ROCHESTER INSTITUTE OF TECHNOLOGY
MICROELECTRONIC ENGINEERING

PECVD Recipes

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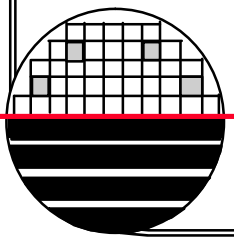

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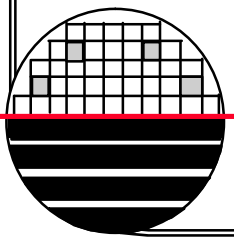
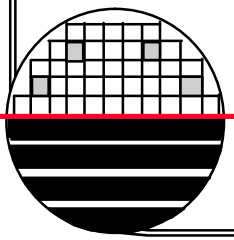


INTRODUCTION

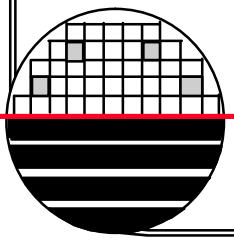
This document was prepared to document FACTORY P-5000 recipes for deposition of oxide from TEOS and nitride from SiH4 and NH3.



RECIPE NAMES

10K CLEAN (Clean for Chamber A)
A6-FAC 0.4M TEOS (Dep of 4000Å Oxide)
A6-FAC 0.8M TEOS (Dep of 8000Å Oxide)
A6-FAC 1.0M TEOS (Dep of 10,000Å Oxide)

B-10K CLEAN (Clean for Chamber B)
B6-10K NIT CON (Dep of 10,000Å Nitride)



PECVD OXIDE FROM TEOS

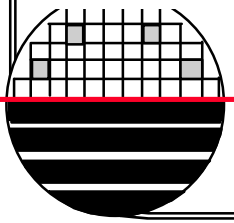
10K CLEAN (Clean)

A6-FAC 0.4M TEOS (Dep)
or
A6-FAC 0.8M TEOS (Dep)
or
A6-FAC 1.0M TEOS (Dep)

10K CLEAN (Clean)

10K CLEAN

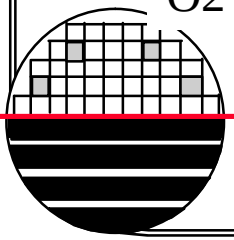
Step #	1 – Low	2 – Stabilization	3 – High	4 – Pump
Chamber	Chamber B Only	Chamber B Only	Chamber B Only	Chamber B Only
By Time	By Time	Press >5 Torr	By Time	By Time
Time Max	45 sec.	10 sec	25 sec	5 sec.
endpoint	No endpoint	No endpoint	No endpoint	No endpoint
Pressure	Full Open	Closed	10 Torr	Full open
Ramp	0 Torr/sec	0 Torr/sec	0 Torr/sec	0 Torr/sec
RF1	650 watt	0 watt	650 watt	0 watt
RF1 Tune	0.0 volts	0.0 volts	0.0 volts	0.0 volts
RF2	0 watt	0 watt	0 watt	0 watt
DPA RF	Off	Off	Off	Off
Temp	0 C	0 C	0 C	0 C
Temp Ramp	0	0	0	0
Purge Flow	Off	Off	Off	Off
Spacing	999 mils	180 mils	180 mils	180 mils
Cham Bypass	Off	Off	Off	Off
Plasma Monit	Off	Off	Off	Off
O2	400 sccm	600 sccm	600 sccm	0 sccm
C2F6B	300 sccm	500 sccm	500 sccm	0 sccm



A6-FAC 0.4M TEOS (or 0.8M or 1.0M)

Step #	1 – Setup	2 – Dep	3 – Pump
Chamber	Chamber A Only	Chamber A Only	Chamber A Only
By Time	By Time	By Time	By Time
Time Max	15 sec.	40 sec. (for 4000Å)	10 sec.
endpoint	No endpoint	No endpoint	No endpoint
Pressure	9 Torr	9 Torr	Full open
Ramp	0 Torr/sec	0 Torr/sec	0 Torr/sec
RF1	0 watt	205 watt	50 watt
RF1 Tune	0.0 volts	0.0 volts	0.0 volts
RF2	0 watt	0 watt	0 watt
DPA RF	Off	Off	Off
Temp	390 C	390 C	390 C
Temp Ramp	0	0	0
Purge Flow	Off	Off	Off
Spacing	220 mils	220 mils	999 mils
Cham Bypass	Off	Off	Off
Plasma Monitor	Off	Off	Off
TEOS	400 sccm	400 sccm	0 sccm
O2	285 sccm	285 sccm	285 sccm

