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Etching of Metallic & Dielectric Films in VLSI Technology

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Abstract

In the present paper we discuss the isotropic etching of various films such as Aluminum, Titanium, Silicon dioxide& Silicon Nitride The second section of this paper contains anisotropic etching of Silicon using Silicon Nitride as a mask. Various types of etchant are available.The etch rate depends upon the pH, concentration and temperature in anisotropic etching. In isotropic etching etch rate depends upon concentration of the acidic medium.

Keywords

Isotropic Etching, Anisotropic Etching, Orientation, Concentration, Temperature, Etch Rate

Introduction

Photolithography is the key process that is used to transfer the pattern on the Silicon Substrate.In this process Etching is the process to open the window in the silicon to enable the doping.It remove the masking material($Si0_2$,Si_3n_4) where the material is not required.The basic meaning of the etching is to eat something.In VLSI Fabrication Technology two types of etching is available one is Wet etching used chemicals and the second is the Dry Etching which use the a gas or a combination of gases.Here we discuss the Wet etching process in which etching is done using chemicals.Wet etching are divided into two parts one is Isotropic which is orientation independent.Another is Anisotropic which is orientation dependent.In isotropic etching the etch rate is independent from crystal orientation and temperature.It mainly depends upon the concentration of the etchant (chemical).Isotropic etching mainly done by Acids.On the other hand anisotropic etching depends upon crystal orientation, concentration of the chemical (base) and the temperature.The first section of this paper discuss the isotropic etching of various films and the second sections discuss the anisotropic etching of Silicon.

Materials for Etching

1. Metal Films : Aluminum (Al), Titanium (Ti)

2. Dielectric Films: $Si0_2$, Si3N4

3. Crystalline Materials: Silicon

1. **Etching of Aluminum**

Temperature: 40ºC

Thickness of the Aluminum film: 500nm

Etch Time: 15 Seconds

Etch Rate: 320nm/min

Etchant	**Concentration**
Phosphoric Acid	75%
Nitric Acid	5%
Acetic Acid	5%
DI Water	15%

2. Etching of Titanium

Etchant	**Concentration**
HF Acid	1%
H_20_2	1%
DI Water	20%

Thickness of the Titanium film: 200nm

Etch Time: 15 seconds

Etch Rate: 3nm/min

3. Etching of Silicon dioxide ($Si0_2$)

Parameter	Value
HF& DI Water	1:8
Thickness of the $Si0_2$ film	400nm
Etch Time	3min
Etch rate	70nm/min

4(a) Etching of Silicon Nitride

Parameter	Value
HF & NH_4F	1:8
Thickness of the film	350nm
Etch time	15min
Etch rate	2nm/min

In the second case to etch Si_3N_4 Phosphoric Acid is used.

(b)Etchant: Phosphoric Acid

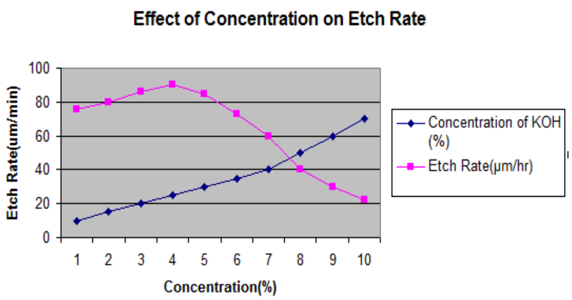
Parameter	Value
Phosphoric Acid	75%
Temperature	130 ºC
Etch Time	15min
Etch Rate	12nm/min

5. Anisotropic Etching of Silicon

Parameter	Value
Orientation of Si Substrate	[100]
Masking Material	Silicon Nitride
Thickness of Masking Layer	350nm
Temperature	80ºC
Etchant	KOH

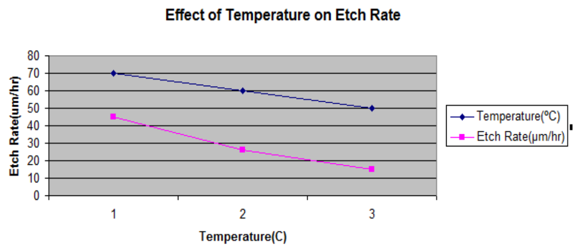
In this case the temperature is fixed at 80ºC and the concentration of KOH (Potassium Hydrooxide) is varied. The etch depth is measured by Stylus Profilometer.

Concentration of KOH (%)	Etch Rate(μm/hr)
10	76
15	80
20	86
25	90
30	85
35	73
40	60
50	40
60	30
70	22



In the second experiment Concentration is fixed at 30% and now the temperature is varied again etch rate is varies.

Temperature(ºC)	Etch Rate(μm/hr)
70	45
60	26
50	15



Conclusion

In future the etch rate of the silicon can be varied according to the etch depth. And the etching process should be optimized to get a steep profile inside the silicon substrate. The process should be optimized to reduce the etch time of silicon. For that purpose concentration and the temperature are the key parameters to change the etch rate. In dielectric films we see that due to low etch rate Si_3N_4 is better for deep etching of silicon.

References

[1]VLSI Technology by S.M. Sze

[2]Kern, W., Vossen, J., Chapter V-1, Thin Film Processes, Academic Press, New York (1978).

[3]J.Electrochem.Soc.137 (11)3612-3632(1990).

[4]Influence of the angle between etched (near) Si {111} surfaces and the substrate orientation on the under etch rate during anisotropic wet-chemical etching of silicon, J.Microchem.Microeng eng., submitted, 2000

[5]M.J.Declercq,"A new CMOS technology using anisotropic etching of silicon,"IEEE J.Solid State Circuits, vol SC- 10, no.4, pp. 191-197, Aug.1975.

[6]D.B.Lee, "Anisotroic etching of silicon, J.Appl.Phys" vol 40, no. 1, Oct.1969.