AIR PRODUCTS

Lowering the Cost of Ownership for Flat Panel Display Chamber Cleaning

MATERIALS

RELIABILITY

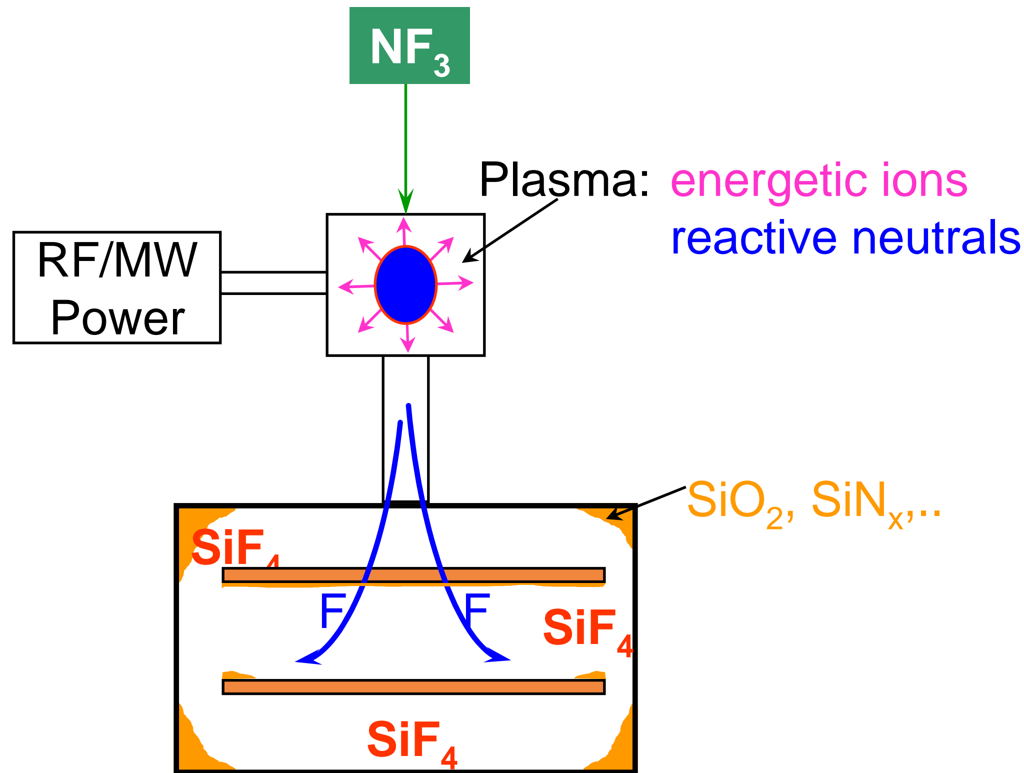
INTEGRATION

INNOVATION

Filippos Farmakis, Benoit Riou, and Mustapha Elyaakoub
Unaxis, Inc.

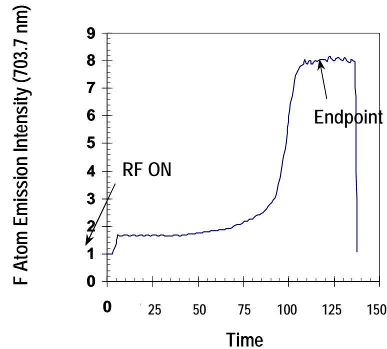
Andrew Johnson, Peter Maroulis, Marty Plishka, Heather Remley, and Mark I. Sistern
Air Products and Chemicals, Inc.