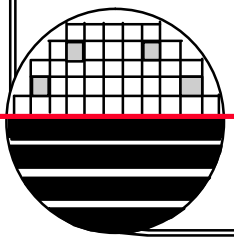
63 sec. (for 8000 Å)
104 sec. (for 10,000 Å)



PECVD TEOS OXIDE PROPERTIES

Etch Rate (Å/min) Data:
PECVD Oxide from Recipe ***A6-FAC 0.4M TEOS (or 0.8M or 1.0M)***

Etchant	10:1 BOE	7:1 BOE	50:1 DI:HF	Pad Etch
Densification = None	2062		611	
Densification 1000 °C, 60min	814		115	
Densification 1100 °C, 360min	562		107	
Thermal Oxide Etch Rate (Å/min)	629	1122	187	623

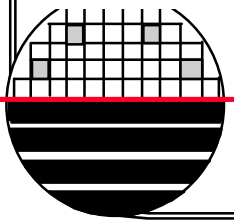


PECVD NITRIDE FROM AMMONIA AND SILANE

B-10K CLEAN (Clean)
B6-10K NIT CON (Dep)
B-10K CLEAN (Clean)

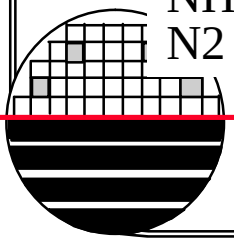
B-10K CLEAN

Step #	1 – Low	2 – Stabilization	3 – High	4 – Pump
Chamber	Chamber B Only	Chamber B Only	Chamber B Only	Chamber B Only
By Time	By Time	Press >5 Torr	By Time	By Time
Time Max	60 sec.	20 sec	75 sec	20 sec.
endpoint	No endpoint	No endpoint	No endpoint	No endpoint
Pressure	Full Open	Closed	10 Torr	Full open
Ramp	0 Torr/sec	0 Torr/sec	0 Torr/sec	0 Torr/sec
RF1	650 watt	0 watt	600 watt	0 watt
RF1 Tune	0.0 volts	0.0 volts	0.0 volts	0.0 volts
RF2	0 watt	0 watt	0 watt	0 watt
DPA RF	Off	Off	Off	Off
Temp	0 C	0 C	0 C	0 C
Temp Ramp	0	0	0	0
Purge Flow	Off	Off	Off	Off
Spacing	999 mils	180 mils	180 mils	180 mils
Cham Bypass	Off	Off	Off	Off
Plasma Monit	Off	Off	Off	Off
O2	400 sccm	600 sccm	600 sccm	0 sccm
C2F6B	300 sccm	500 sccm	500 sccm	0 sccm



