

Aluminum Etch Application Note

Material	Etch Gases	Reactive Species	By-product
Aluminum	Boron Trichloride (BCl ₃) and Chlorine (Cl ₂)	Free chlorine	AlCl ₃

Pure aluminum, by itself, etches readily in a Cl₂ plasma. However, a native oxide layer covers all aluminum films. Pure Cl₂ does not etch this oxide, so BCl₃ is added to increase the amount of sputtering and to scavenge the oxygen in the aluminum oxide layer. In most modern integrated circuits the aluminum is alloyed with small amounts (0.5% to 2%) of silicon and copper. Copper in particular is difficult to etch by RIE, so BCl₃ is also useful for increasing the amount of physical sputtering which removes the copper. Typically the aluminum itself is removed very rapidly, but complete removal of other metal residue requires a longer etch. A variety of wet chemical etchants can also be used to remove the metallization, but the chemicals will enter the vias and isotropically undercut the next lower metal line.

It is important that aluminum etching be done in a separate reactor (or one that has been cleaned thoroughly) than the reactor used for silicon compound etching. The reason for this is that the chemistries "poison" each other. Fluorine containing polymer residues from oxide etching will react with aluminum to form aluminum fluoride on the metal surface, which is inert to chlorine etch. Aluminum chloride by-products, left behind from the aluminum etch, form an aluminum fluoride powder when exposed to fluorinated plasma: this powder subsequently falls and contaminates the sample surface. Another, important consideration in aluminum etching is moisture contamination. For this reason, as well as safety considerations, a vacuum load-lock is highly recommended for this application.

Obviously, aluminum etching is one of the most difficult processes. However, if done correctly very good etch results can be obtained. A good starting recipe for a more uniform but isotropic etching of the Al is:

Parameter	Value	Comments
Pressure	180-mTorr	Best pressure for good uniformity
RIE Power	200-watts	High Etch Rate, but necessary to remove native oxide
BCl ₃ Flow	30 sccm	
Cl ₂ Flow	10 sccm	Too much of this can cause undercutting
Etch Rate	0.5-um/min	

*Note: Lowering the pressure to 30-mTorr will yield an anisotropic etch of the Al, if that is what's desired.

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