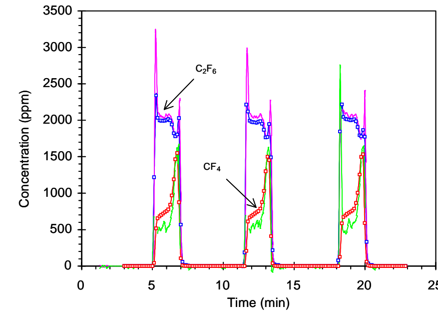
CVD Chamber Cleaning

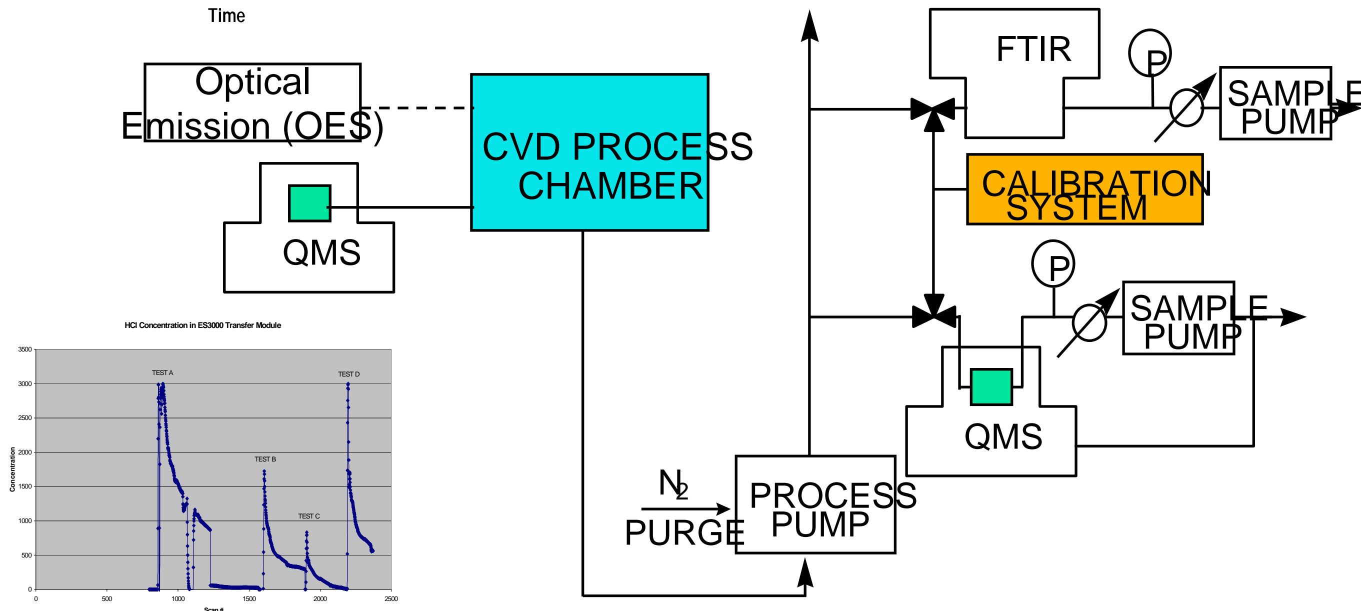


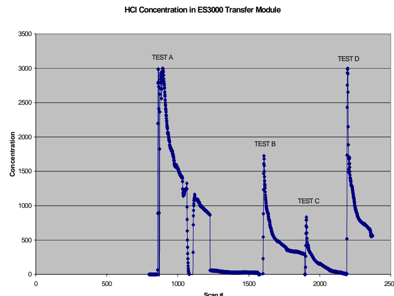
- Remote plasma generates F atoms that are transported to CVD chamber
- CVD residue volatized by chemical etch
- Optical emission cannot be used for EPD since there is no glow discharge
- Use QMS and FTIR as process monitors

