

Legacy Systems, Inc.



Advanced Ozone Photoresist Strip & Comparison

The U.S. EPA Award Winning Coldstrip™ System Process



**NO OTHER S/C EQUIPMENT
MANUFACTURER WORLDWIDE
HAS WON THIS AWARD - EVER**

- Equipment and Process Comparisons

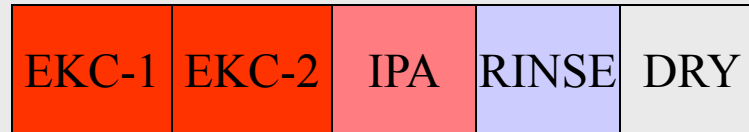
Station Size Reduction

Piranha Station – 6 Tanks



OR

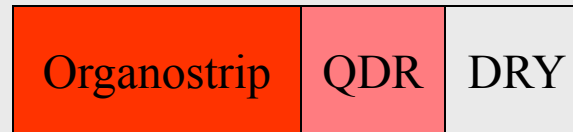
Solvent (EKC or ACT) Station – 5 Tanks



200 Wafers per Hour



Organostrip™ – 3 Tanks



Coldstrip – 2 Tanks



Legacy Ozone Processes vs Piranha And Solvent Strippers Summary

	Coldstrip	Organostrip	Piranha	Solvents (like EKC)
Process Time (mins)	5-15	1-10	5-15	5-15
Process Temp (C)	4-10	Ambient	100-130	60-75
Solution Lifetime (Days)	>7	>7	0.3 - 2	<7
Metal Film Compatibility	Yes	Yes	No	Yes
Water Spots / Stains	No	No	Yes	Yes
Particulates	Very Low < 15	Very Low <15	Very High > 10,000	Very High > 1,000
Process Cost / Yr \$K	21K	104K	311K	198K

Organostrip versus Conventional Solvent

	Solvent Strippers	Legacy Organostrip
Raw material cost	High > \$50 / Gal	Low < \$24/Gal
Photoresist strip mechanism	Dissolves	Decomposes & Oxidizes
Lifetime	Limited, gets saturated with dissolved photoresist	Virtually Unlimited
State and Federal Law Restrictions	Waste disposal regulated	None
Temperature	Heated 60-75C	Room Temperature
Rinsing Water	>1 min, difficult, multiple unites	<20s, easy

Comparison of Ozone Resist Strip Processes

	Legacy Organostrip	Semitool Hydrozone	FSI Mercury / Ozone
Resist Strip Rate	> 30 um /min	> 30 um/min	< 1 um/min
Process Temp	Ambient	>90 C	30-60 C
Physical State	Liquid	Vapor / Gaseous	Liquid
Compatible with Metal Films	Yes	No	No
Particles Left After Resist Strip	<15	500	100
Automated Equipment Cost	\$500k	~ \$750k	~ \$650k

Cost of Ownership Comparison Organostrip vs Solvent PR Strip

1	50 - 150mm wafers processing system	50 - 150mm wafers processing system
2	Process Tank Volume = 32 liters = 8.5 gallons	Process Tank Volume = 32 liters = 8.5 gallons
3	Recirculation Loop Volume = 45 liters = 12 gallons	Recirculation Loop Volume = 45 liters = 12 gallons
4	High Temperature Bellows Pump 40 liters/min	Low Temperature Pump
5	Heaters	Eliminated
6	Quartz or Stainless Steel Heated Recirculating Tank	PVDF, PFA, or PTFE tank
7	IPA followed with Ambient QDR	Ambient Temp QDR
8	Solvent Stripper 45 liters at makeup	45 liters of ORGANOSTRIP / OZONE at makeup
9	Wafer Throughput 4 Batches/hr = 200 wafers per TWO tanks	Wafer Throughput 6 Batches/hr = 300 wafers/hr per tank
10	Bath Changeout 1 Week	Bath Changeout once every month
11	350 Days/Year	350 Days/Year
12	Rinse Water 10 gal/min @ 5 mins Ambient Temp	Rinse Water 10 gal/min @ 2.5 mins Ambient Temp

Yearly Chemical Consumption	Cost	Yearly Chemical Consumption	Cost
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Chemical	Solvent Stripper	600	\$57,000	0	\$0
	Organostrip	0	\$0	288	\$17,280

Rinse	IPA	2,975	\$44,625	0	\$0
	DI Water	1,680,000	\$84,000	1,680,000	\$84,000

Oxygen (cu ft)	0	\$0	433,278	\$2,166
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Thermal	KWH	KWH \$	KWH	KWH \$
	146,136	\$12,370	4,109	\$94

Total Consumable Cost	\$197,995	\$103,530
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Total Consumable Savings per Year **\$94,465**

Wafer Throughput per Year **1,680,000** **5,040,000**

Cost of Ownership Comparison Coldstrip vs Piranha PR Strip

		Sulfuric Resist Strip Processing		COLDSTRIP™ Processing	
		Yearly Chemical Consumption	Cost	Yearly Chemical Consumption	Cost
Chemical	Sulfuric Acid	4200 Gals	\$42,244.00	0	\$0
	Hydrogen Peroxide	1710 Gals	\$26,657.00	0	\$0
Water	Hot	1,316,000 Gals	\$65,800.00	0	\$0
	Cold	1,974,000 Gals	\$98,700.00	12,600	\$630.00
Oxygen Cu.Fl.		0	\$0	433,278	\$2,166.00
Thermal	kWh	146,136	\$12,370.00	1109	\$94.00
		Estimate			
Acid Neutralization		# of LBS.	\$1,500.00	0	\$0
Parts Consumption			\$65,932.00		\$18,000.00
Total Consumable Cost			\$311,203.00		\$20,890.00

Total Savings per Year \$290,314.00

Smallest Station Footprint

	<u>Wafers per Hour</u> (1.2 – 1.5 um's)	<u>Station Footprint</u>
<u>Manual Station</u>		
1 Process Tank + QDR + SRD's	600	60" Width x 60" Depth
2 Process Tanks + 2 QDR's + SRD's	1200	101" Width x 60" Depth
<u>Semi/Fully Automated</u>		
<u>100 wafer batches</u>		
1 Process Tank + QDR + SRD's	600	108" Width x 48" Depth
2 Process Tanks + 2 QDR's + SRD's	1200	132" Width x 60" Depth

Organostrip™ vs Mercury MP Sizes

FSI Mercury MP Footprint (Source FSI)

Helios - 14.75" w x 24.8 d
Booster Pump - 14.75" w x 24.8 d
Canister 1 – 22.0" w x 39.75" d
Canister 2 – 22.0" w x 39.75" d
Electrical Cabinet – 20.0" w x 43.75" d
Process Cabinet – 53.0" w x 40" d
Total Square Feet = 38.0

