MINIMIZING PFC AND HAP EMISSIONS DURING ULTIMA HDP-CVD PROCESSING: PSG, USG, AND FSG FILMS

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AIR PRODUCTS

SEMICONDUCTOR PROCESS EMISSIONS

- GASES OF CONCERN
  - PFCs: CF_4, C_2F_6, C_3F_8, NF_3
  - HAPs: HF, F_2
  - VOCs
- DETERMINE PROCESS EMISSIONS
  - ANALYTICAL METHODOLOGY
- MINIMIZE PFC AND HAP EMISSIONS
  - ULTIMA HDP-CVD: PSG, USG, AND FSG
  - REMOTE NF_3 CLEAN TECHNOLOGY
  - DELATECH CDO ABATEMENT

ABATEMENT

CALIBRATION SYSTEM

755 Torr

FTIR

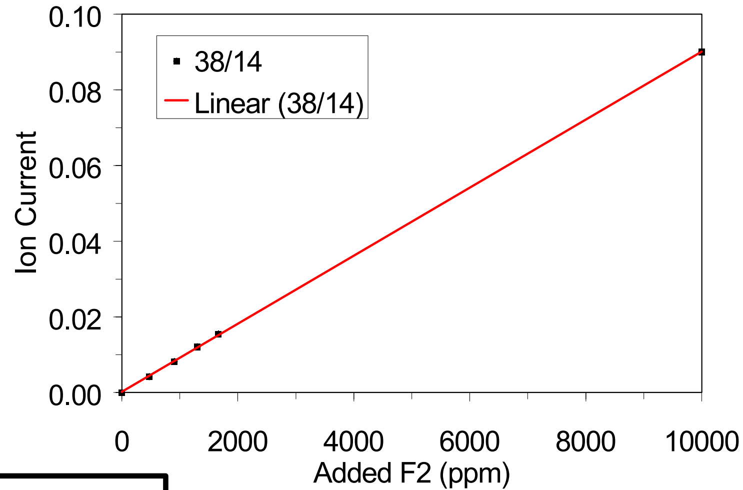
SAMPLE PUMP

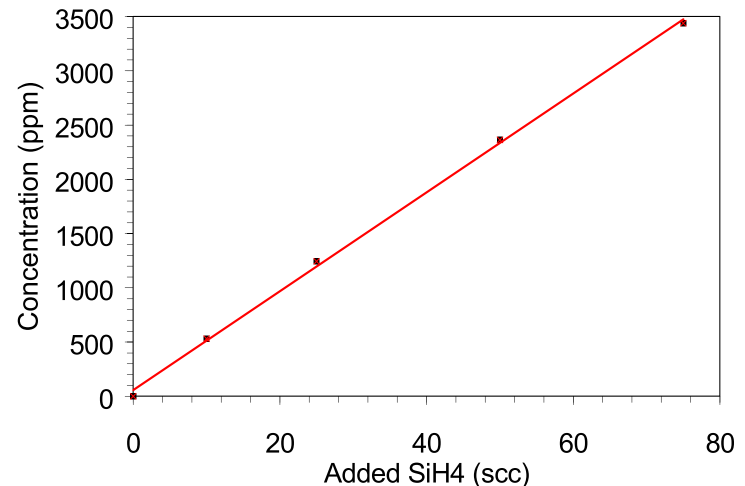
MASS SPECTROMETER

N2 PURGE

ROUGH PUMP