Semiconductor Process Monitoring

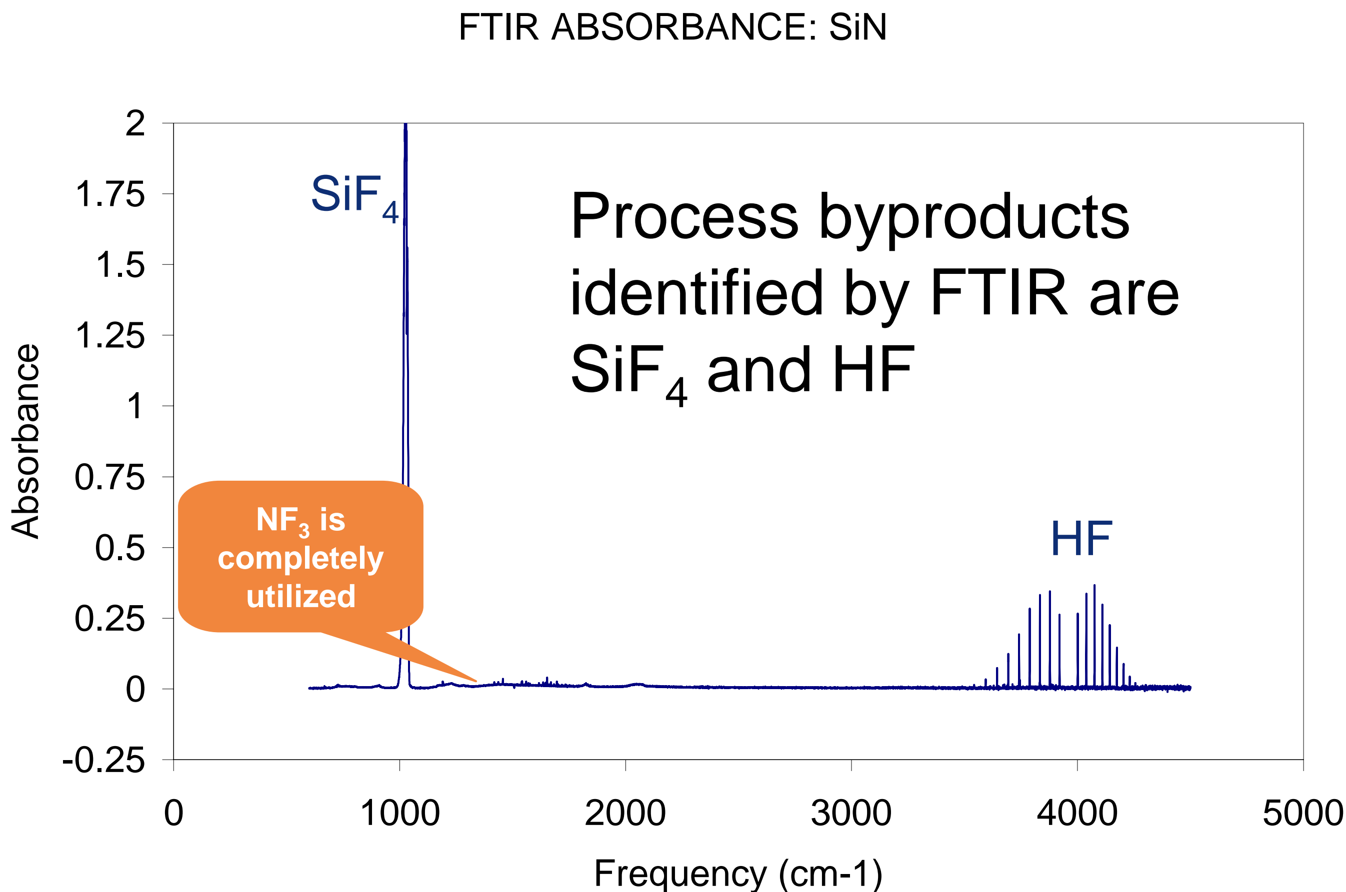




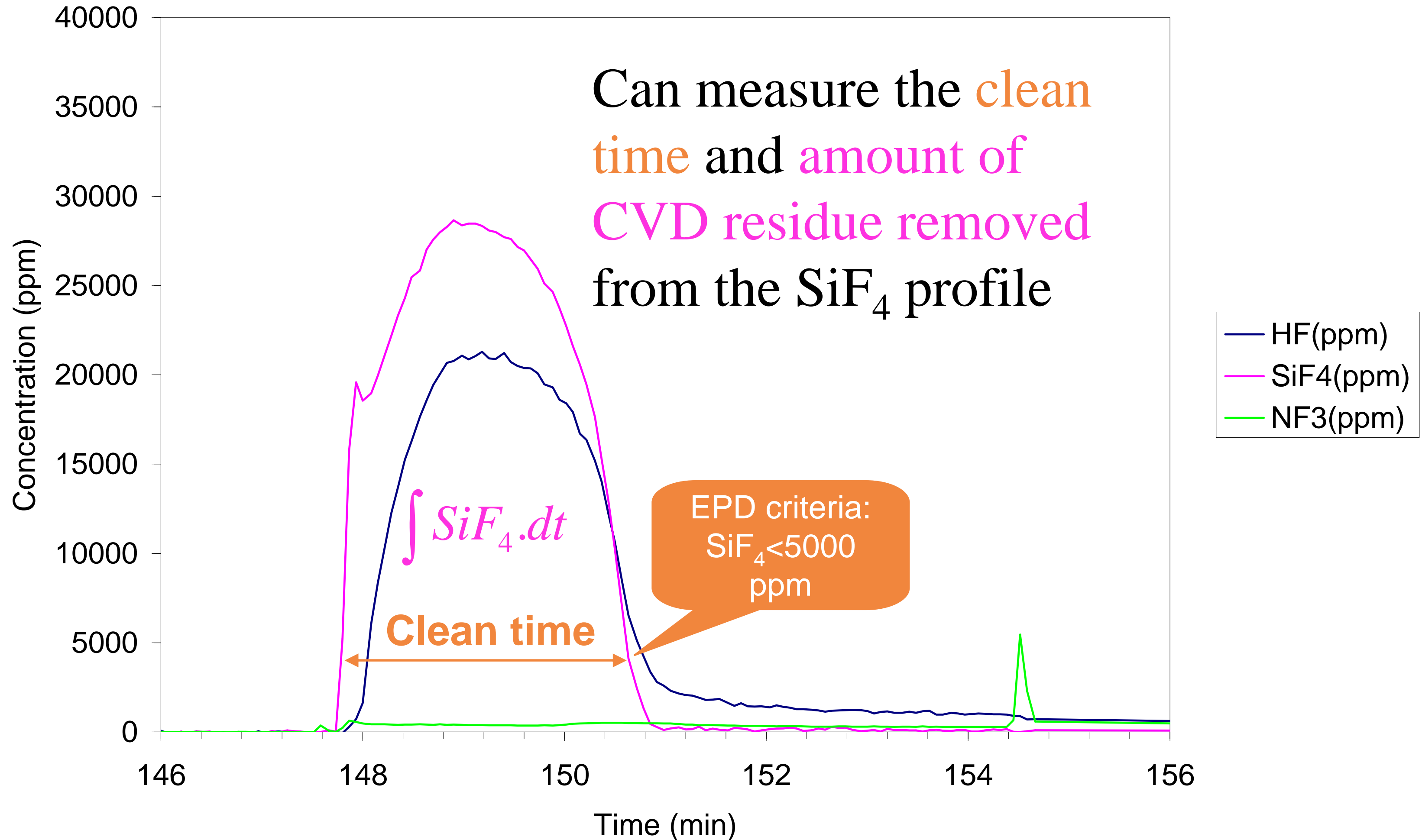




