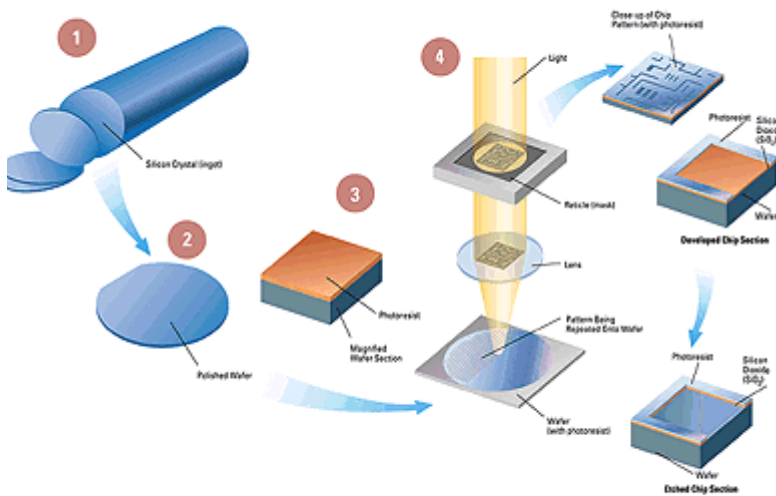
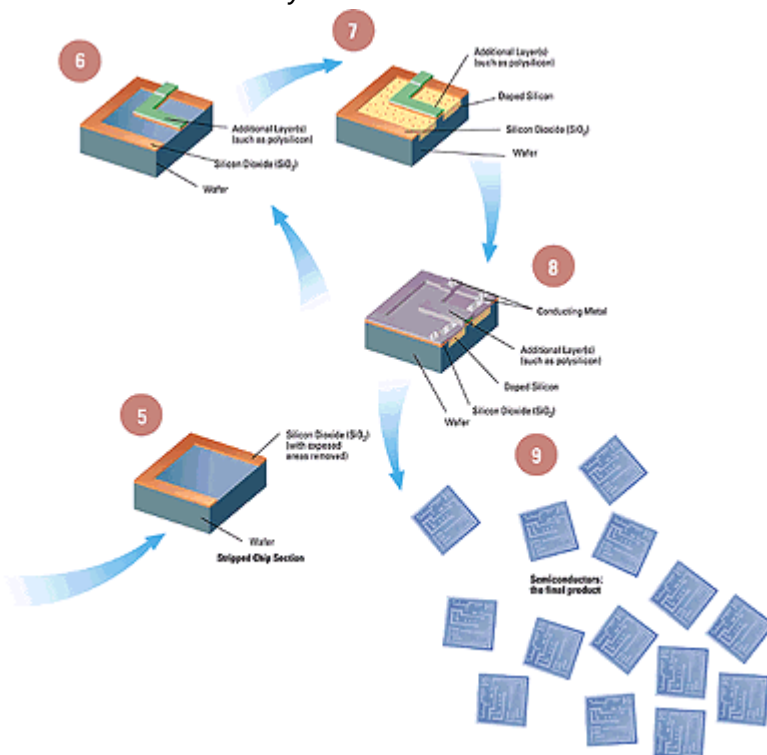


How Semiconductor Chips Are Made



1. First, a 99.9999% pure silicon crystal ingot is sliced into thin wafers.
2. Polishing the wafer removes surface scratches and impurities, leaving a near-perfect base for building chips.
3. Portions of the silicon are chemically altered to create the source and drain regions of the transistor, which control the flow defined by photolithography, where the wafer is coated with a light-sensitive material called photoresist. Next, light is shined through a patterned mask onto a chip-size section of the wafer -- a process similar to printing a photograph from a negative. A machine called a stepper repeats this process for each chip on the wafer.
4. The exposed areas of the photoresist harden. During the development process, non-hardened photoresist is washed away.



5. Atoms of dopant materials -- such as boron or arsenic -- are forced into an area by ion bombardment in a process called doping, and are "activated" by a thermal annealing step. The resist material blocks the dopants from entering any areas where they are not intended to be. After ion implantation, the

hardened resist is stripped off, and the process is repeated for other types of dopants implanted in different areas. In subsequent steps, a similar patterning process is used, but the resist acts as an etch mask.

6. *Next, the gate of the transistor is formed by depositing and patterning a layer of silicon dioxide (which forms the gate oxide) and then a layer of polysilicon, which is then heavily doped. This polysilicon gate acts as a "faucet" to turn the flow of electrons between the source and drain on and off.*

7. *The rest of the fabrication steps involve forming the "wires" that connect the gate, source and drain of the transistors to one another and to the outside world. Layers of silicon dioxide -- a dielectric, or insulator -- are deposited on the wafer using chemical vapor deposition (CVD). During CVD processing, gases that contain atoms of the material to be deposited react on the heated wafer surface, forming a thin film of solid material. Metals, primarily aluminum, are deposited by the physical vapor deposition (PVD). During PVD -- also called sputtering -- gas ions accelerate toward a "target" of the material to be deposited. The ions chip off atoms of the target material, which fall and accumulate on the wafer.*

8. *Steps 3,4 and 5 are repeated to build up patterned layers of silicon dioxide, metals and other materials to complete the circuit design. A layer of conducting metal (usually aluminum) is deposited (CVD or PVD), exposed (photolithography), and etched to form tiny metal interconnects. Complex chips require several metal layers, with vertical connections between them called vias.*

9. *The wafer is cut up, or diced, to form chips. The chips are put in packages, and a wirebonder electrically connects the chips to the appropriate package pins or leads.*

Article courtesy of Semiconductor International

Adapted from [Design News](#). Figure courtesy of [SEMATECH](#).