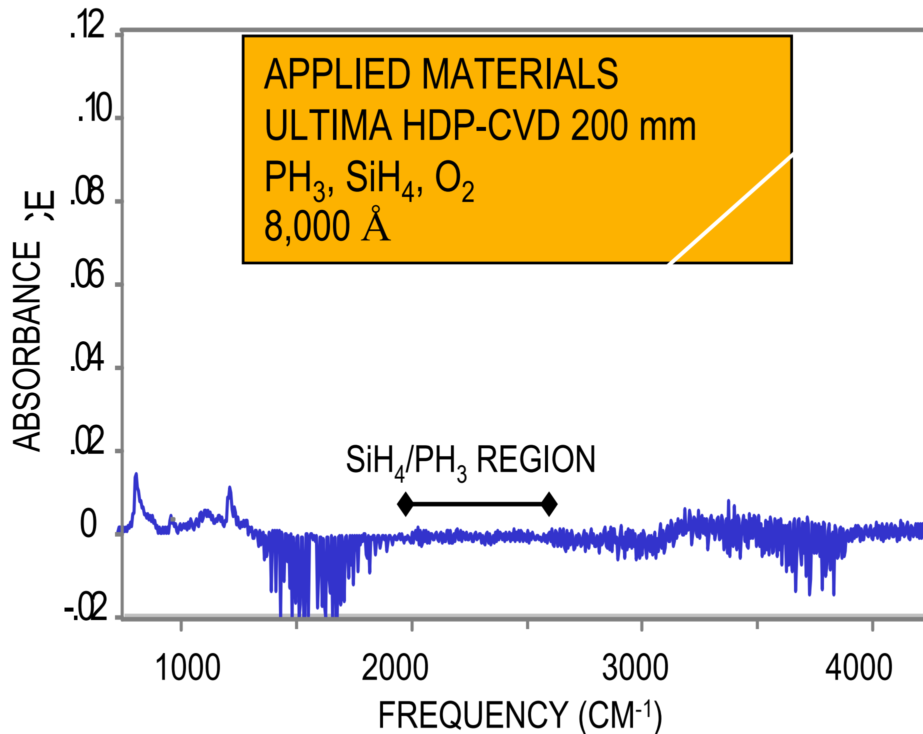
PROCESS GASES

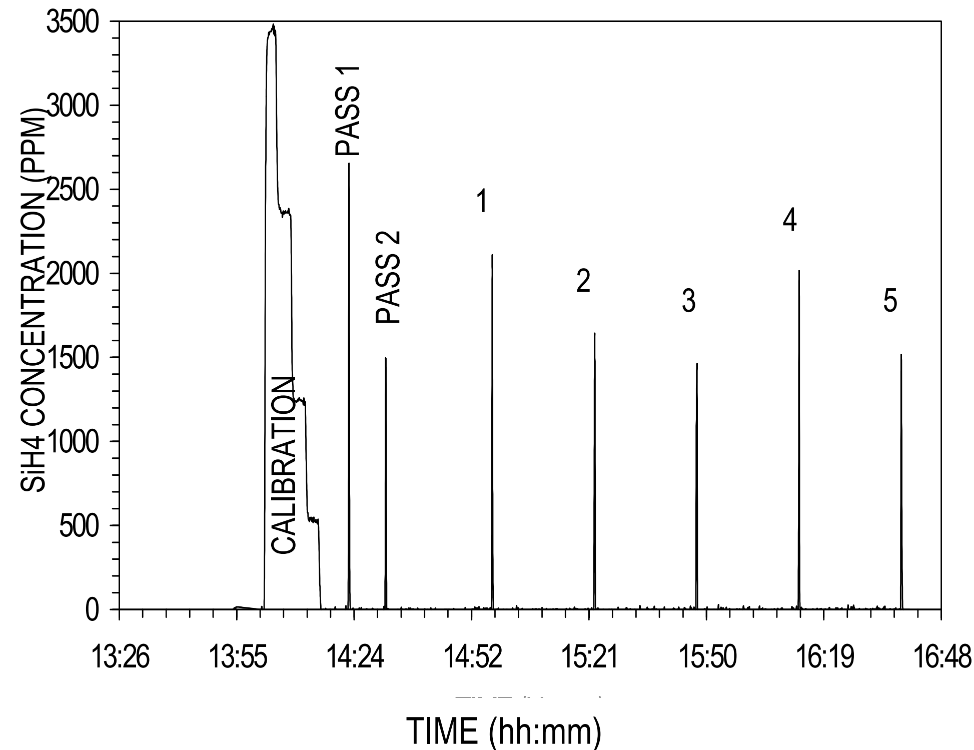




AIR PRODUCTS

ULTIMA HDP-CVD: PSG DEPOSITION

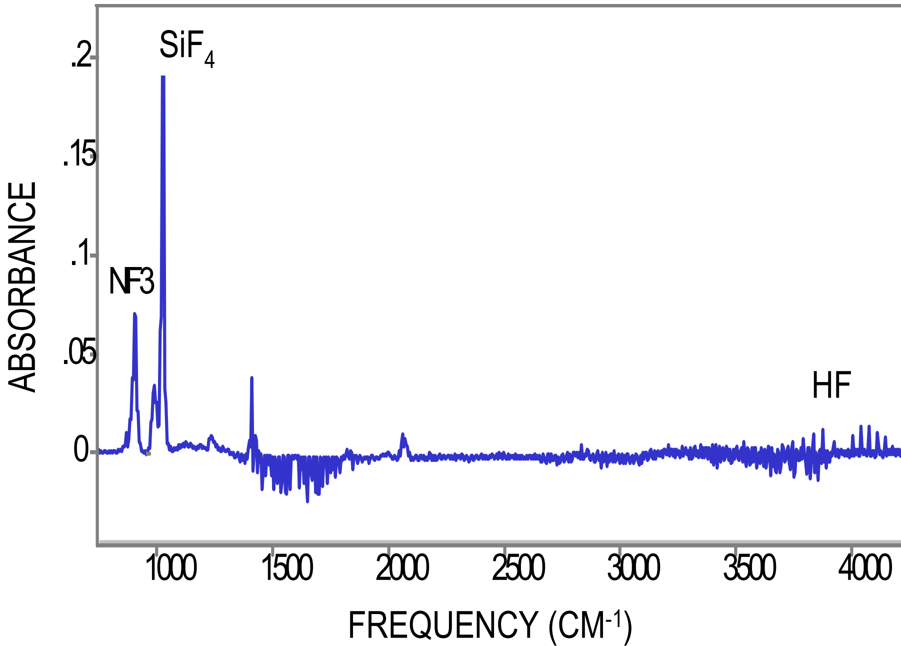


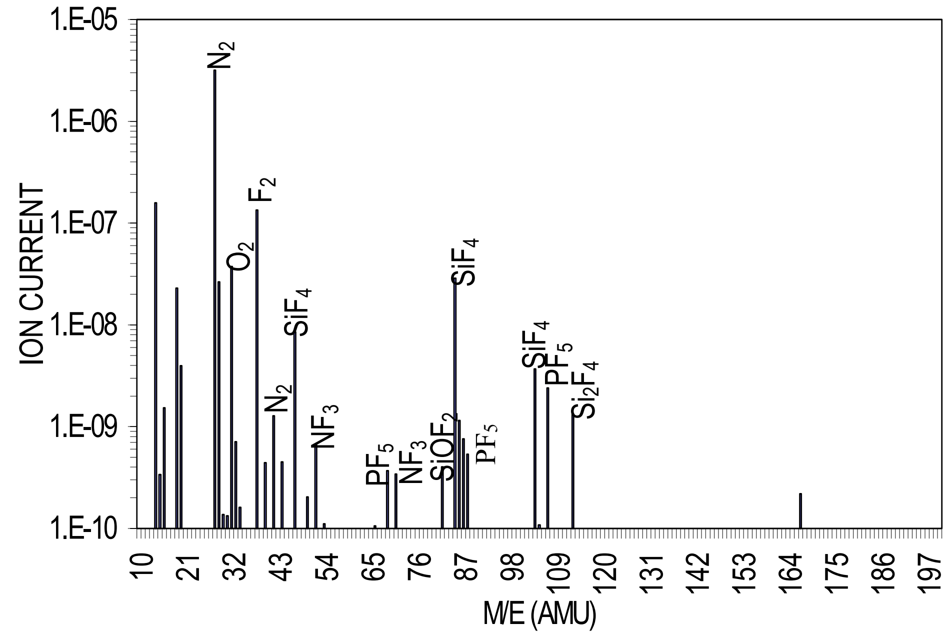


- SiH_4 AND PH_3 PROCESS GASES FULLY UTILIZED
- NO OTHER BYPRODUCTS

AIR PRODUCTS