LEGACY ORGANOSTRIP™

Single Pair Process Station – 108" w x 48" d = **TOTAL Square Feet = 36**
600 Wafers per Hour

Dual Pair Process Station – 132" w x 60" d = **TOTAL Square Feet = 55**
1,200 Wafers per Hour

Organostrip vs Piranha for Resist Stripping

- Organostrip operates at Room Temperature Piranha is heated to 130C
- Organostrip is Faster than Piranha with 100 Wafer Batches and 6 Batches per hour per Process Tank (@1.2-1.5um)
- Organostrip is compatible with many Metal Films where Piranha is NOT suitable
- Organostrip does not leave metal or particle residues on Wafers, Piranha DOES
- Organostrip is Less Expensive and EPA Approved (Green Chemistry); Piranha is More Expensive and NOT EPA Endorsed

Organostrip vs Piranha for Resist Stripping

- Organostrip operates at Room Temperature Piranha is heated to 130C
- Organostrip solution lifetime is > 1 week with 24/7 operation, the Piranha solution lifetime varies between 8-24 hours depending on Peroxide Concentration and Process Temperature

- Legacy Ozone Resist Strip Process Technologies
- And
- Legacy Resist Strip Process Data

COLDSTRIP™

- Subambient Temperature Water
- 100 – 150 ppm Dissolved Ozone Conc
- DUV and I-Line Resist Removal 2000Å/min
- Compatibility with Many Metal Systems

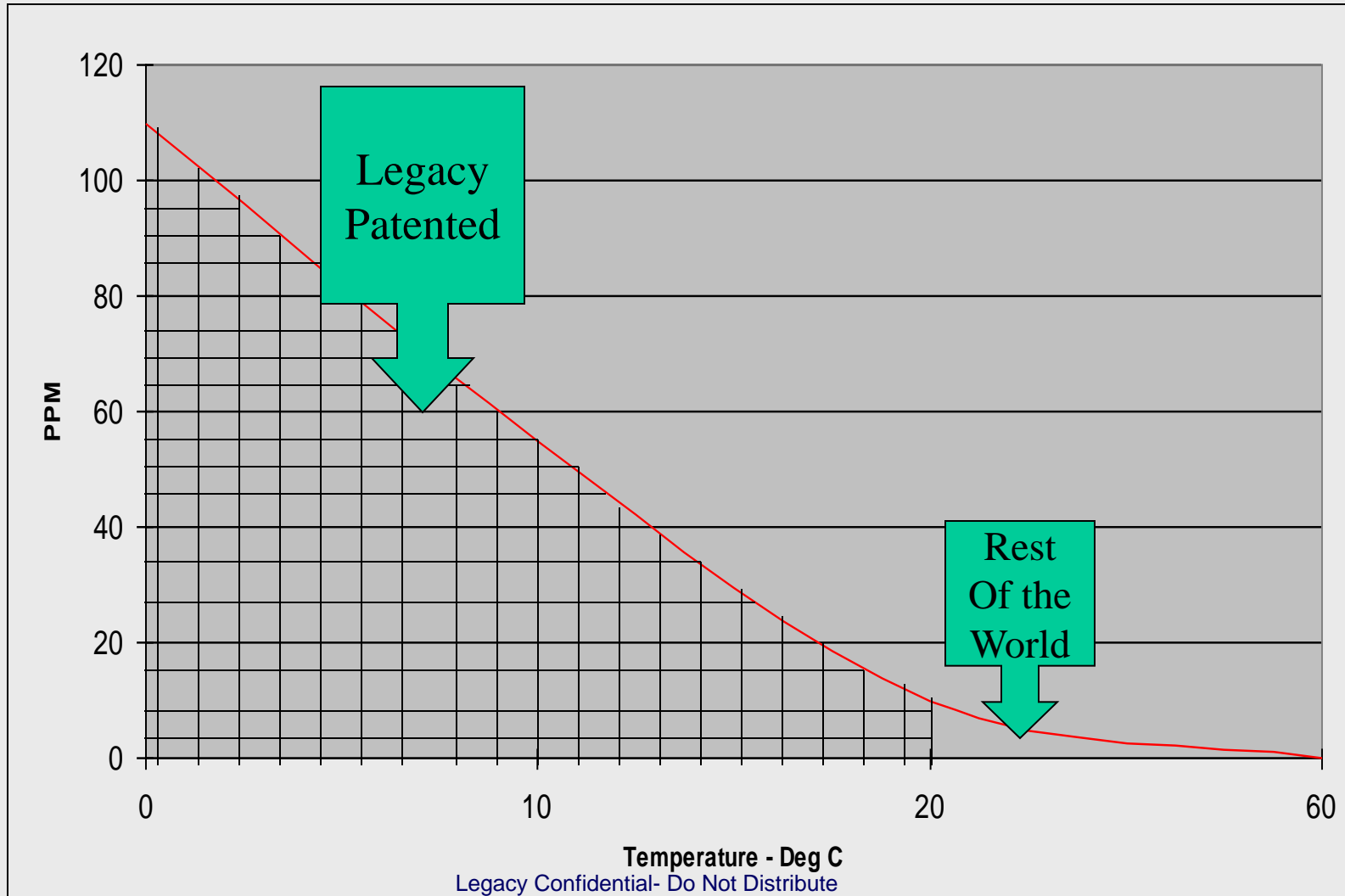
Organostrip (I, II, and III)™

- **>100ppm Ozonated Organic Solvent / Rinse**
- **Ambient Temperature Processing**
- **100 Wafer Batch Photoresist Stripping & Organic Cleaning (600 Wafers per Hour @ 1.2 – 1.5 um Resist Thickness)**
- **Negative, I-line, and DUV Resist Removal >10,000Å/min = 1 micron per minute**
- **Compatible with All Metals Tested; Even Cu**

