ROCHESTER INSTITUTE OF TECHNOLOGY
MICROELECTRONIC ENGINEERING

LAM4600 Plasma Etch Tool Recipes

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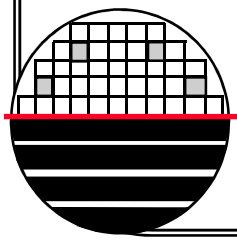
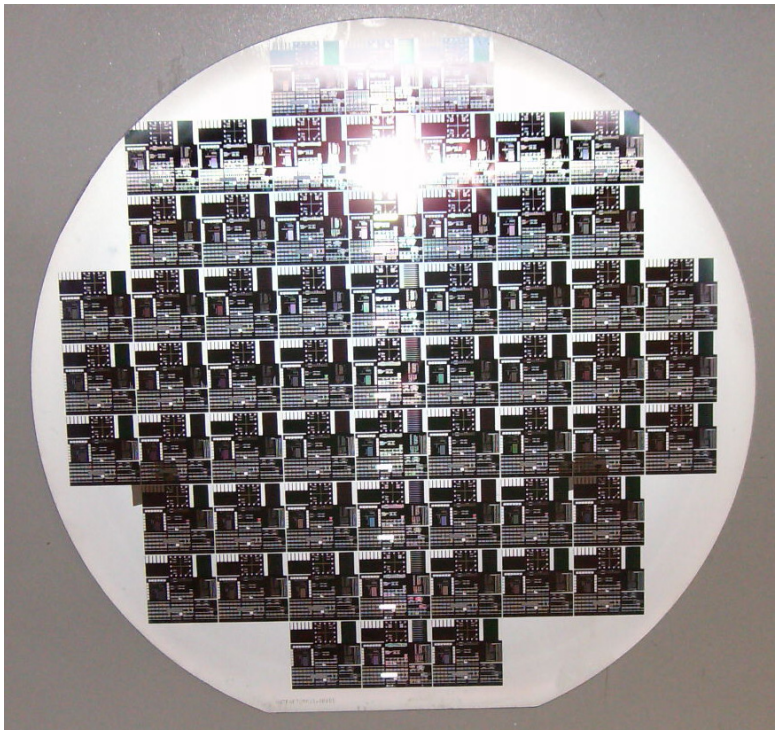
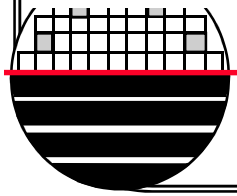


ALUMINUM ETCH USING LAM4600



INTRODUCTION

The LAM4600 is a Reactive Ion Etch (RIE) Tool for Anisotropic Aluminum Plasma Etch. It is a load lock vacuum system to keep room air out of the main etch chamber. The entire system is heated slightly above room temperature because the byproducts of the etch (Aluminum/Chlorides) are volatile and can be pumped out of the chamber but at a slightly lower temperature the byproducts will deposit on the inside surfaces of the tool, pump lines, and pumps. The Gas Reactor Column (GRC) removes the chlorine byproducts from the gas that is exhausted to the outside world. Endpoint detection is available and is based on plasma brightness (similar to the LAM490 tool) Other materials can be etched with these chemicals. The tool has a built in water rinse station at the exit that can be used (or not) to reduce chlorine residue on the wafers. We do an external SRD rinse on the wafers after etching.



LAM 4600 ALUMINUM ETCHER

Aluminum Plasma Etch Chemistry

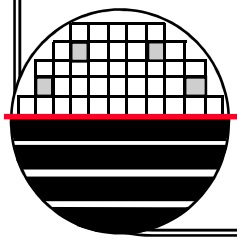
Cl2 – Reduces Pure Aluminum

BCl3 – Etches native Aluminum Oxide

-Increases Physical Sputtering

N2 – Dilute and Carrier for the chemistry

Chloroform – Helps Anisotropy and reduces photoresist damage



LAM4600 ANISOTROPIC ALUMINUM ETCH

Step	1	2	3	4	5
Pressure	100	100	100	100	0
RF Top (W)	0	0	0	0	0
RF Bottom	0	250	125	125	0
Gap (cm)	3	3	3	3	5.3
O2 111	0	0	0	0	0
N2 222	13	13	20	25	25
BCl 333	50	50	25	25	0
Cl2 444	10	10	30	23	0
Ar 555	0	0	0	0	0
CFORM 666	8	8	8	8	8
Complete	Stabl	Time	Time	Oetch	Time
Time (s)	15	8	200	10%	15