B6-10K NIT CON

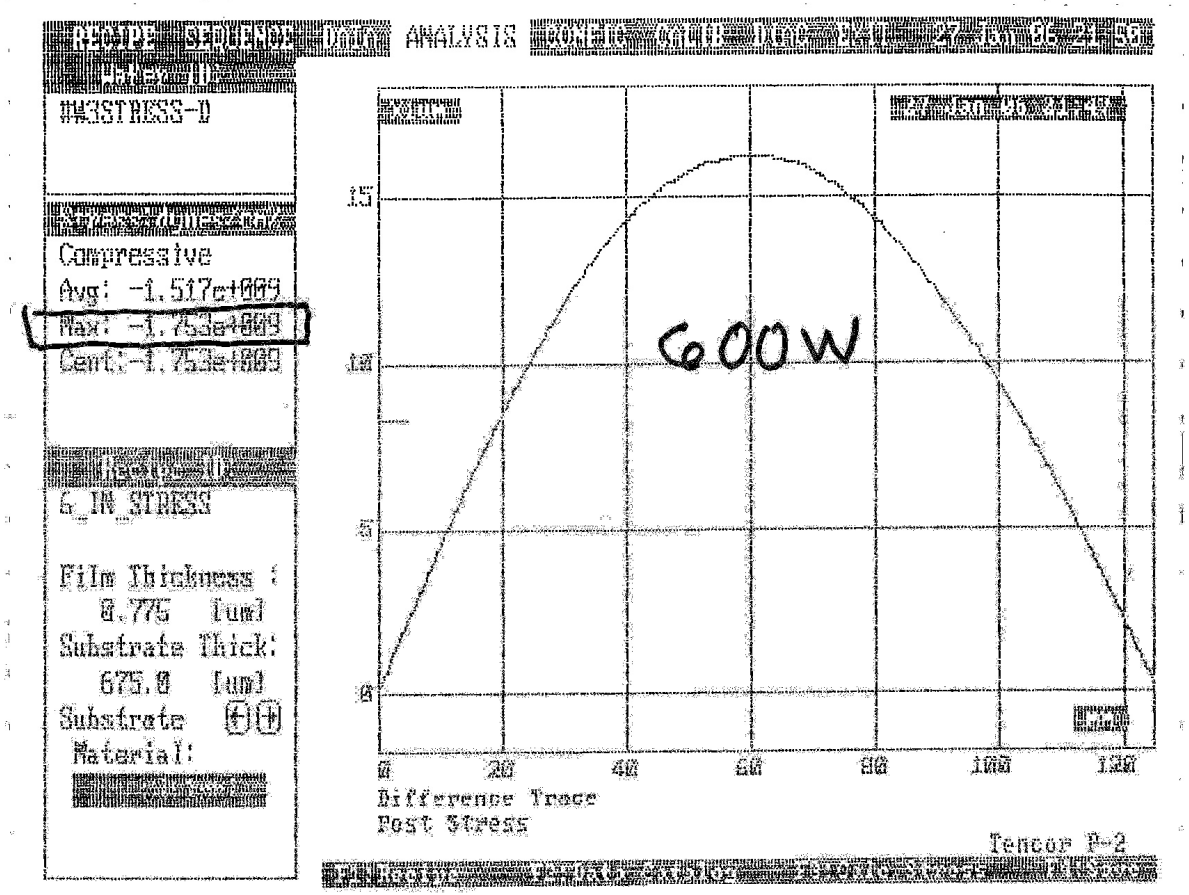
Step #	1 – Setup	2 – Dep	3 – Pump
Chamber	Chamber B Only	Chamber B Only	Chamber B Only
By Time	By Time	By Time	By Time
Time Max	15 sec.	60 sec. (for 10K)	20 sec.
endpoint	No endpoint	No endpoint	No endpoint
Pressure	4.5 Torr	4.5 Torr	Full open
Ramp	0 Torr/sec	0 Torr/sec	0 Torr/sec
RF1	0 watt	600 watt	0 watt
RF1 Tune	0.0 volts	0.0 volts	0.0 volts
RF2	0 watt	0 watt	0 watt
DPA RF	Off	Off	Off
Temp	400 C	400 C	400 C
Temp Ramp	0	0	0
Purge Flow	Off	Off	Off
Spacing	290 mils	290 mils	330 mils
Cham Bypass	Off	Off	Off
Plasma Monitor	Off	Off	Off
SiH4	130 sccm	130 sccm	0 sccm
NH3	60 sccm	60 sccm	0 sccm
N2	2000 sccm	2000 sccm	0 sccm



PECVD NITRIDE PROPERTIES

Recipe	B6-10K NIT CON	10K NIT LowSiH	10K Low H
Power (watts)	600	200	300
Pressure (Torr)	4.5	4.5	4.5
Gap (mils)	290	330	290
SiH4 (sccm)	130	45	75
NH3)sccm)	60	55	0
N2 (sccm)	2000	2700	2700
Index	2.0	1.5	3.3
Stress (Kpascal)	10 to –10	1000	20
Al etch rate (Å/min)	3.1	20.5	0.5
Hot Phos etch rate (Å/min)	890	651	1269
KOH etch rate (Å/min)	19.3	0	35
BOE etch rate (Å/min)	290	369	209
Dep Rate (Å/min)	148	42	67
Good for LOCOS	yes	no	no