ULTIMA HDP-CVD: PSG CHAMBER CLEAN

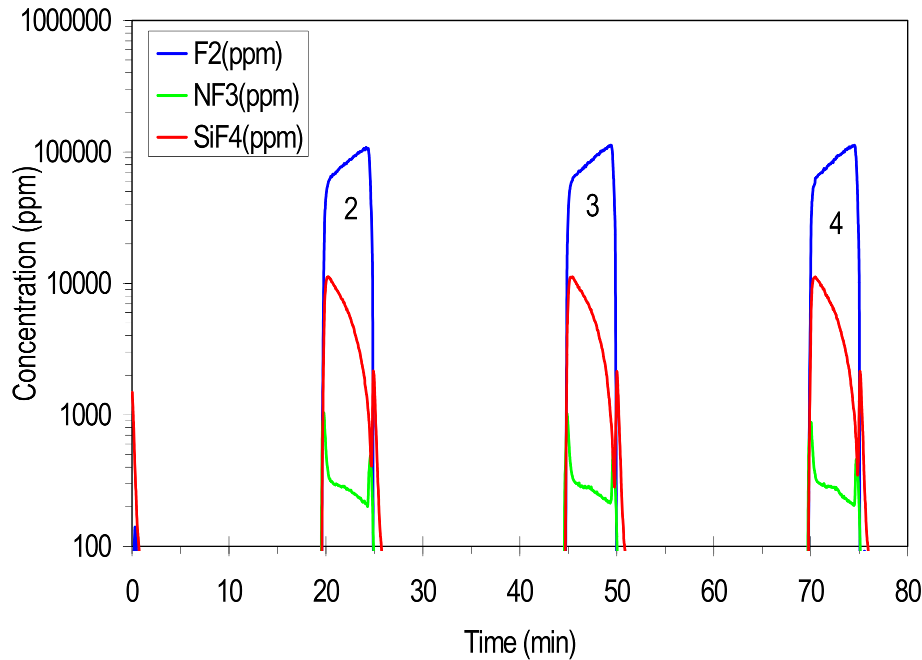


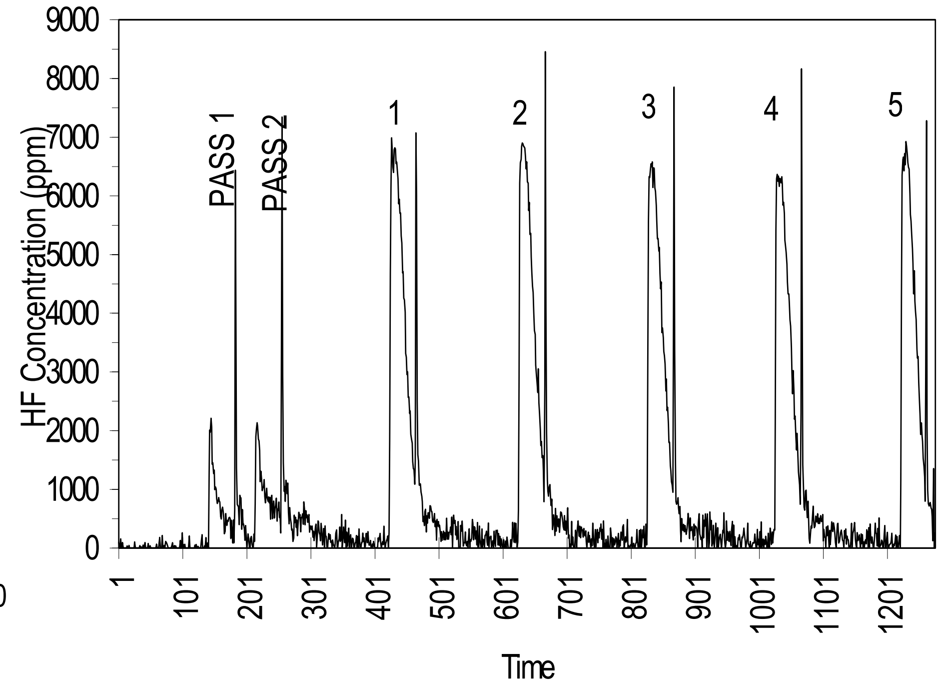


- IDENTIFY CLEAN BYPRODUCTS
  - NF_3, SiF_4, F_2, PF_5, HF, O_2

AIR PRODUCTS

CONCENTRATION PROFILE: ULTIMA HDP-CVD PSG CLEAN





- VOLUMETRIC EMISSIONS
  - INTEGRATE UNDER PROFILE
  - MULTIPLY BY PUMP PURGE (22.8 SLM)