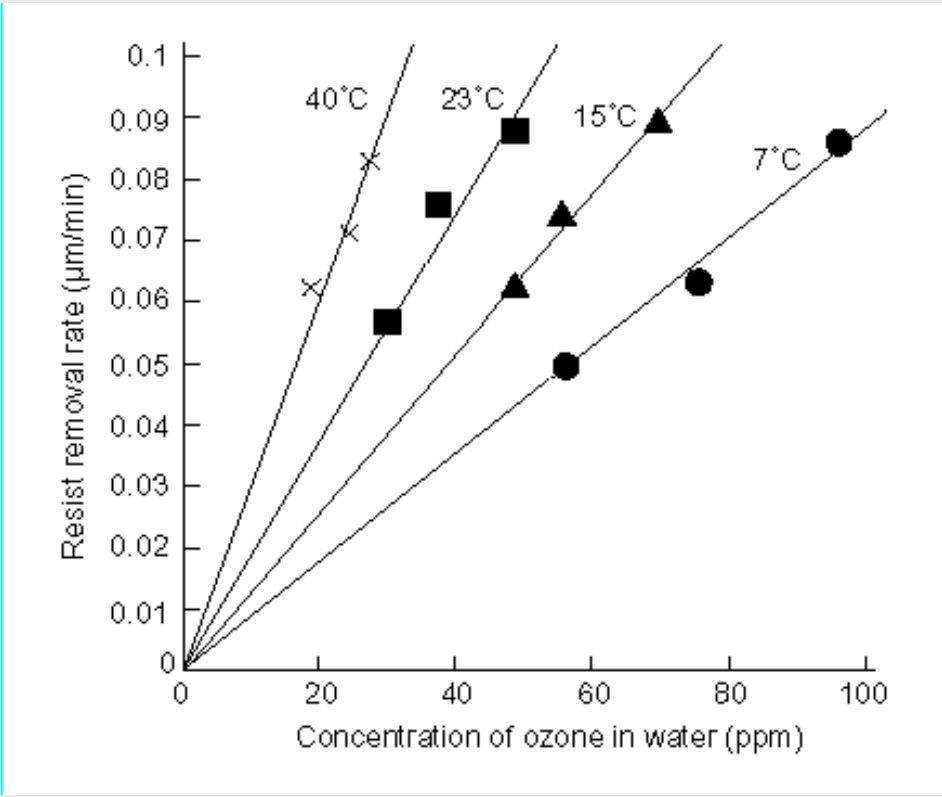
Break-Thru O₃ Technology

- Works with all metals tested - Aluminum, Copper, Gold, Tantalum, Titanium, Tungsten, and many others
- Delivers Exact Chemistry to Point of Use
- Replaces 2-3 Traditional Wet Benches/Ashers

Ozone Solubility in H2O



Resist Removal Rate increases linearly with increased dissolved ozone concentration



Data from processing at atmospheric pressure only

Graph from Mitsubishi Electric Advance Technical Report by Hirozoh Kanegae, September 1999

BE Photoresist Removal

DUV PR 193 strip rates in Ozonated Solvent

Processed Chemistry :-

Ozonated solvent
Temperature of the chemistry is RT
Rinse is 10 to 20sec

Material : DUV PR 193
Thickness : 3300A

Stripped in <2s

**DUV PR 193 films are stripped very fast in Ozonated solvent,
Not really a challenge**

Metal Etch Rates of the Stripping Solution (um/min):

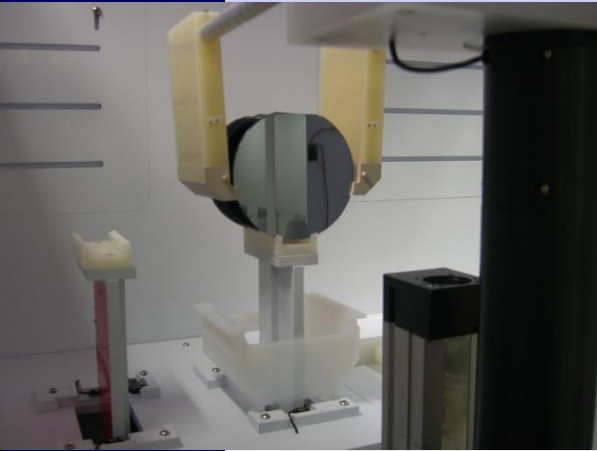
Measured Data on Metal Corrosion in Ozonated solvent at room temperature