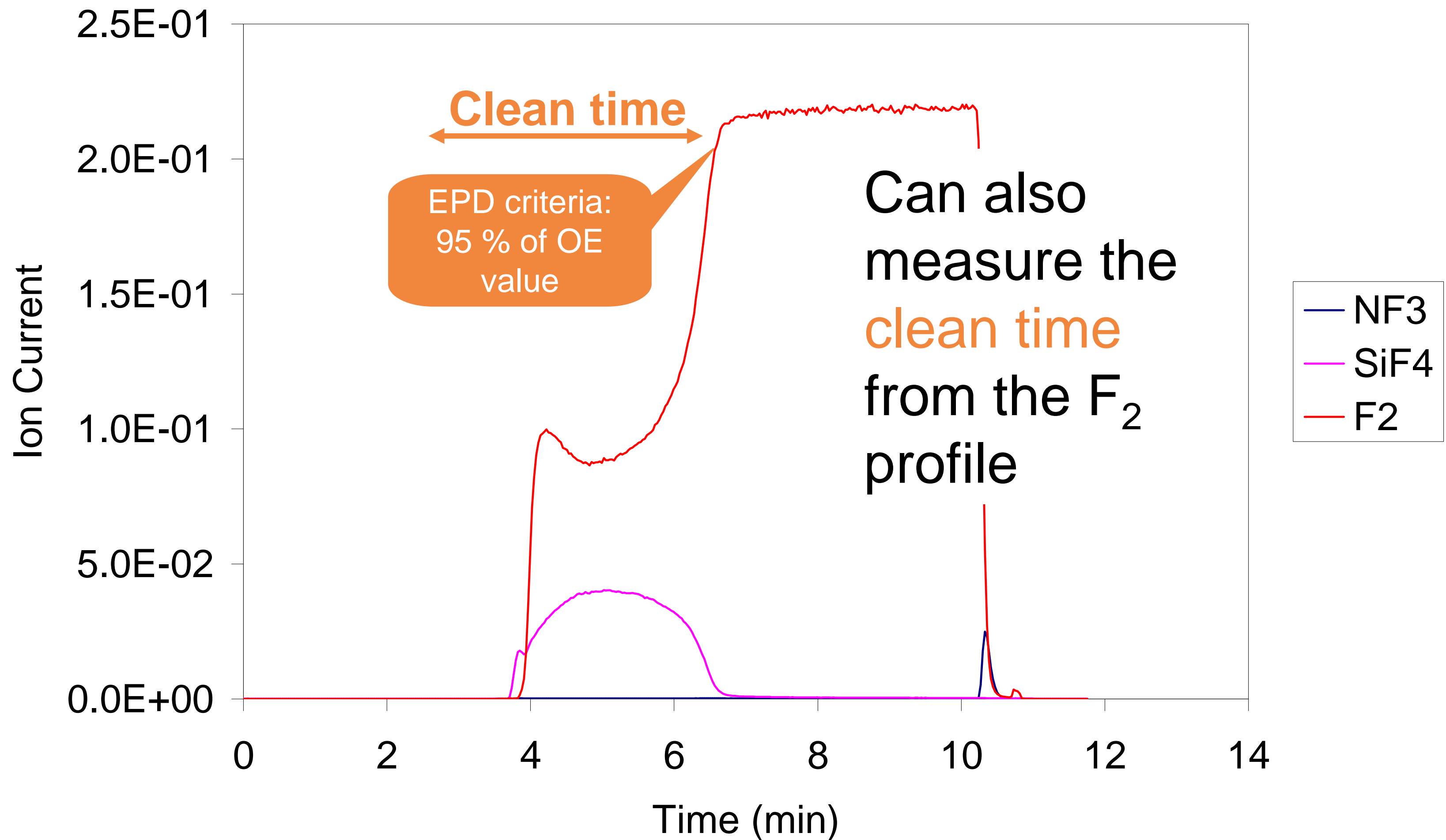
KAI3000 Chamber Clean: Byproduct Identification (FTIR)