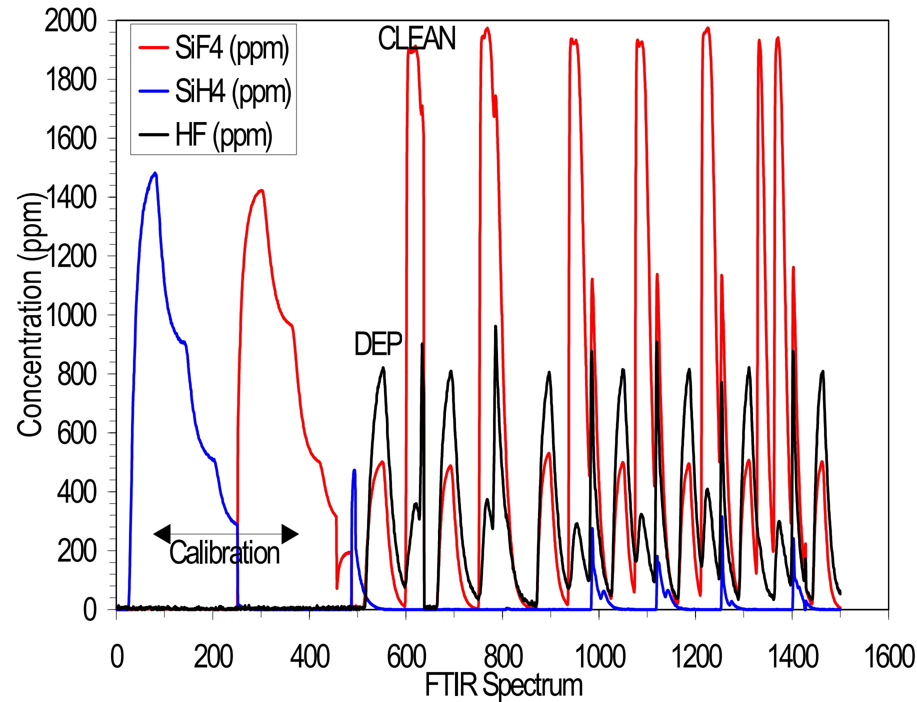
AIR PRODUCTS

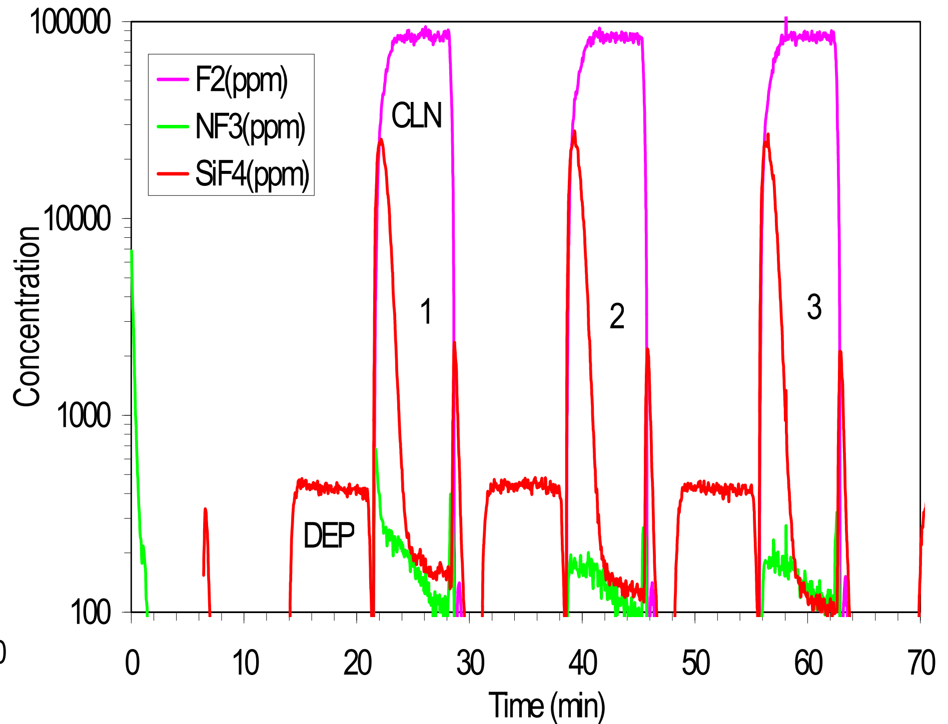
VOLUMETRIC EMISSIONS

	PSG CLEAN						**AVE**
	PASS1	**PASS2**	**1**	**2**	**3**	**4**	**(scc)**
NF3(scc)	60	41	44	39	38	37	**39**
SiF4(scc)	73	60	687	672	662	651	**668**
PF5	4	3	34	34	33	33	**33**
F2(scc)	8153	9668	7707	8670	8908	8940	**8556**
HF(scc)	122	189	547	539	520	510	**529**
Utilization (%)	99	99	99	99	99	99	**99**
F-Balance	0.79	0.93	0.89	0.98	0.99	1.00	**0.96**
	PSG DEP						**AVE**
	PASS1	**PASS2**	**1**	**2**	**3**	**4**	**(scc)**
SiH4(scc)	0	0	0	0	0	0	**0**
PH3(scc)	0	0	0	0	0	0	**0**