Metal	ozonated solvent
Al	0
TiN	0
Cu	0.002um/min
W	0
Cr	0
Mo	0.0006um/min

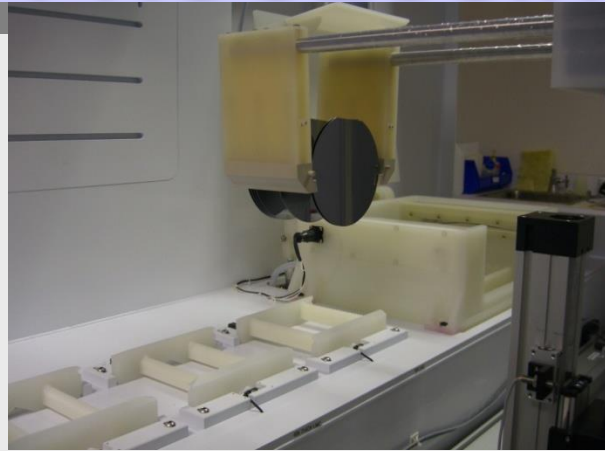
Almost non-corrosive to metals

- Legacy Equipment Set

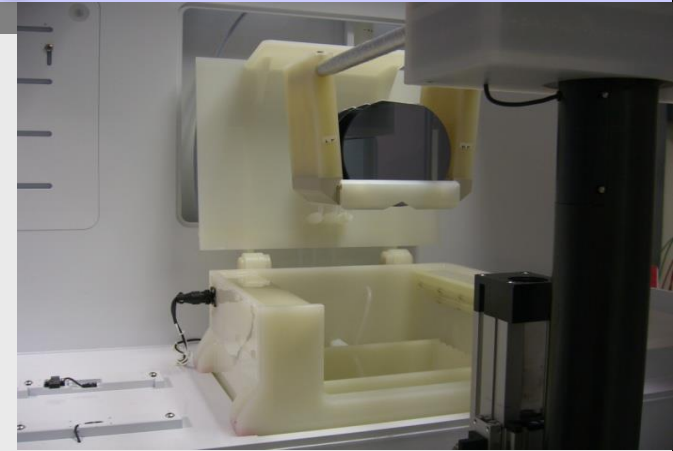
Cassetteless DRY to DRY PROCESSING



Pick up from
standard cassette



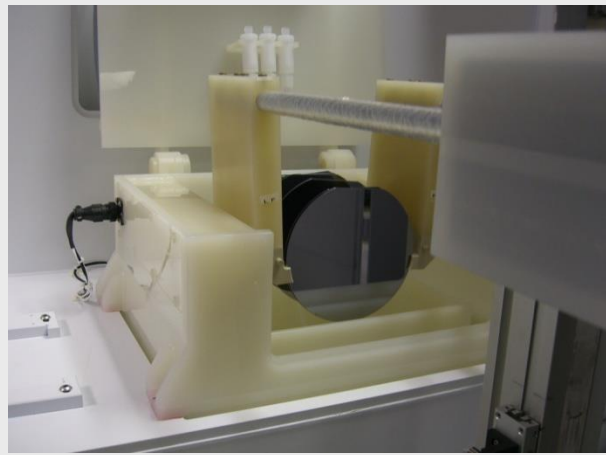
Move into cassette-less carrier



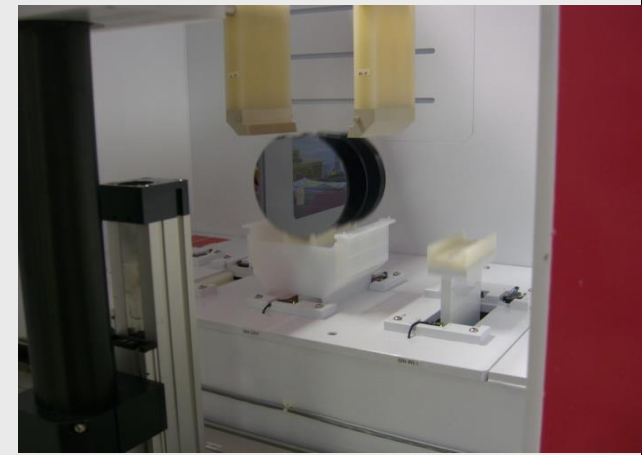
Lower into "Patented" DryZone Dryer



Wafers in DryZone,
auto lid closing

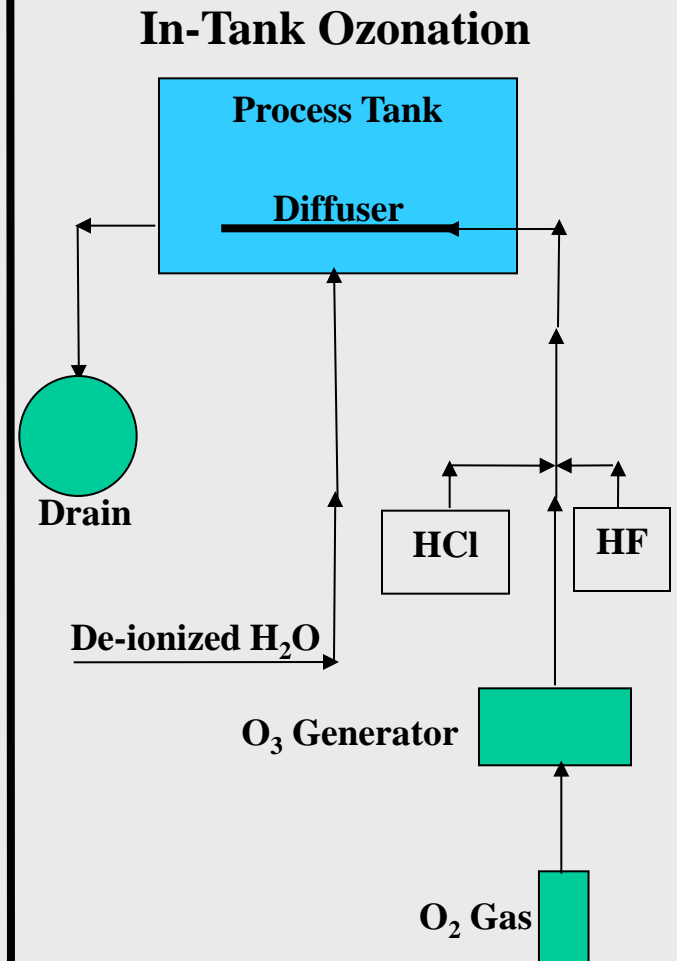
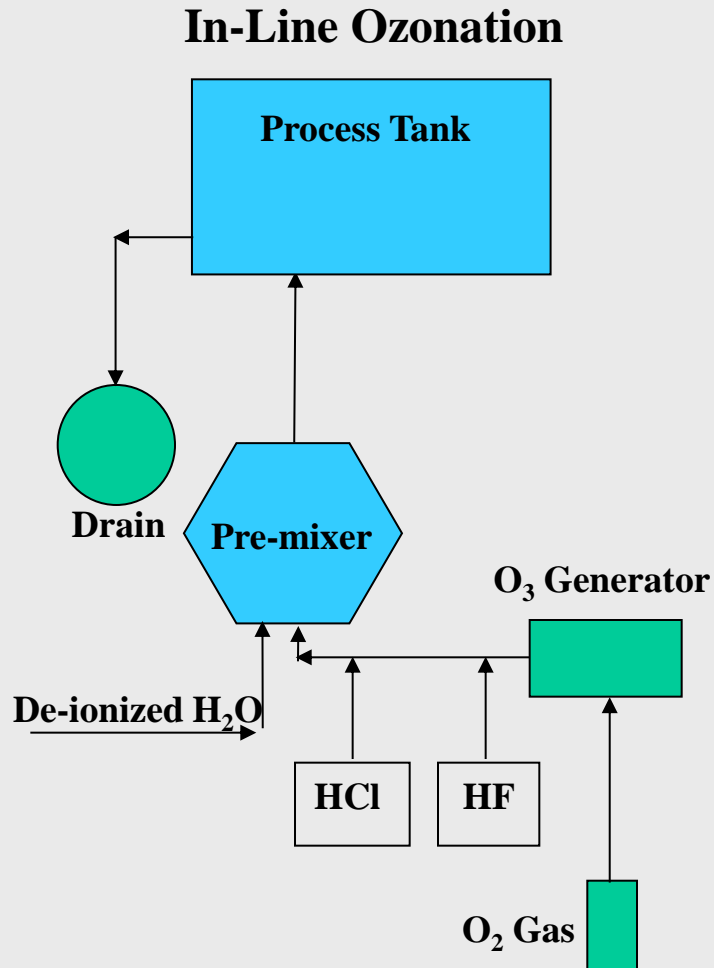