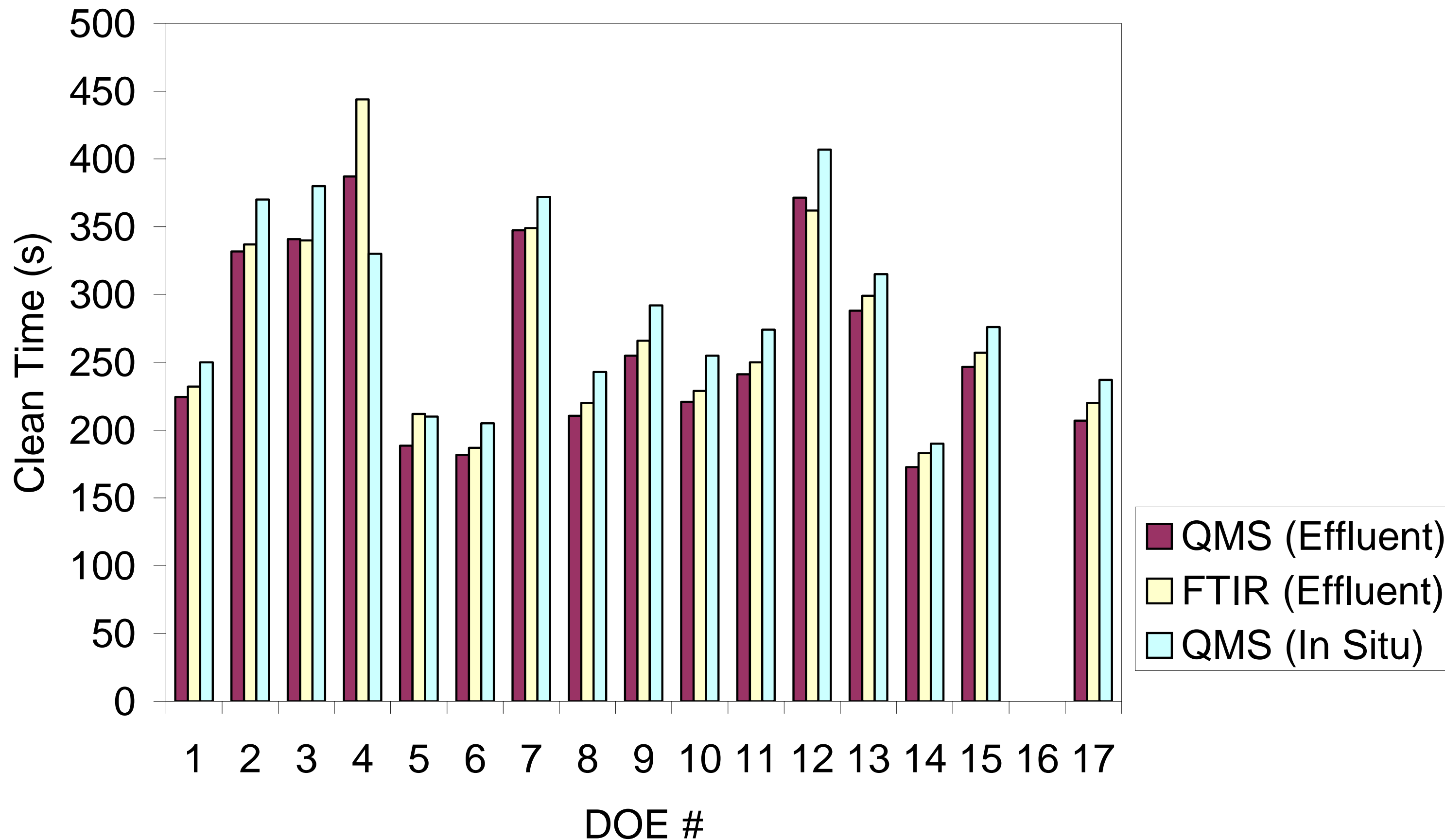
Concentration Profile (FTIR)



