Chapter 3 Summary

3.1 INTRODUCTION TO DEVICE FABRICATION

The simple example of the device fabrication process shown in Fig. 3–1 includes (a) formation of SiO_2 layer, (b) its selective removal, (c) introduction of dopant atoms into the wafer surface, and (d) dopant diffusion into silicon.

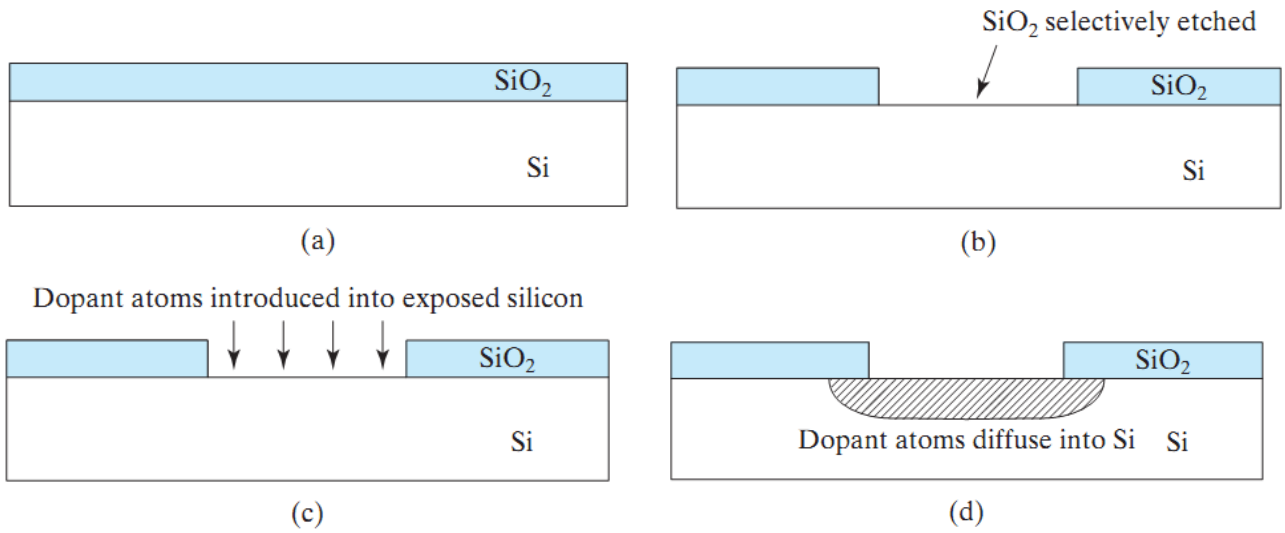

FIGURE 3–1 **Some basic steps in the silicon device fabrication process:**

(a) Oxidation of silicon

(b) Selective oxide removal

(c) Introduction of dopant atoms

(d) Diffusion of dopant atoms into silicon.

Substrate is a thin slice of semiconductor material, such as crystalline silicon, used in electronics for the fabrication of integrated circuits.

Lithography is a process where an arbitrary pattern can be accurately and repeatedly produced in a specialized layer of material on a substrate by inducing a chemical modification. Lithography facilitates the drive forever decreasing dimensions of semiconductor devices and is therefore a keystone of the nanotechnology revolution.

Photolithography (optical lithography or UV lithography) is a process used in microfabrication to pattern parts of a thin film or the bulk of a substrate. It uses light to transfer a geometric pattern from a photomask to a light-sensitive chemical "photoresist" on the substrate. Lithography is the most difficult and expensive process among all the IC fabrication steps.