Dry wafers coming out of DryZone



Dry wafers back into cassette

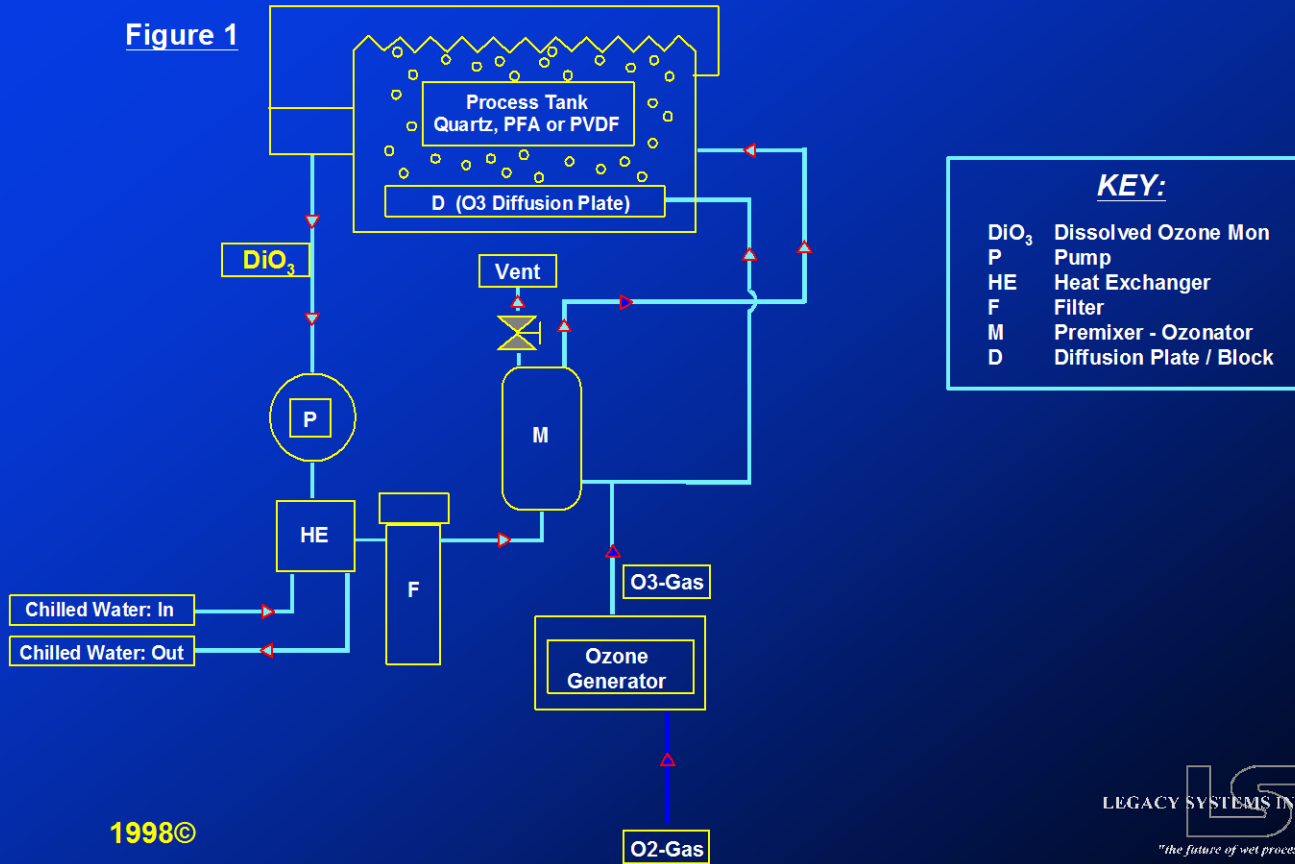
Ozone In Cleaning Chemistry



Coldstrip™

Coldstrip™ (Chilled Ozone) Process Flow Schematic

Figure 1



KEY:

DiO ₃	Dissolved Ozone Mon
P	Pump
HE	Heat Exchanger
F	Filter
M	Premixer - Ozonator
D	Diffusion Plate / Block

1998©

Diffuser Technology

"Static"



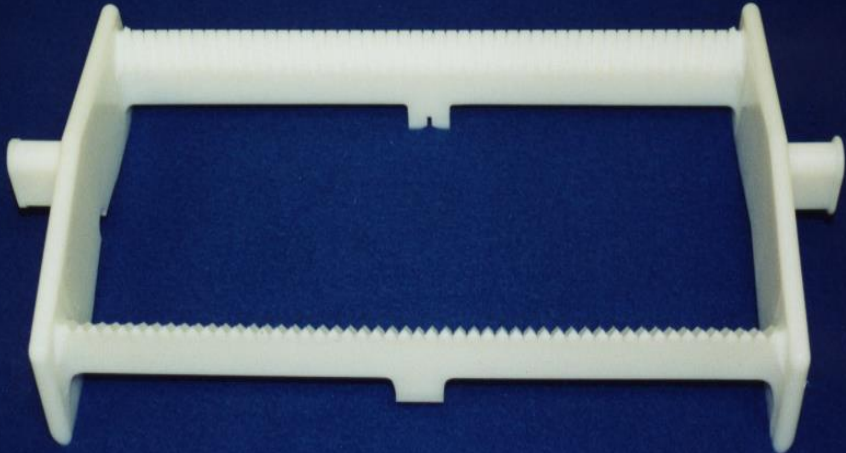
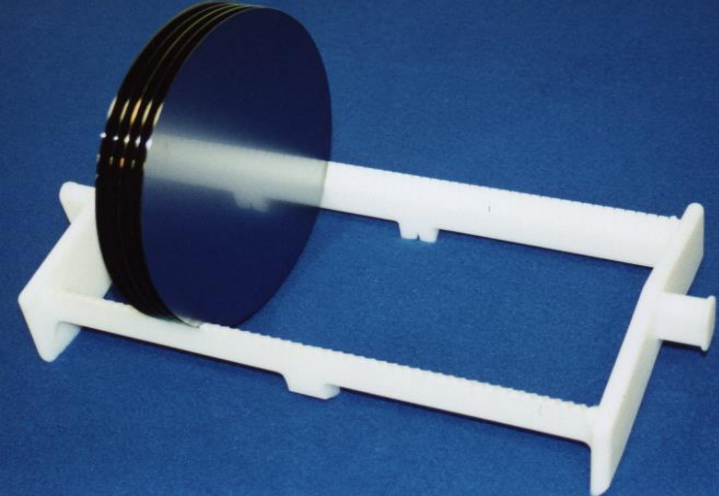
Patented Diffuser, all Teflon construction, contains over 300,000 mixing sites.

"Dynamic"



Patented Premixer vessel

Fluid Dynamics & Process Tank



Dissolved Ozone

Ozonated Water (85+ ppm)





