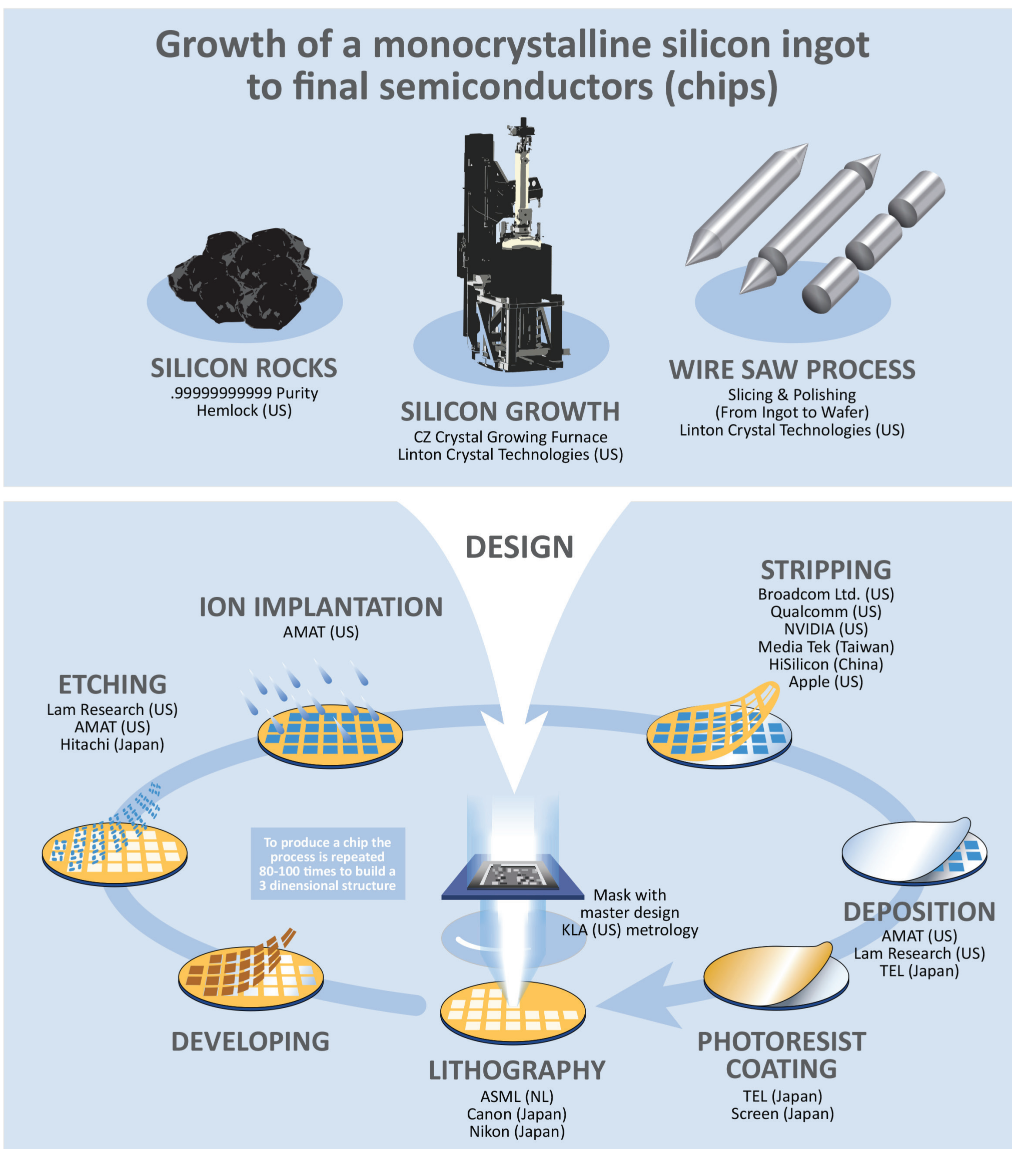
Process Primer: From Ingot to Semiconductor Wafer

Creating a semiconductor wafer is a complex and differentiated process, with several primary stages. The first of these is the growth of a monocrystalline silicon ingot, the material from which an electrically charged wafer will be created.

Growing the Ingot

The preferred method of ingot growth for the semiconductor industry is the Czochralski process. First, rocks of "11 nines" purity silicon (99.999999999 percent pure) are placed in a quartz crucible within a specialized vacuum furnace. This is then heated to 1,425 °C (2,597 °F), melting the silicon. A small seed crystal mounted in a fixture at the end of a cable is lowered to touch the surface of the melt. The crucible and the cable holding the seed crystal rotate in opposite directions, and the seed is slowly drawn away from the melt. This allows growth of the cylindrical crystal ingot to the desired diameter and length. The temperature and pull speed are carefully monitored and controlled throughout the growth process to maintain crystal quality and avoid unwanted instabilities or defects. Additionally, the crystal can be either p-type or n-type, with different electronic properties, by adding dopant impurity atoms to the silicon, such as boron or phosphorous.



A single-wire saw cuts the top and bottom (crown and tail) off the ingot and then cuts it into sections of a manageable length (e.g. 500 mm). At this point, a multi wire saw will cut the sections into wafers. The final process steps in preparing the wafers for use in semiconductors are lapping, polishing, and washing.Layers of material are then applied to the prepared silicon wafer: a silicon oxide layer, a silicon nitride layer and a layer of a photoresist coating.

Short-wave ultraviolet light forming the desired pattern for the integrated circuit is then projected onto (and into) the wafer. Etching is then done to remove excess material from the pattern traces. This process is repeated numerous times, depending on the circuit's complexity.

The next step, ion implantation, dopes the silicon crystal lattice with substances such as boron or phosphorous to modify the crystal's conductivity. Excess photoresist is then stripped, and the wafer is ready for electrical testing and assembly.