Concentration Profile (QMS)

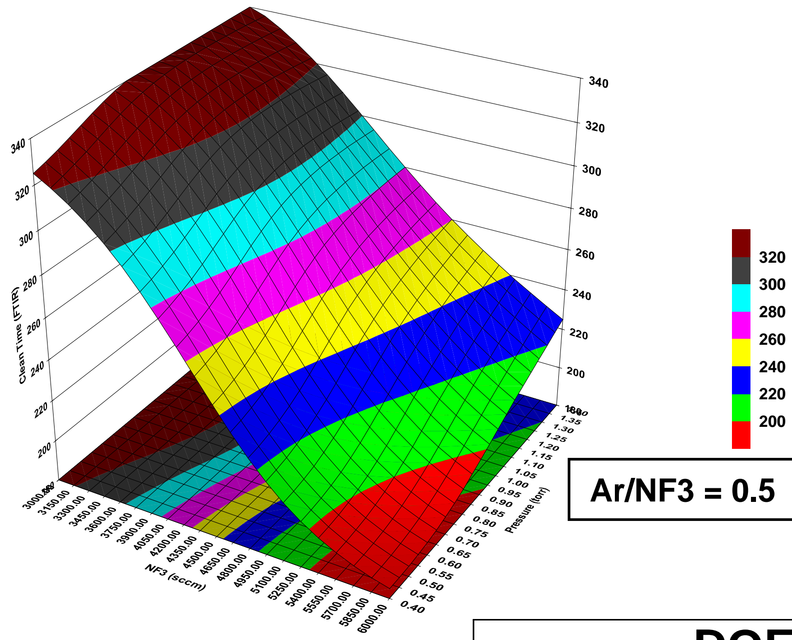


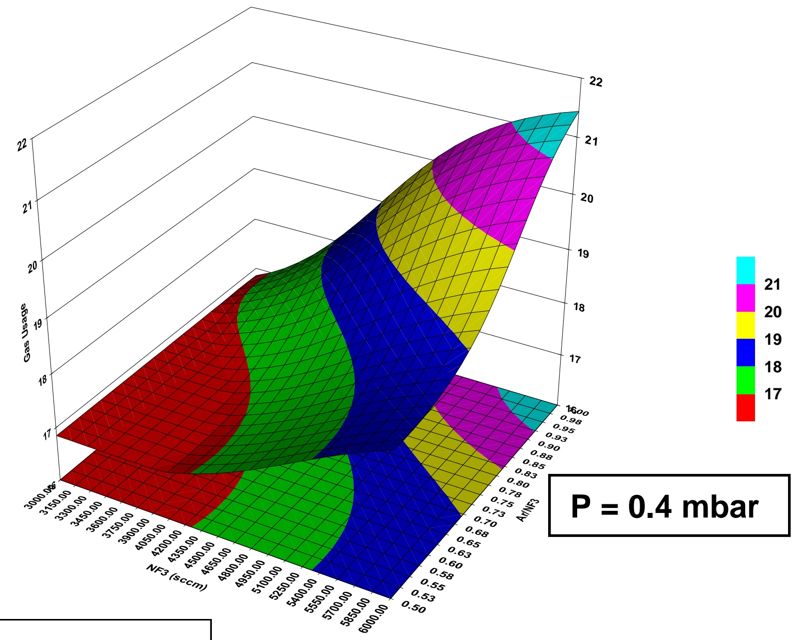
Clean Time Summary



- Good agreement between all three clean time measurements
- Can obtain absolute agreement by adjusting the EPD criteria