300mm Wafer DryZone™ Station



DryZone™ Dryer

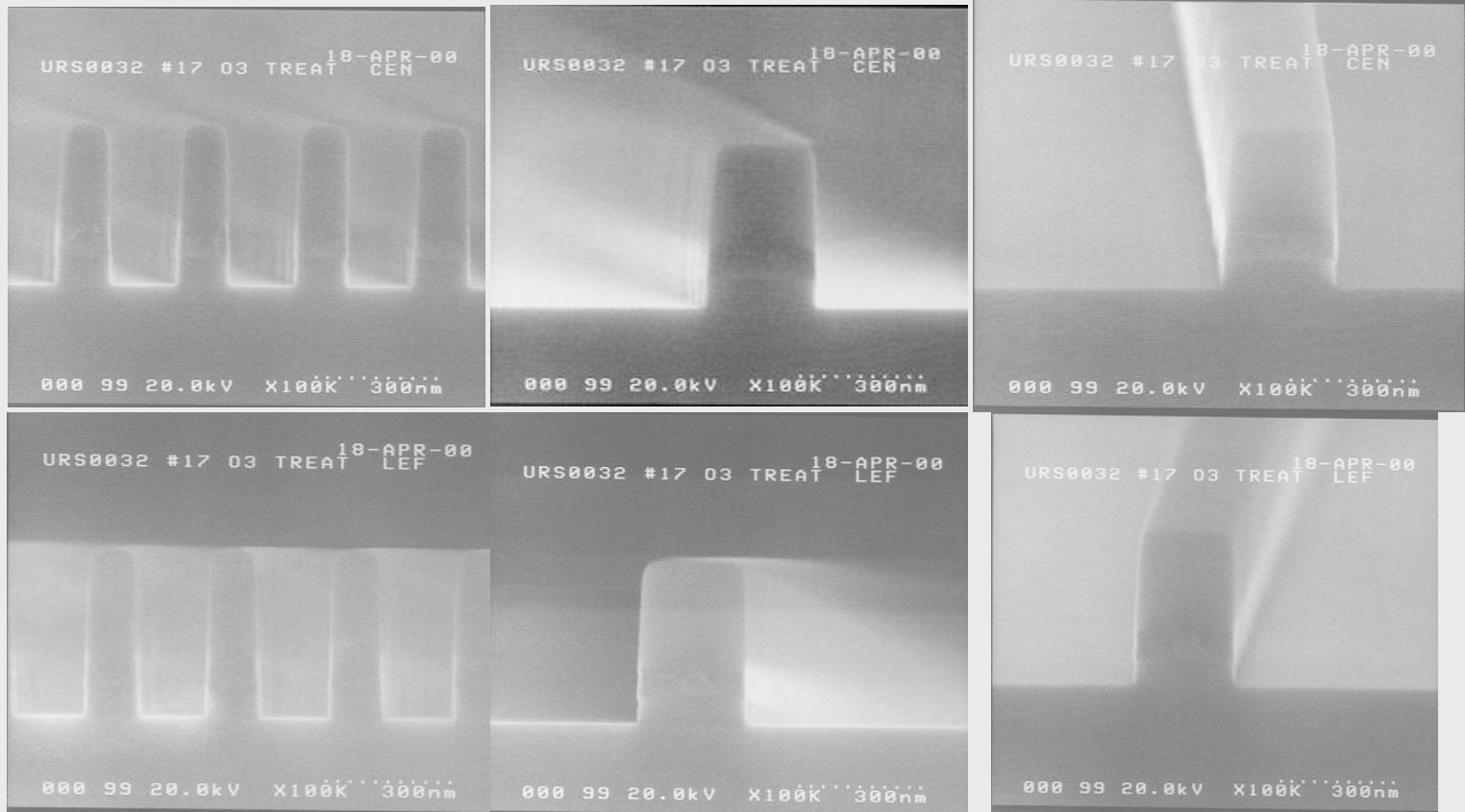


- Customer SEM Photo Data

Typical Process Performance ColdStrip™

OZONE CLEANING AFTER FG W/POLY ETCH POLYMER REMOVAL TEST RESULTS

AFTER OZONE CLEANING (5°C , 5MIN , O3 98PPM) FG W/POLY ETCH SEM PHOTO
 ==> AFTER ETCH THE DEPO POLYMER WAS PERFECTLY REMOVED



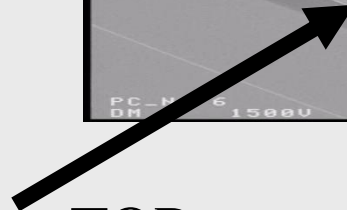
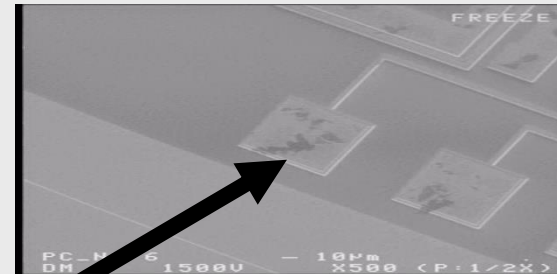
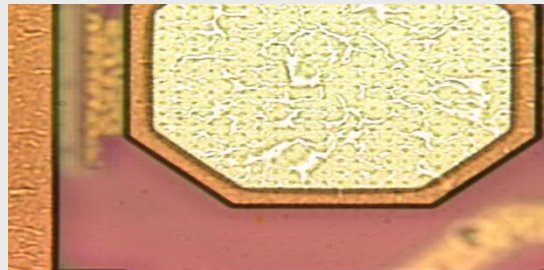
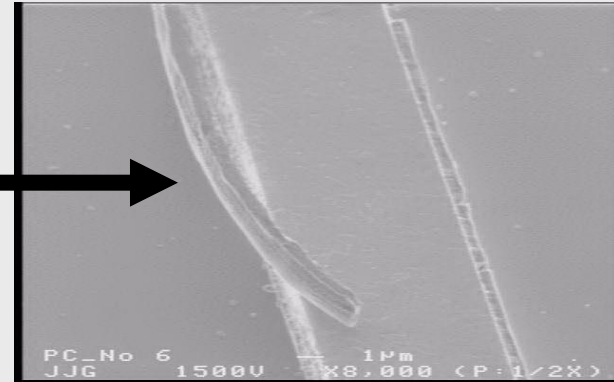
M/C(DENSE)

PERI(ISO)

