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ANALYSIS THE STUDY OF ELECTROLESS PLATING FOR ELECTRONIC AND METALLIZATION APPLICATIONS

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ABSTRACT

Generally, the responsibility for the design and development of semiconductor devices lies mainly with the physicist and the 'electronic engineer. However, throughout the different stages involved in the actual manufacture of a semiconductor device, the knowledge of chemistry is very essential. It is the aim of this chapter to review briefly the role of chemical and electrochemical processes utilized in the preparation of such very small devices. The electrical characteristics of these devices are also briefly reviewed. The electrical characteristics of a semiconductor device greatly depend upon the contaminants present on the surface of semiconductor. Therefore, during chemical processing of a device it is necessary to minimize the amount/ of impurities present on its surface. These contaminants can be removed by boiling the samples in Cone. HNO .for some time at elevated temperature, washing in deionized water and then degreasing it in the vapors of organic solvents in sequence. Since metallization of dielectric finds many useful applications in the field of electronics as well as in other industries, the above processes might also be helpful in the fabrication of metal dielectric combination. With this end in view, the author of this thesis started in 1977 some experimental investigations to fabricate methl-semiconductor contacts and for metallization of dielectrics both chemically and electrochemically and to study their properties.

Keywords: - Semiconductor, Electrical, Chemical, Metal, Plating

I. INTRODUCTION

Generally, the responsibility for the design and development of semiconductor devices lies mainly with the physicist and the 'electronic engineer. However, throughout the different stages involved in the actual manufacture of a semiconductor device, the knowledge of chemistry is very essential. It is the aim of this chapter to review briefly the role of chemical and electrochemical processes utilized in the preparation of such very small devices. The electrical characteristics of these devices are also briefly reviewed.

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Immersion deposition method

This method is also known as electrochemical displacement method of metal deposition. The electrochemical displacement reaction involves the displacement of a' noble metal ion by a less noble metal through electron transfer.

Naturally, immersion deposition method is limited to systems in which the metal to be deposited is more noble than the substrate.

Contact deposition method

In this method of metal deposition the substrate to be plated is placed in an intimate contact with an active metal in a solution of a more noble metal salt. An example is the contact tinning of copper wherein the work is brought in contact with zinc chips in an electrolyte containing tin salts. The zinc enters the solution and the tin plates out on the copper.

Chemical reduction method

Chemical reduction of metal deposition is based on the reduction of a metal salt to the corresponding metal with the help of a suitable reducing agent.

The reaction once started proceeds to completion in a relatively short time and causes complete precipitation of the metal ion available throughout the body of the solution.

The plating thickness in this case is rather small, of the order of a few microns. Although copper, gold, antimony, platinum and alloy deposits have been made, the metal most commonly deposited by this method is silver.

Electro less plating method

Electro less plating method is basically the same as chemical reduction method in which solutions are formulated so as to prevent or at least minimize the tendency for the oxidation-reduction reaction to take place throughout the plating solution.

As such, metal reduction does not occur readily.

II. METALLIZATION

Conductive films provide electrical interconnection among devices as well as the outside. Figure 1.1 depicts the metallization scheme of a MOSFET. The primary metallization applications can be divided into three categories: gate, contact, and interconnection.

Polysilicon and silicide are frequently used in gates and interconnects in MOS devices.

Aluminum and copper are the metals of choice as contact and second-level interconnection to the outside. In some cases, a multiple-layer structure involving a diffusion barrier is used.

Titanium / platinum / gold or titanium / palladium / gold is useful in providing reliable connection to external components.