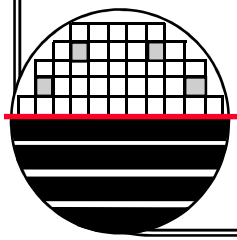
Rate ~38Å/s

Thickness = 7500Å

Various tool modifications resulted in different etch rates for different years

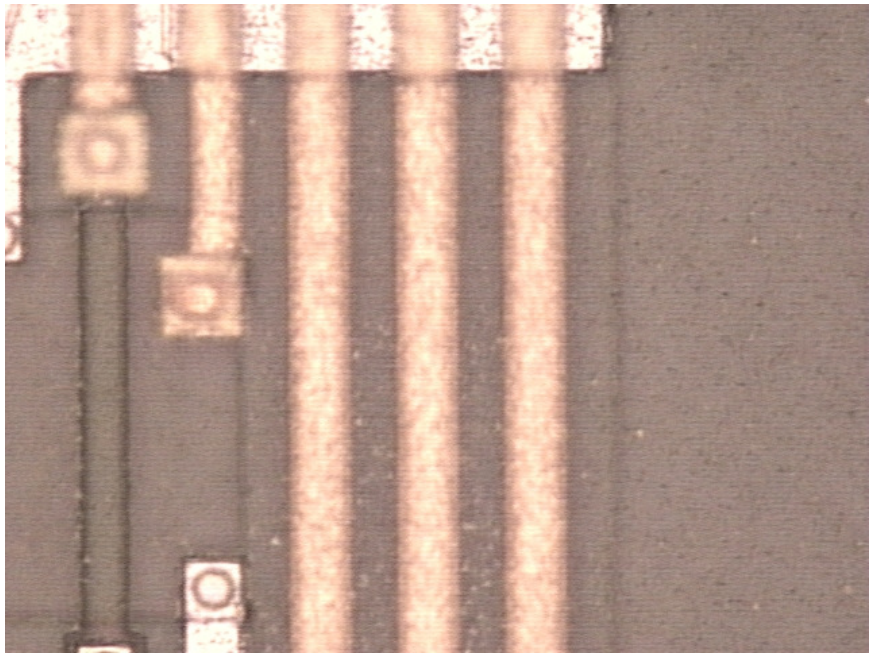
Channel	B
Delay	130
Normalize	10 s
Norm Val	5670
Trigger	105%
Slope	+

Endpoint (not used)

