LAM4600 Plasma Etch Tool Recipes

Dr. Lynn Fuller

Webpage: http://people.rit.edu/lffee
Microelectronic Engineering
Rochester Institute of Technology
82 Lomb Memorial Drive
Rochester, NY 14623-5604
Tel (585) 475-2035
Email: Lynn.Fuller@rit.edu

Department webpage: http://www.microe.rit.edu

4-21-2015 Lam4600_Etcher.ppt
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.
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**

Recipe: Number 122122

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<th>3</th>
<th>4</th>
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**Rate ~38Å/s**

**Thickness = 7500Å**

Various tool modifications resulted in different etch rates for different years.

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<td>Slope</td>
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Fuller, April 2015 – 200s for 7500Å
Fuller March 2014 – 230s for 7500Å
Fuller April 2013 – 200s for 7500Å
Fuller, January 2012 -300s for 7500Å
RESULTS FROM ALUMINUM PLASMA ETCH

Photoresist on Metal Two

Photoresist Removed

6µm
**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

Germain Fenger
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.
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.