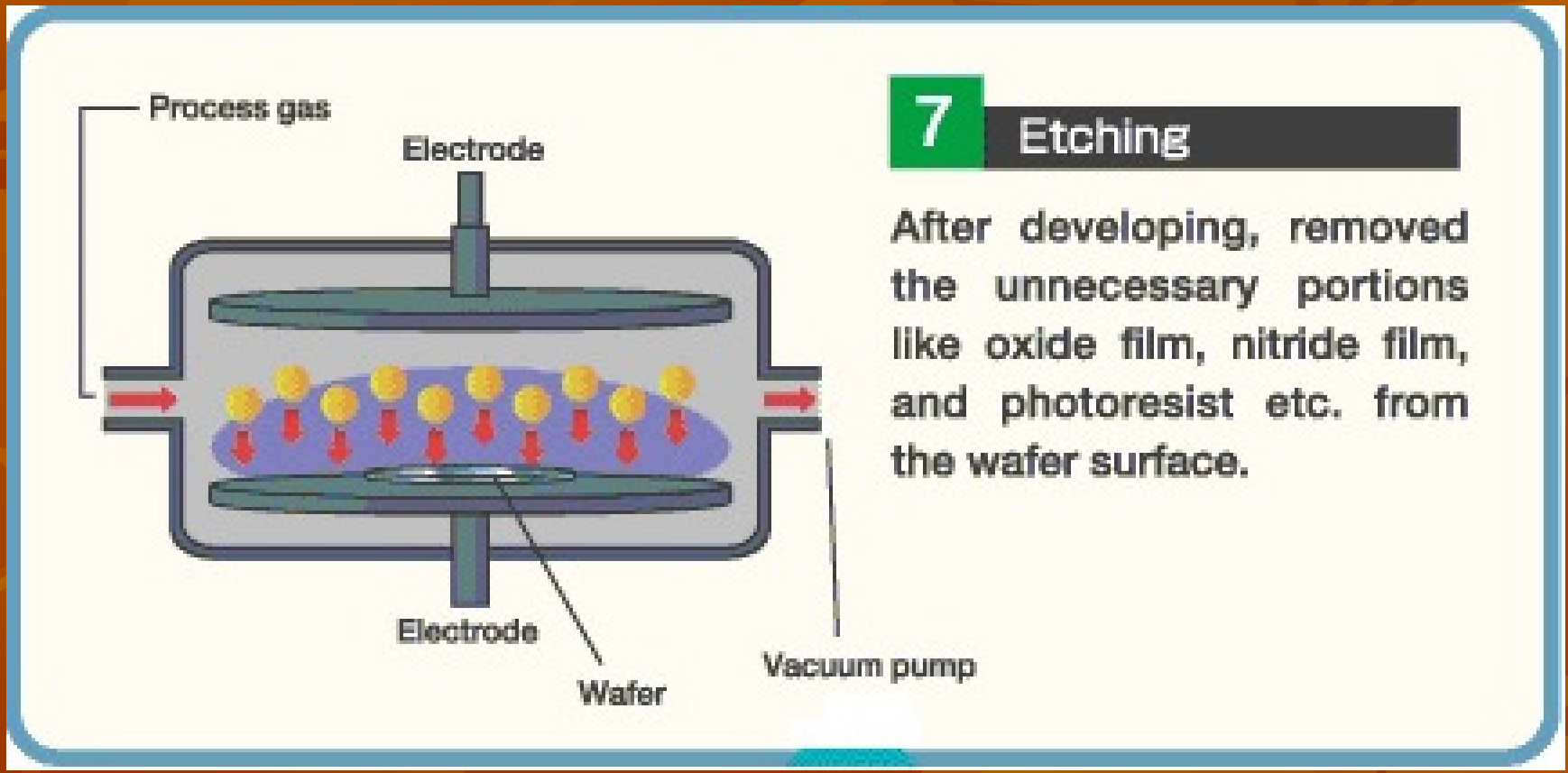
Photoresist Application



Photolithography



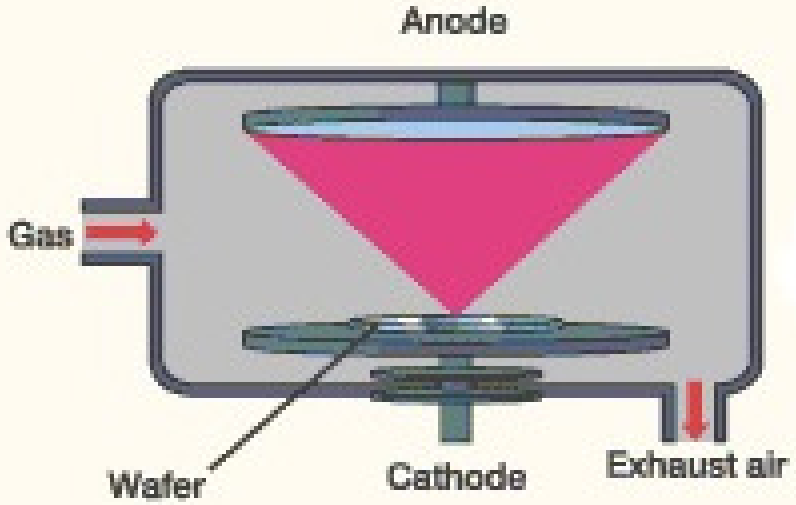
Etching


Process gas
Electrode
Electrode
Wafer
Vacuum pump
7
Etching
After developing, removed the unnecessary portions like oxide film, nitride film, and photoresist etc. from the wafer surface.

Metal Depositions

8 Metal Depositions

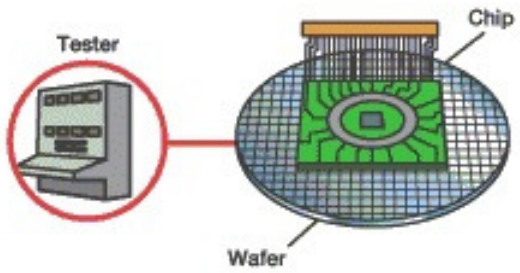
Aluminum is deposited on the wafer surface to connect the transistors in each chip. Each chip on the wafer is electrically tested, and those are distinguished pass or not.



Testing

9 Testing

In the back-end process, the chips are cut out from the wafer, and completed wiring, packaging. In this stage, the wafer becomes the computer chip as you have seen. Finally, chips pass the final inspection and reliability test, then can be shipped out to the customers.



Your Comments and Inputs, Please

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