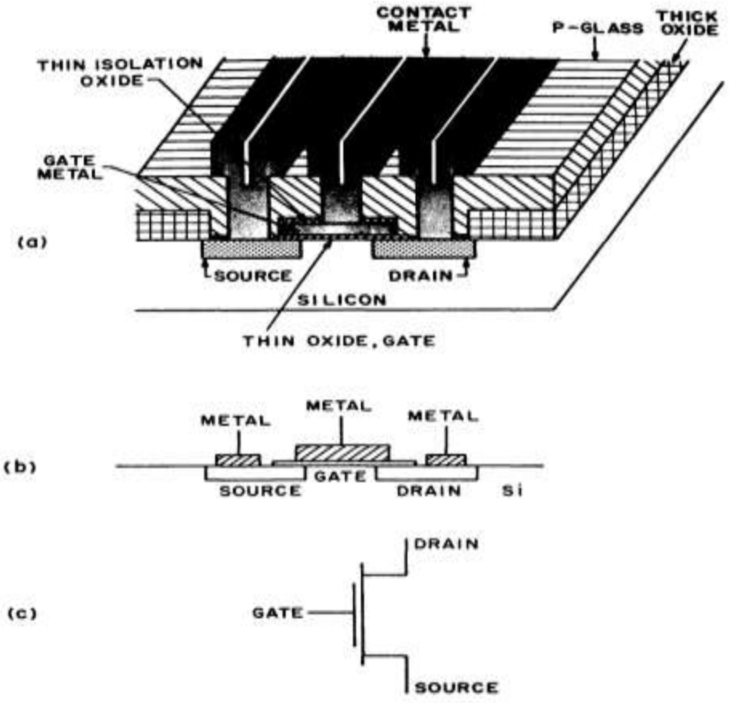

Figure 1.1 A typical MOSFET: (a) Three-dimensional cross section. (b) Schematic representation. (c) Circuit representation.

Metallization Choices

No metal satisfies all the desired characteristics tabulated. For example, even though aluminum possesses most of the desired properties, it suffers from a low melting point, spiking shorts, and electromigration. Polysilicon, refractory metal silicides (MoSix, TaSix, WSix, and TiSix), aluminum, and copper are used in gates and interconnects

Physical Vapor Deposition

The most common forms of physical vapor deposition (PVD) are evaporation, ebeam evaporation, plasma spray deposition, and sputtering. Evaporation and ebeam evaporation used to be the workhorses in the IC industry but sputtering is now the dominant PVD technique in the industry.

Chemical Vapor Deposition

Chemical vapor deposition (CVD) offers several advantages, of which three are particularly important:

(1) Excellent step coverage.

(2) Large throughput.

(3) Low-temperature processing.

A number of metals and metal compounds, such as Al, Cu, WSi2, TiN, and W, can be deposited by chemical reaction or thermal decomposition of precursors. The nature of metal CVD is not different from that of Si or SiO2 CVD. A precursor chemical containing the desired metal and a chemical reaction or decomposition are the key ingredients. Usually the wafer needs to be heated to 100oC to 800oC to provide the initial thermal energy to overcome the reaction barrier.

III. ELECTROPLATING / ELECTROLESS PLATING FOR ELECTRONIC APPLICATIONS

Electroplating and electro less plating processes are used extensively on electronic devices. When should plating be used? What metals or alloys are best suited for the application? What are the advantages and disadvantages of plated deposits compared with other methods, such as Chemical vapor deposition, sputtering, and thick or thin film materials? These and other questions are addressed in this paper. Properties and characteristics of plated deposits are discussed. Some typical applications are reported.

Why plating? When should plated deposits be used?

Plating, including electroplating and electro less plating of metals and alloys serve many useful functions in electronic devices. Corrosion protection, diffusion barriers, conductive circuit elements, via hole filling for semi-conductors integrated circuits, through hole connections for printed wiring boards, and flexible circuits. Plating is used to fabricate passive devices on dielectric surfaces such as resistors, capacitors, and inductors and to improve conductivity of metallized circuits, which use thick film conductors, or frits on ceramic substrates such as molybdenum, "moly-mag", tungsten and other such materials.

Via hole filling

Very large-scale integrated circuits (VLSI) use multilevel circuit interconnections to provide high density and reliability in a compact structure. During fabrication, a layer of metallization is deposited on the silicon wafer, and conductors are etch-defined. A layer of dielectric is then deposited and windows (via holes) are etched through the dielectric to connect points on the metallization. The next layer of metallized conductors is then applied to form interconnections.

Corrosion Control

Corrosion of electronic components is destructive in many ways. Loss of surface conductivity, increase in contact resistance, and deterioration of the component, broken connections, soldering, brazing and wire bonding are made difficult. Failures in dielectric between metal lines due to accelerated corrosion when voltage gradients are applied. Chang reported that in the absence of a voltage gradient, corrosion was only just apparent after 2000 hours, but corrosion was observed within 50 hours with a 25 volt potential difference, between the two conductors 0.5mm apart The corrosion rate increases linearly with increasing potential differential.

IV. CONCLUSION

In solar cell fabrication, the compatibility of the manufacturing steps for the different parts of the device is not always a given. Defining the optimal manufacturing route requires the implementation of specific process combinations for specific efficiency goals and price constraints. A pattern-transfer process using an inkjet printer mask for the patterning of front-side SiNx was developed. First, an evaluation of the chemical etching of PECVD SiNx layers in HF was performed. Then, the combination of this step with proper etch-mask formation by inkjet printing was developed and optimized to achieve a standard opening resolution ~ 50 µm width, though a minimum of ~ 20µm was achieved. As an alternative a direct writing method was analysed. It consists in the ablation of the coatings with different laser sources.

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