PERI(ISO):TILT

Post Metal RIE Resist Removal Issues

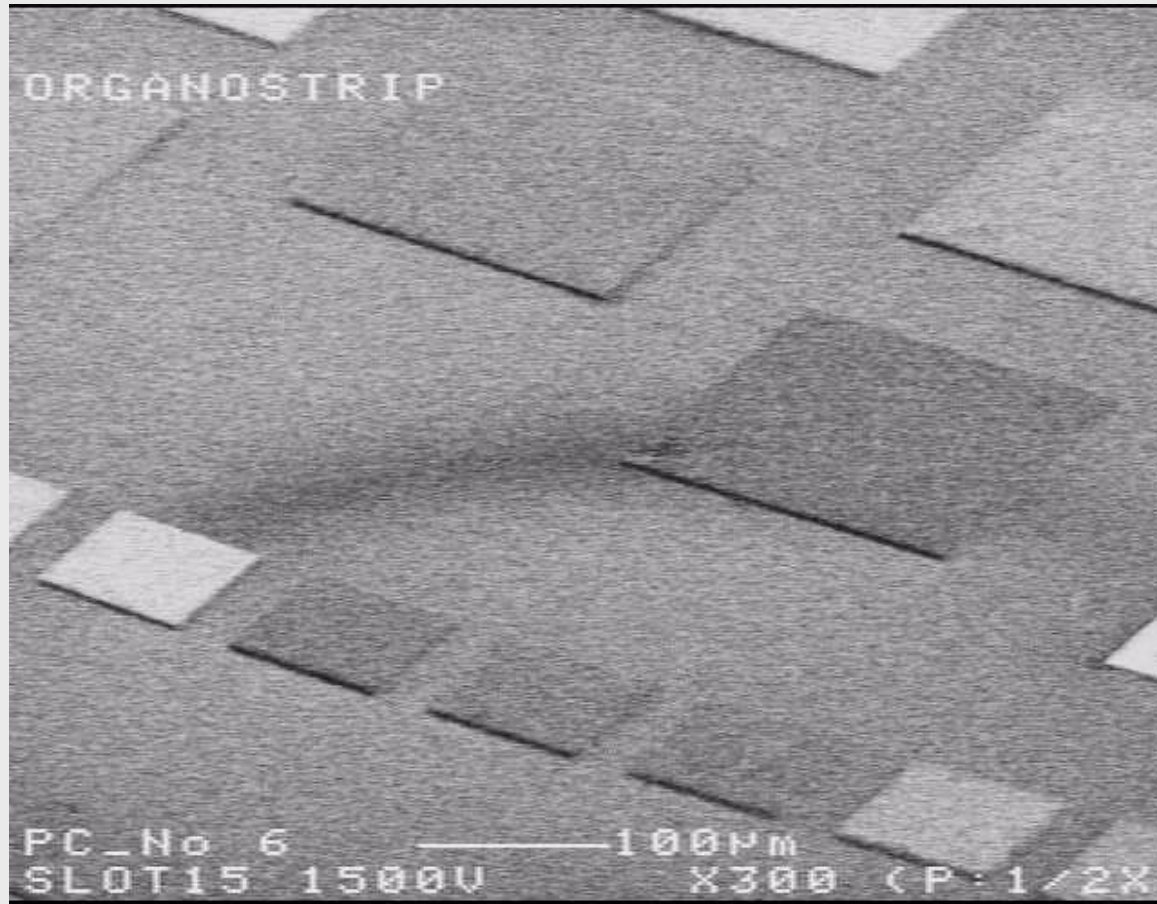
Polymer Rails
Peeling Off Sidewall
Of Aluminum



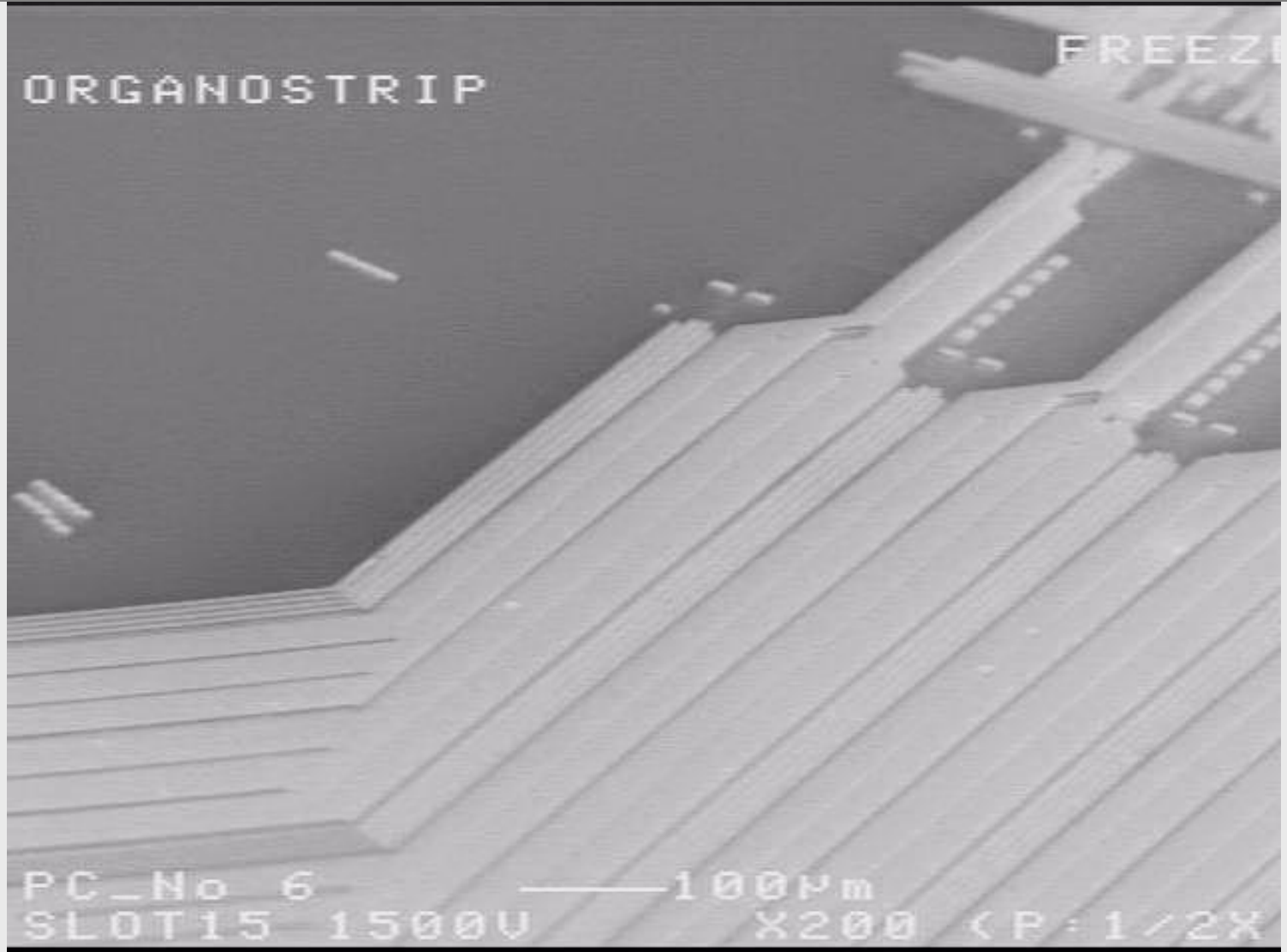
Polymer Residues on TOP
of metal are also undesirable.