Some types of lithographic methods:

Photolithography (optical lithography): (using UV light to generate the patterns)

Electron-beam lithography (EBL): (electron beams are used to generate the pattern)

Nano-imprint lithography (NIL): (a mold is pressed or imprinted into a material to generate the patterns)

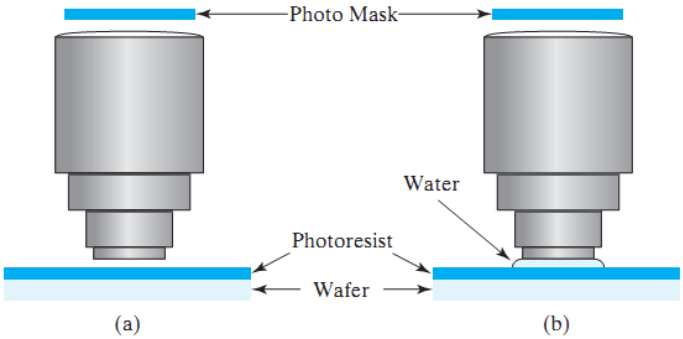

FIGURE 3–6 Schematics of (a) conventional dry optical lithography and (b) wet or immersion lithography. The wavelength of light source is 193 nm in both cases, but the effective wavelength in (b) is reduced by the refraction index of water, 1.43.

Etching is the process of removing the uppermost layer of the substrate by a liquid ("wet") or plasma ("dry") chemical agent in the areas that are not protected by photoresist.

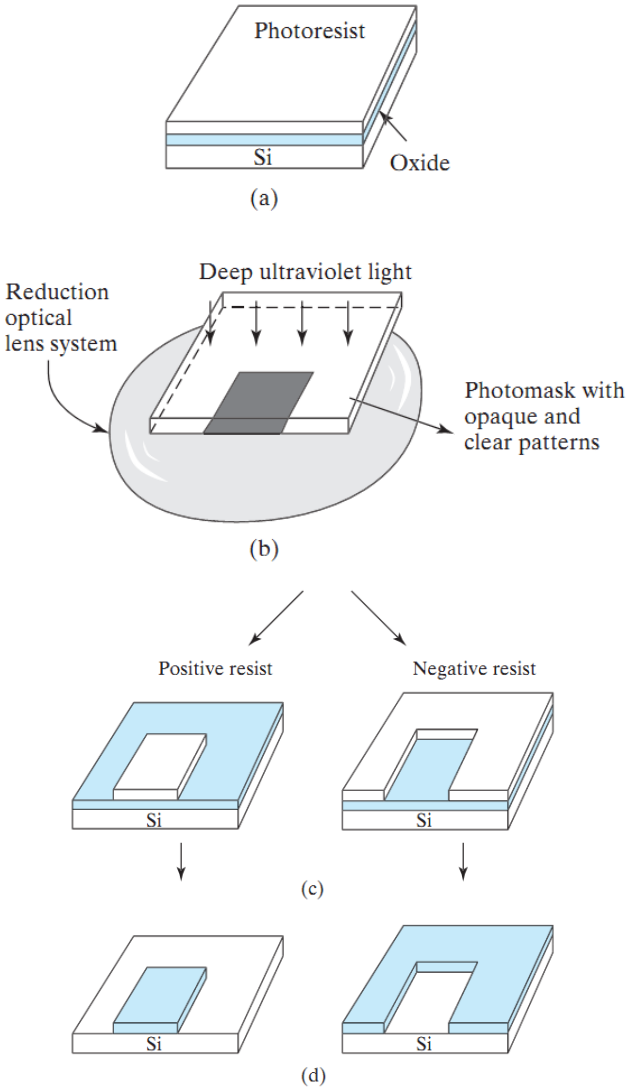

FIGURE 3–5 **Major steps in the lithography process:**

(a) Application of resist

(b) Resist exposure through a mask and an optical reduction system;

(c) Development of exposed photoresist

(d) Oxide etching and resist removal.

- A solid material may be **crystalline**, **polycrystalline**, or **amorphous**.

- Layer-upon-layer method of making circuits on a wafer substrate is called **planar technology.**

- **Lithography (in Greek, Lithos** means stone**; graphein** means to write**)** is the main tool used in IC manufacturing to record a **binary image** (**pattern**) on a layer of **photosensitive material** (**photoresist**) spun over a substrate, generally **a semiconductor wafer**.

- **Lithography** and **etching** are the basic techniques of defining physical patterns by, changing the doping concentration through ion implantation and diffusion, and depositing thin films over the semiconductor's substrate.