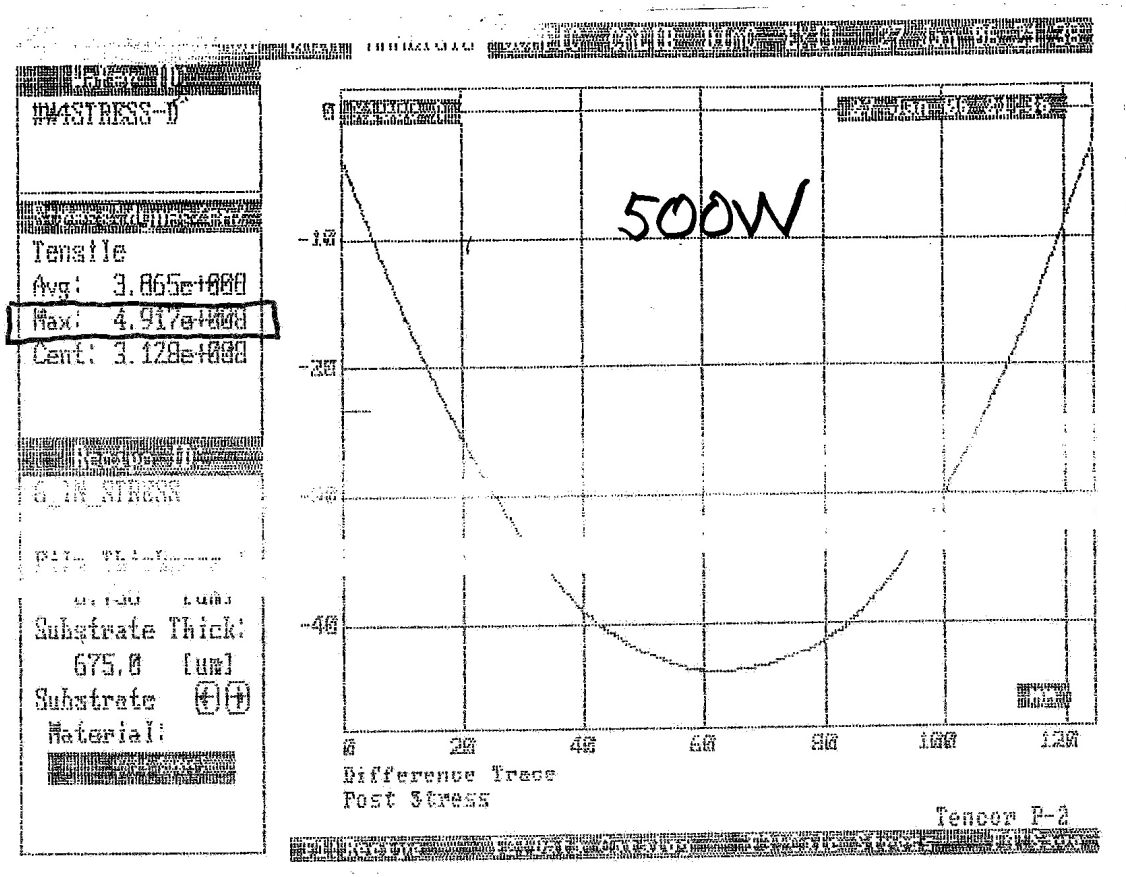
MEASURED STRESS IN PECVD NITRIDE



At 600 watts

Stress = 1.5E9 dynes/cm2

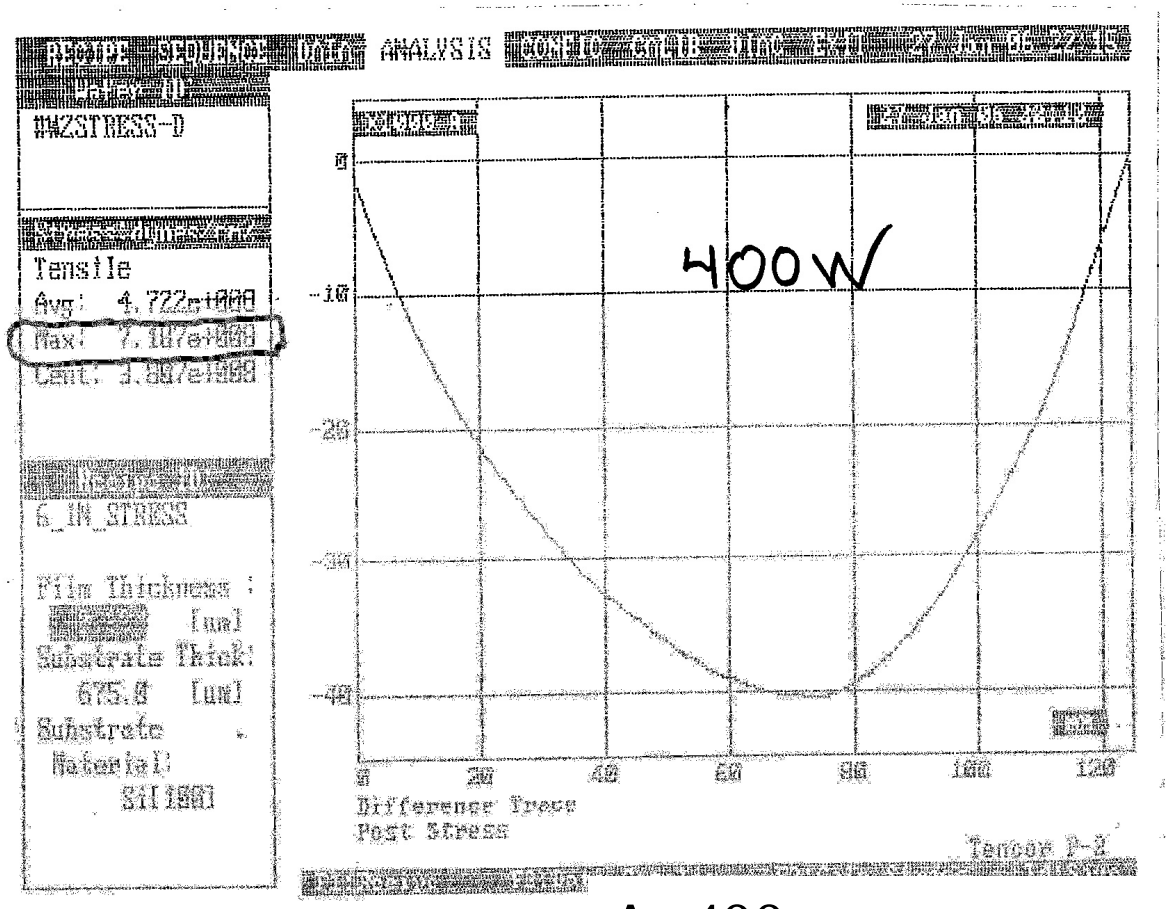
MEASURED STRESS IN PECVD NITRIDE



At 500 watts

Stress = -4.9E8 dynes/cm2

MEASURED STRESS IN PECVD NITRIDE



At 400 watts

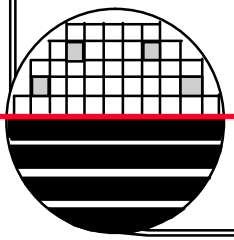
Stress = -7.2E8 dynes/cm2

PECVD OF CARBON FILM (DIAMOND LIKE FILM)

Drytech Quad Tool
CH4 flow 45 sccm
50 mTorr
200 Watt
Deposition Rate ~ 320 Å/min
Index of Refraction = 2.0

SUMMARY

These PECVD materials are quite different than oxides and nitrides deposited by thermal oxidation or LPCVD.



REFERENCES

1. Silicon Processing for the VLSI Era, Volume 1 – Process Technology, 2nd, S. Wolf and R.N. Tauber, Lattice Press.
2. The Science and Engineering of Microelectronic Fabrication, Stephen A. Campbell, Oxford University Press, 1996.
3. Measured Stress using the Tencore P2, Gianni, 2005.