Safety and Particulate Management of Process Effluents

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SubFab Safety

- Polysiloxane condensation from Epi process and damaged foreline pipe
- AlCl3 solid from Metal Etch, NH4Cl white solid from LPCVD, brown residue from MOCVD
- Acidic TEOS-based polymer, Br2 based liquid condensation causing foreline corrosion
Potentially Hazardous Byproducts

- Chlorosiloxane polymer – explosive and flammable
- SiO2 and Si particles with trapped SiHx - flammable
- Si particles – dust explosion

Accidents can occur while running process or during pump and exhaust line PMs. Best prevention is to minimize the amount of byproduct build-up.
Past Experience

Winbond ‘96 and UMC/UICC ‘97

And SKHynix in 2013…..
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Subfab Product Development History

- 2009: iSYS SYSTEM (Fully Integrated). First Customer Shipment
- 2010: iSystem Controller only. Beta shipment
- 2011: iSystem Controller version 1.2
- 2012: iSystem Controller version 2.0, Rack Mount for efficient volume installation
- 2013: iSystem CMS Developed
- 2014: 1000 iSystem units shipped. Over 1400 tools supported.
- 2015: Aeris-S
- 2016: 2000 units shipped
- 2017: Aeris-G Improved
Aeris-S Overview

- Located between chamber and pump
- One unit per chamber required
- Installation in any orientation
- Ideal for new installations or existing tool retrofit
- Low installation cost and utilities consumption provides excellent CoO

- High flow capacity, 100slm total
- Designed for “dirty” chemistries

- Controller provides tool interface recipe control & selection
- Controls reagent flow, power and purge

- Magnetically Enhanced, Capacitively Coupled plasma source
- Separate generator, up to 6kW
Aeris-S Design Advantage

• Magnetically Enhanced Capacitively Coupled Plasma Source for wide process window and low CoO
• Magnetic field confines electrons, improves plasma density via plasma Hall-Effect and get better DRE
• Symmetric toroid design with no pumping conductance restriction; less impact for wafer process transparency
• Grounded enclosure, no RF leak out.

Process Control

► Downstream gas injection to adjust plasma pressure
► Reagent injection/purge pressure in unit
► Power (1-6KW)
**Minimal additional footprint required**
- Plasma source can be installed above the pump in any direction
- Controller can handle up to 4 plasma units

**Aeris-S addresses the following problems:**
- High operating cost due to frequent dry pump maintenance cycles
- Foreline cleaning and replacement
- Local exhaust abatement maintenance cycle
- Exposure of workers to hazardous substances
- Overall subfab safety management

**Aeris-S designed to treat:**
- Unstable effluents (Fluorine, chlorides, MO-precursors, etc.)
- Incomplete reaction in process chamber (HCDS, TEMAZ, etc.).
- High solid concentration in effluent (Nitride, TEOS, etc.).

Aeris-S improving subfab and worker safety
TEOS Oxide Application
HARP Improvement Case Study

• HARP issue is condensed powder in pump
  – Approach was to use unreacted chamber clean F2 gas to clean pump
  – Aeris-S only operated during Clean recipe

• Demonstrated PM cycle improvement during customer evaluation period
  – Improved dry pump PM cycle from 182 to 260 days
  – Improved post pump abatement PM cycle from 60 day average to 260 days
  – Gate valve & pump exhaust lines identified to have less powder build-up

Pump lifetime can be further improved
Aeris-S Working Principle at HARP DEP

TEOS breakdown on wafer and chamber

Waste stream:
- TEOS Si(OC2H5)4
- CO
- HCOOH
- CO2
- CH4

Aeris-S completes the TEOS oxidation

Aeris-S eliminates TEOS build up in pump and converts it into “cleanable” SiO2
Aeris-S Working Principle at HARP Clean

F radicals convert SiO2 into SiF4

F radicals recombine and don’t react anymore

Aeris-S activates F2 and converts solid SiO2 into SiF4

Pump neutral gaseous effluents

Aeris-S activates F2 and removes SiO2 build up
SiF4 concentration can be used as indicator of clean efficiency
  ► More SiF4 in effluent means more SiO2 has been converted.

Aeris-S re-activates F2 to F radicals and converts SiO2 to SiF4
  ► Twice the SiF4 emission level with Aeris-S
• Turn on Shiva during Chamber CLN. (not for DEP)
• Shiva long term performance is stable since Feb 2015
Summary

- Aeris-S re-activates F2 to F radicals and converts solid SiO2 to gaseous SiF4
- Stable operation since Feb 2015
- Improved dry pump PM cycle >60%
- Improved scrubber inlet PM cycle 2x
- Customers can eliminate post-pump N2 injection
SRP Application
Prior Pumps (Before Aeris-S Installed)

All 3 booster inlets had varying amounts of black gooey film and streak marks.
Pump Inlet (after Aeris-S Installed)

Looks Brand New !!
Thanks for Your Attention!