Bond Pads

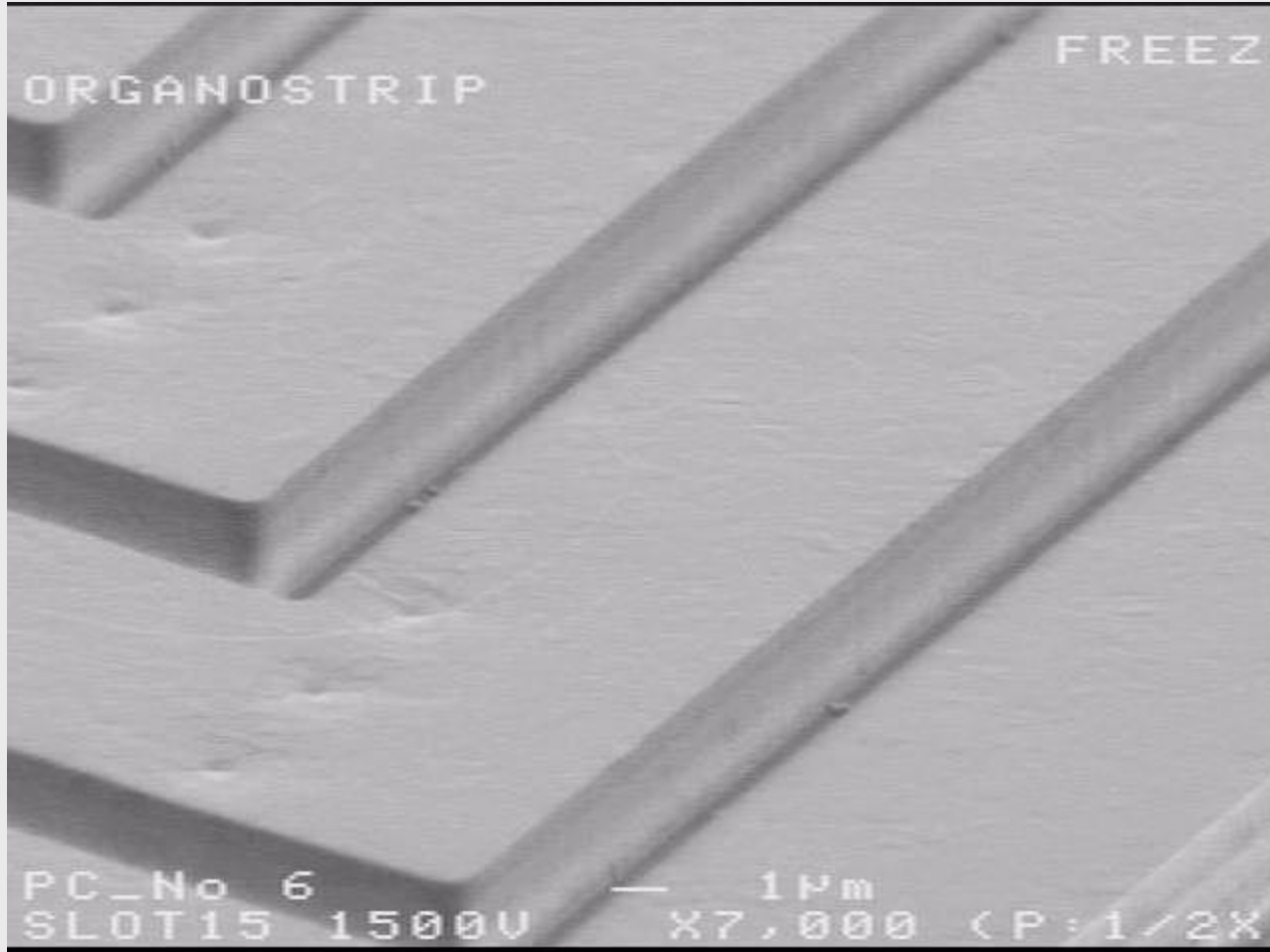
Pads are Generally Very Clean



AlCu/W

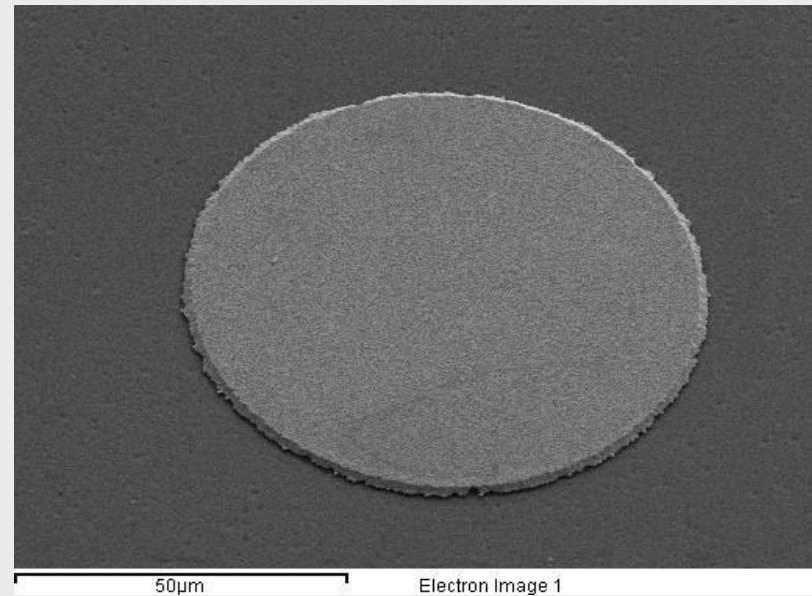
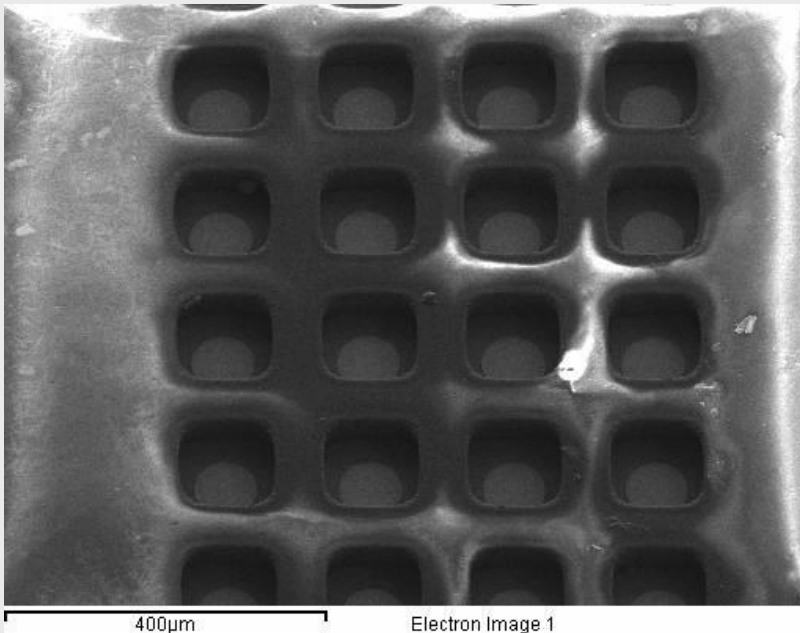


AlCu/W Inductors



Inductors very good.

Cu Pads with resist



Negative Photoresist is completely removed without corrosion to the Aluminum under layer and Cu pad

Copper Wiring