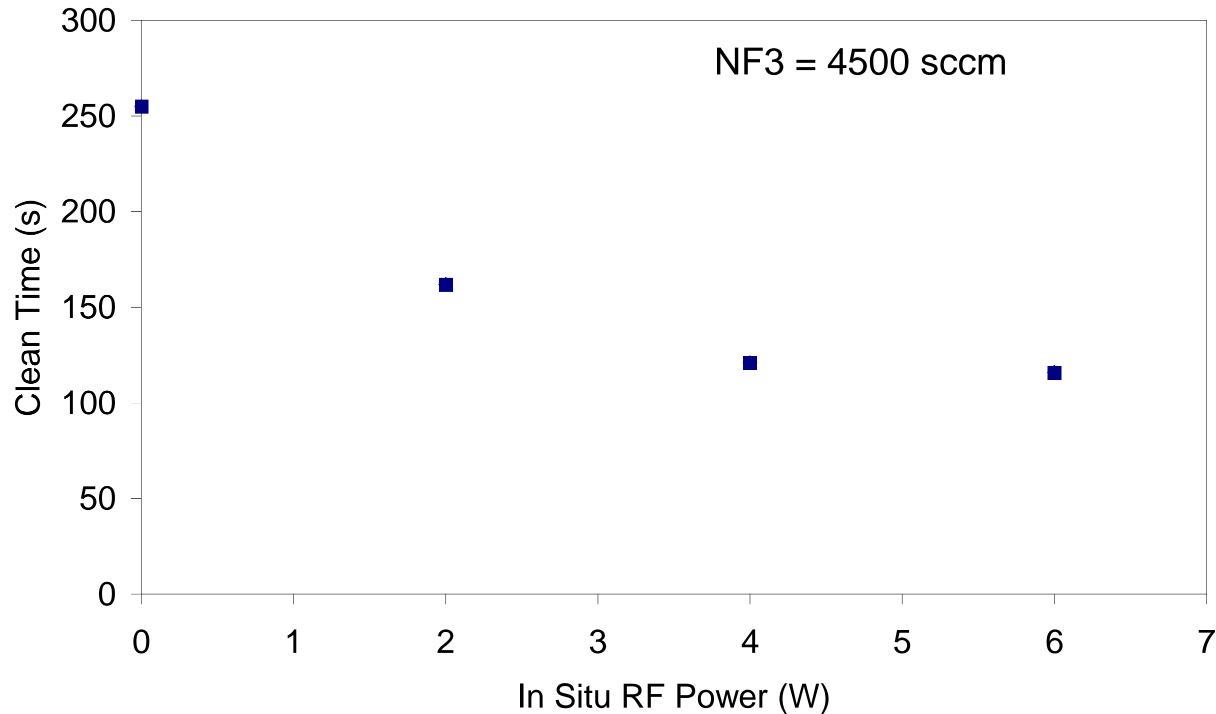
Response Surface





DOE		
Factor	+	-
NF_3 (sccm)	3000	6000
Ar/NF_3	0.5	1.0
P (mbar)	0.4	1.4

RF Assist Clean



- Apply RF power and simultaneously sustain in situ plasma
- 50 % reduction in clean time: 255 s to 120 s
- RF power of 4 kW is sufficient. No further reduction if higher power applied