AIR PRODUCTS

ULTIMA HDP-CVD: FSG DEPOSITION AND CLEAN





- DEPOSITION BYPRODUCTS
  - HF, SiF_4
- CLEAN BYPRODUCTS
  - F_2, SiF_4, NF_3

AIR PRODUCTS

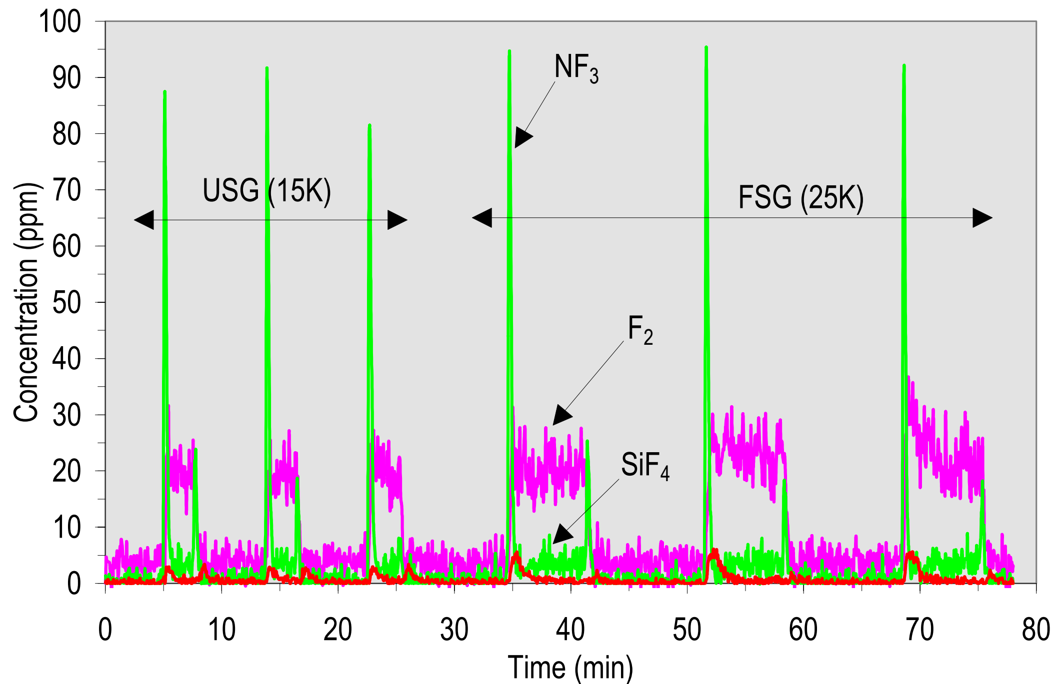
VOLUMETRIC EMISSIONS: ULTIMA HDP-CVD FSG

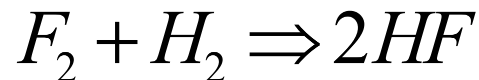
DEP (scc)	1	2	3	4	5	6	7	8	9	10	11	12	13
SiF_4	37	29	35	39	29		30	28	38	55	34	34	53
HF	62	54	53	57	50		53	50	54	56	47	49	58
SiH_4	4	0	0	3	0		0	0	0	0	0	0	1

CLEAN (scc)	1	2	3	**AVE**
NF_3	40	27	29	**32**
SiF_4	793	849	817	**820**
F_2	13,559	13,443	13,562	**13,522**
HF	99	99	99	**99**
F-Balance	1.00	1.00	1.00	**1.00**
Utilization (%)	99.6	99.7	99.7	**99.7**

AIR PRODUCTS

PROCESS ABATEMENT: DELATECH CDO





$$F_2 + H_2 \Rightarrow 2HF$$

- MEASUREMENTS DOWNSTREAM OF THE DELATECH
  - MONITOR PROCESS BYPRODUCTS
  - TOTAL GAS FLOW 177 SLM

AIR PRODUCTS

FLUORINE REMOVAL EFFICIENCY

	USG (15 kA)		FSG (25 kA)	
	BEFORE CDO	*AFTER CDO*	*BEFORE CDO*	*AFTER CDO*
NF_3 (scc)	22	7	32	10
SiF_4 (scc)	249	1	820	2
F_2 (scc)	7,056	13	13,522	31
HF (scc)	100	n/a	100	n/a

- F_2 EFFICIENTLY CONVERTED TO HF
- HF EFFICIENTLY SCRUBBED
- FLUORINE EMISSIONS REDUCED 99.8 %

AIR PRODUCTS

SUMMARY

- QUANTITATIVE ANALYSIS OF ULTIMA HDP-CVD PROCESSES
  - PSG DEPOSITION AND CLEAN
  - USG DEPOSITION AND CLEAN
  - FSG DEPOSITION AND CLEAN
- REMOTE NF_3 CLEAN ELIMINATES PFC EMISSIONS
  - MMTCE 0.15×10^{-9}
  - PROCESS BENEFITS
- DELATECH CDO REMOVES 99.8 % FLUORINE INFLUENT