

Report-1: Fabrication of ICs

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Pirhna Cleaning, Di-water, Etching - wet and dry, RIE(Reactive Ion Etching System), Thermal Oxidation, Thermal Vapor Deposition, DC sputtering

1 Introduction

Fabrication of ICs consists of several processes which include - Wafer Preparation, Oxidation, Diffusion, Ion Implantation, Chemical vapor decomposition, photolithography, metal decomposition(- consists of Thermal Oxidation, Thermal vapor deposition, DC sputtering) and packaging.

Wafer preparation involves cutting, shaping and polishing the substrate. A wafer is a thin material on which the ICs are embedded, and it is usually of pure silicon crystals. On this silicon wafer, oxidation is carried out to make it an insulator at 1250° . **Oxidation** is of two types - wet and dry. Dry oxidation means, it is oxidized with oxygen. Wet oxidation means the silicon is oxidized with steam or water vapor and has much faster growth rate than the dry type as water molecules are smaller than oxygen molecules and diffuse faster through silicon dioxide. However, the benefits of using dry oxidation are that although it has a slower growth rate, it is more controlled, more dense, and cleaner than wet oxidation.

This is followed by diffusion process which is used for adding impurities to the substrate which changes its resistivity and it takes place at temperatures between 1000° and 1200° . The depth and width of the impurities depend on the temperature range and the timings. The high doping concentration improves the conductivity of a metal.

DC Sputtering is used for depositing a thin film on the substrate which is placed in a vacuum chamber containing an inert gas – usually Argon – and a negative charge is applied to a target source material that will be deposited onto the substrate causing the plasma to glow. Free electrons flow from the negatively charged target source material in the plasma environment, colliding with the outer electronic shell of the Argon gas atoms driving these electrons off due to their like charge. The inert gas atoms become positively charged ions attracted to the negatively charged target material at a very high velocity that “Sputters off” atomic size particles from the target source material due to the momentum of the collisions. These particles cross the vacuum deposition chamber of the sputter coater and are deposited as a thin film of material on the surface of the substrate to be coated. DC Sputtering can be a relatively inexpensive, cost effective solution for coating a wide range of decorative metal coatings and has limitations when it comes to dielectric target materials – coatings which are non-conducting insulating materials that can take on a polarized charge.

In **Photolithography or Optical lithography**, using light to produce thin films on the substrate(silicon wafers). It protects certain areas during successive fabrication processes (deposition, ion implantation, etc.). The types of light used to introduce mask patterns include UV light, X-rays, and extreme UV that emits at different frequencies. The most used type of light to produce the film is Ultra-Violet light. The substrate is first coated with a photoresist on which a mask pattern with the help of photolithography is applied. The exposed areas of the wafer become soft and can be removed. It creates a pattern on the wafer. The wavelength of each type of light determines the feature size impressed on the photoresist.

Di-water - has a conductivity of $18.5\text{M}\Omega\text{-m}$ and it is used for cleaning the substrate to remove dust, or other impurities. It is only used for cleaning purposes over normal water.

Reactive Ion Etching(RIE) is a type of **Dry Etching process**. It produces anisotropic etching unlike wet etching processes, due to its vertical delivery of reactive ions. Its method of operation - using the oscillating electric field, we can generate a plasma which consists of ionised atoms, which move up and down inside the chamber. They get embedded in the wafer and develop negative charge, which creates a potential difference between plasma and the wafer. This, in turn causes the positive ions to move towards wafer, and colliding with the particles that have to be etched.

2 References

1. [Sputtering](#)
2. [Wet and Dry Oxidation](#)
3. [Fabrication of ICs](#)