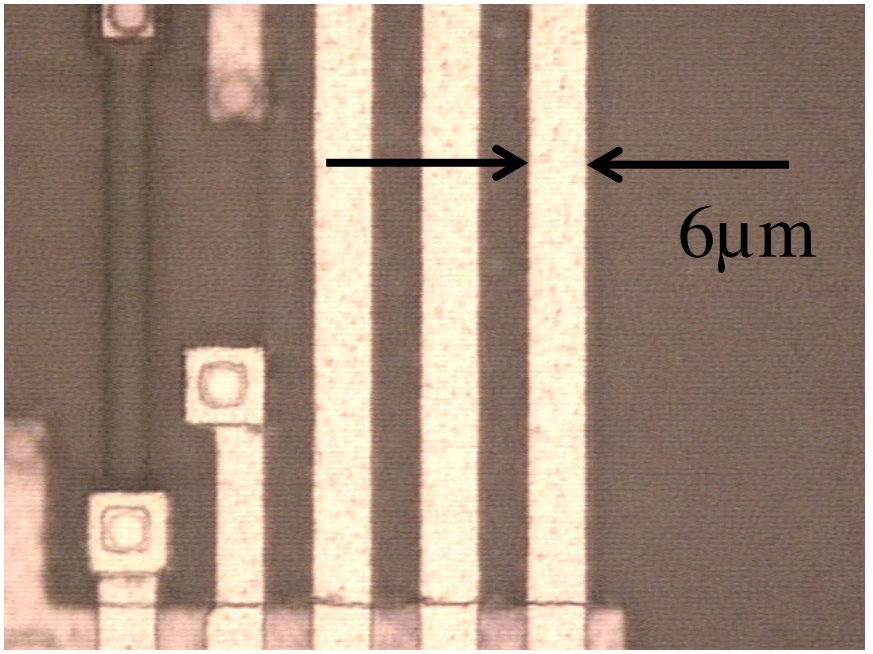


Fuller April 2013 – 200s
Fuller, January 2012 -300s
Fuller, March 2011 -230s

RESULTS FROM ALUMINUM PLASMA ETCH



Photoresist on Metal Two



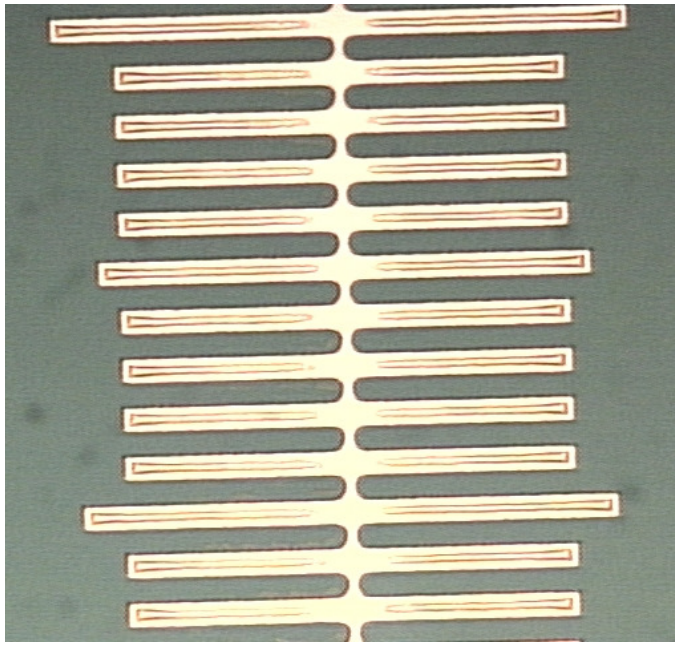
Photoresist Removed

RESIST REMOVAL POST CHLORINE RIE ALUMINUM ETCH

Problem: Photoresist is hardened (and chemically changed) in Chlorine RIE during Aluminum etch and ashing is ineffective in removing the resist.

Solution: Use a Solvent based photoresist stripper process. (similar to Baselinc CMOS process at U of California at Berkeley)

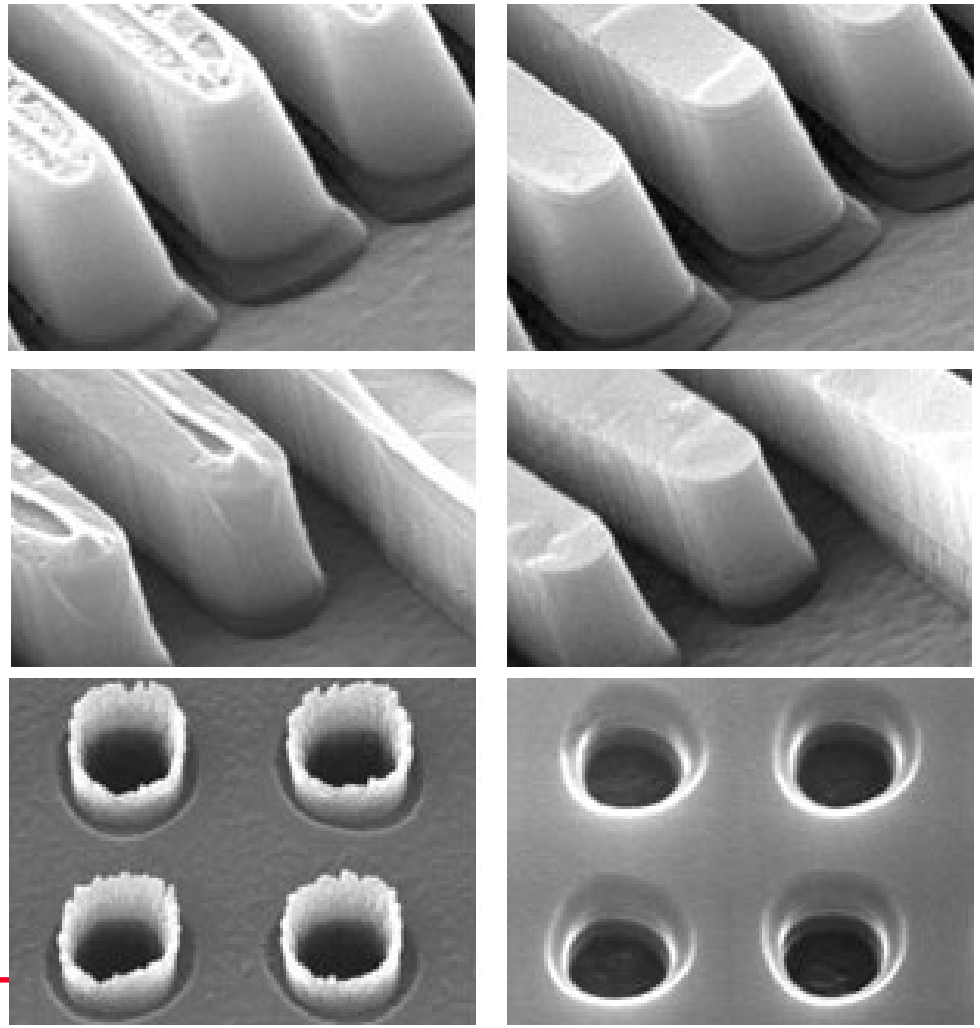
Picture of aluminum wafers post chlorine RIE and after ashing. Note resist remaining on aluminum. Even very long ashing (60 min.) does not remove residue.