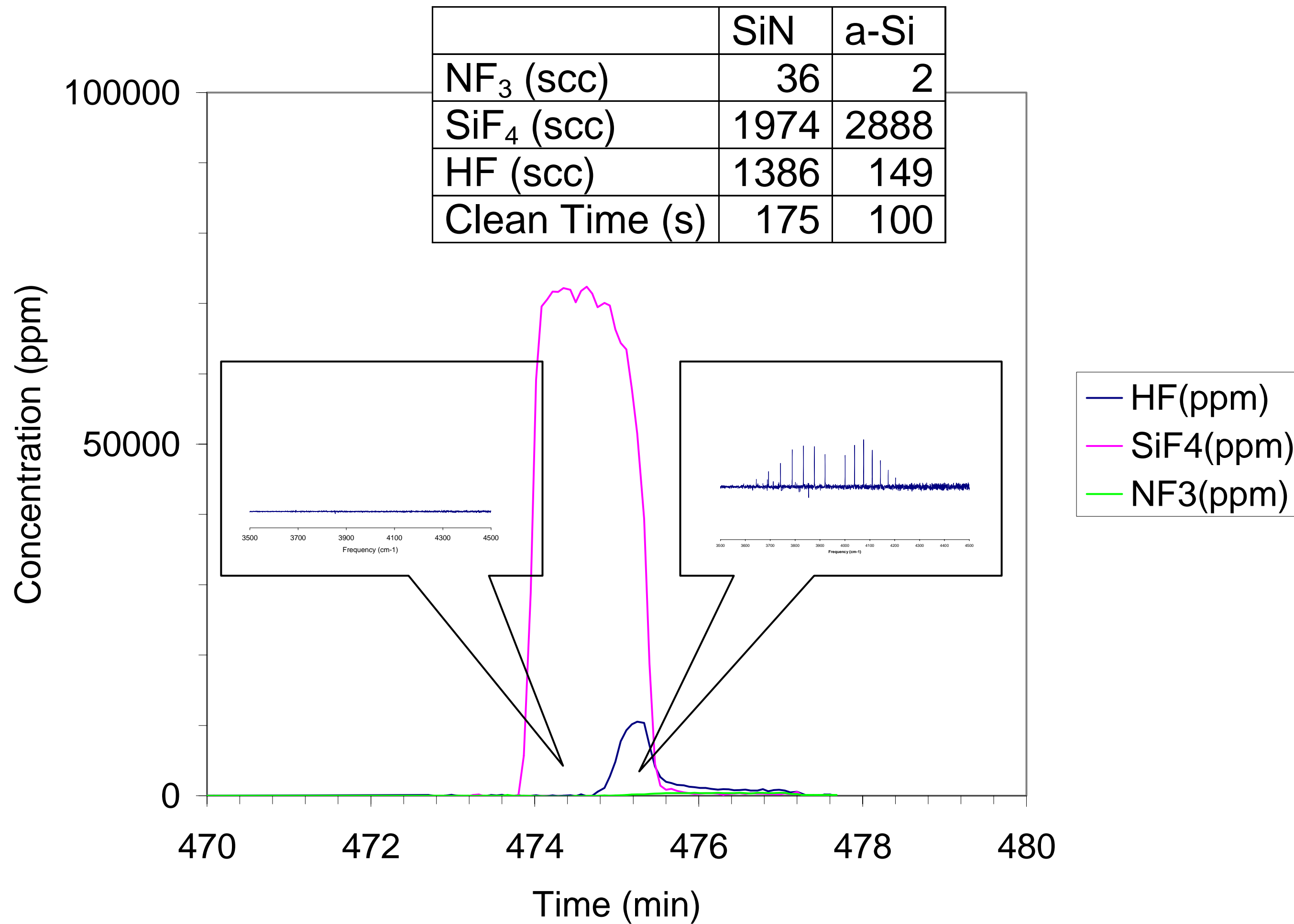
OPTIMIZED CHAMBER CLEANS

	Baseline	Low Usage	RF Assist	Fast RF
NF_3 (sccm)	6000	4500	3000	6000
Ar (sccm)	3000	2250	1500	3000
P (mbar)	0.4	0.9	0.4	0.4
RF (W)	-	-	4 kW	4 kW
SiF_4 (scc)	1969	2116	2194	1875
Clean Time (s) (Change)	183	229 (+25 %)	170 (-7 %)	91 (-50 %)
Gas usage (L) (Reduction)	18.3	17.2 (- 6 %)	8.5 (-54 %)	9.1 (-50 %)

- Faster cleans favored by higher NF_3 flow rate, lower Ar concentration, and lower pressure
- Gas usage can be reduced 6 % while maintaining 250 s clean time
- RF assist provides fast cleans (-50 %) and lower NF_3 usage (-50 %)

[#] SiF4 and clean time data are for 0.9 mbar/6 kW process

a-Si PECVD



	SiN	a-Si
NF_3 (scc)	36	2
SiF_4 (scc)	1974	2888
HF (scc)	1386	149
Clean Time (s)	175	100

SUMMARY

- Optimized NF_3-based chamber cleans developed for Unaxis Gen 7 FPD equipment
- NF_3-based chamber cleans provide lower gas usage and faster cleans than SF6-based clean used for earlier generation equipment
- PFC emissions have been eliminated by using NF_3-based clean
  - GWP: NF_3 (10,500), SF_6 (22,200)
  - NF3 Utilization >99.75 %
- Remote NF_3 plasmas can effectively clean remote areas of the large Gen 7 CVD chambers