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Microchip Fabrication

A Practical Guide to
SEMICONDUCTOR PROCESSING

PETER VAN ZANT

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A Practical Guide to Semiconductor Processing

Peter Van Zant

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Chapter

13

Metallization

Overview

Fabrication of circuits is divided into two major segments. First the active and passive parts are fabricated in and on the wafer surface. This is called the Front End Of the Line or FEOL. In the Back End of the Line (or BEOL), the metal systems necessary to connect the devices and different layers are added to the chip. In this chapter the materials, specifications, and methods used to complete the metallization segment is presented along with other uses of metals in chip manufacturing. Vacuum pumps, used in CVD, evaporation, ion implant, and sputtering systems are explained at the end of the chapter.

Objectives

Upon completion of this chapter, you should be able to:

1. List the requirements of a material for use as a chip surface conductor.
2. Draw cross sections of single and multilayer metal schemes.
3. Describe the purpose and operation of a thin-film fuse.
4. Make a list of materials used in the metallization of semiconductor devices. Identify their specific use(s).
5. Draw and identify the parts of a vacuum evaporator.
6. Describe the principle of sputtering.
7. Draw and identify the parts of a sputtering system.
8. Describe the principle and operation of oil diffusion, turbo and cryogenic high-vacuum pumps.

Introduction

The most common and familiar use of metal films in semiconductor technology is for surface wiring. The materials, methods, and processes of "wiring" the component parts together is generally referred to as *metallization* or the *metallization process*. Metallization includes all of the steps in the metallization sequence described in Chapter 5.

Conductors-Single Level Metal

In the MSI era metallization was relatively straight forward (Fig. 13.1), requiring only a single level metal process. Small holes, called *contact holes* or *contacts*, are etched through the surface layers, to the device/circuit component parts. Following contact masking, a thin layer (10,000 to 15,000 Å) of the conducting metal (mostly aluminum or aluminum alloys) was deposited by vacuum evaporation, sputtering, or CVD techniques over the entire wafer. The unwanted portions of this layer are removed by a conventional photomasking and etch procedure or by lift-off. This step leaves the surface covered with thin lines of the metal that are called *leads*, *metal lines*, or *interconnects*. Generally a heat-treatment step, called *alloying*, is performed after metal patterning to ensure good electrical contact between the metal and the wafer surface.

Regardless of the structure, a metal system must meet the following criteria:

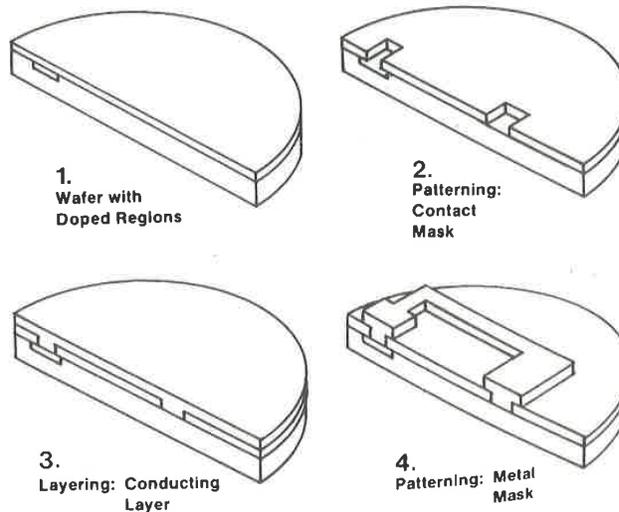


Figure 13.1 Metallization sequence.

- Good
- Good
- Ease
- Good
- High
- Corr
- Long
- Capa
- Unifo

Conduc

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Figure 13.2
July, 1997)