Germain Fenger

MORE PICTURES OF RESIST SCUM PROBLEM

Pictures on left show resist residue after ashing. Pictures on right show effectiveness of ACT 935 solvent strip process.



From: [ACT-CMI Data Sheet]

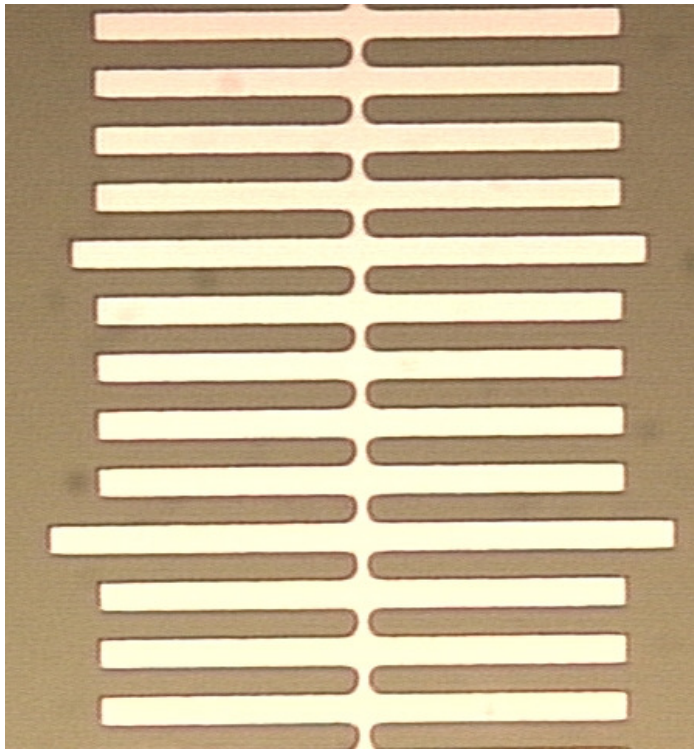
RESIST REMOVAL AFTER PE4600 PLASMA ETCH

Obserations:

A solvent based photoresist stripper followed by a plasma ash is effective at removing Chlorine "burned resist"

Recommendations:

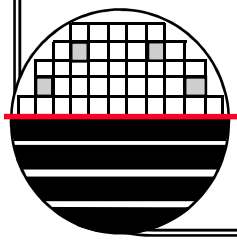
PRS2000 at 90C for 10 min
Rinse 5 min. / SRD
Follow up with 6" Factory ash on the Branson Asher



No photoresist was found on wafers

SAFTY

We have a chlorine gas leak detector integrated with the building alarm system so that if a gas leak occurs the alarm sounds, the gas bottles are closed and pump and purge valves are activated.



SUMMARY – CONCLUSION

1. Smooth metal is necessary for good plasma etching.
2. Aluminum film non-uniformity of less than 10% is needed to give best results.
3. A new plasma etch recipe that is more anisotropic was created and shown to work for wafers with non uniformity of ~22%
5. Resist strip using solvent strip followed by oxygen plasma strip is effective after chlorine plasma etch of aluminum.