EXHAUST MANAGEMENT

◆ ACID EXHAUST

◆ PRIMARILY ACID COMPOUNDS.

◆ MINIMAL VOLATILE ORGANIC COMPOUNDS (VOC). HMDS FROM PHOTO CAN BE EXHAUSTED (RATHER THAN TO VOC EXHAUST).

◆ AMMONIA NEEDS TO BE ALMOST ZERO (DUE TO FORMATION OF AMMONIUM HALIDES). AMMONIUM HALIDES PLUG DUCT AND POSSIBLE VISIBLE EMISSIONS.

◆ GENERALLY EXHAUSTED TO CENTRALIZED ACID SCRUBBER.
AMMONIA EXHAUST

- ALMOST ENTIRELY AMMONIA.

- MINIMAL VOLATILE ORGANIC COMPOUNDS. HMDS FROM PHOTO CAN BE EXHAUSTED (RATHER THAN TO VOC EXHAUST).

- ACID NEEDS TO BE ALMOST ZERO (DUE TO FORMATION OF AMMONIUM HALIDES).

- GENERALLY EXHAUSTED TO CENTRALIZED AMMONIA SCRUBBER. LOW pH (<5) SCOURBING SOLUTION.
AMMONIA EXHAUST (CONTINUED)

- POINT-OF-USE ABATEMENT CAN BE USED INSTEAD OF INSTALLING AMMONIA EXHAUST SYSTEM. THE POU ABATEMENT WOULD THEN EXHAUST TO ACID EXHAUST.
HIGH ACID EXHAUST (RARE)

- A FEW FABS HAVE HIGH ACID EMITTING PROCESSES (EXAMPLE: AGUA REGIA, HOT NITRIC, ETC.) THAT CANNOT BE EFFECTIVELY ABATED BY STANDARD ACID SCRUBBER. THE EMISSIONS FROM THESE PROCESSES CAN CREATE ACID MIST VISIBLE EMISSIONS FROM STANDARD SCRUBBERS.

- A SPECIALIZED SCRUBBER IS NEEDED FOR THIS HIGH ACID EXHAUST (EXAMPLE: WET SCRUBBER WITH HIGH pH AND A SUB-MICRON FILTER).
EXHAUST MANAGEMENT

HIGH ACID EXHAUST (CONTINUED)

POINT-OF-USE (POU) ABATEMENT CAN BE USED INSTEAD OF INSTALLING HIGH ACID EXHAUST SYSTEM. THE POU ABATEMENT WOULD THEN EXHAUST TO ACID EXHAUST.
EXHAUST MANAGEMENT

◆ VOC EXHAUST

◆ VOLATILE ORGANIC COMPOUNDS ONLY.

◆ GENERALLY ABATED BY VOC CONTROLS. IN RARE CASES, POU VOC ABATEMENT IS USED FAB-WIDE.

◆ HMDS FROM PHOTO CAUSES ISSUES WITH MOST TYPES OF VOC CONTROLS USED IN SEMICONDUCTOR INDUSTRY (PLUGGING WITH SILICON DIOXIDE).
GENERAL/HEAT EXHAUST

- GENERALLY USED FOR NON-CONTAMINATED EXHAUST, INCLUDING EXHAUST WITH HIGH TEMPERATURES.

- GENERALLY NOT ABATED (VERY LOW EMISSIONS)
EXHAUST MANAGEMENT

◆ OTHER EXHAUST

◆ PYROPHORICS (MAINLY GAS CABINETS, BUT HAVE SEEN PROCESS EXHAUST IN FAB).

◆ EPI PROCESSES (VENT TO ROOF DUE TO HYDROGEN).

◆ CENTRALIZED PFC RECOVERY/ABATEMENT - RARE

◆ HYDROGEN RECOVERY (FROM EPI) - RARE
EXHAUST MANAGEMENT

◆ OTHER EXHAUST

◆ EMERGENCY RELEASE FROM GAS CABINETS (TOXICS, ETC). GENERALLY DILUTED OR ABATED TO MEET ONE-HALF IDLH REQUIREMENT.

◆ OUTSIDE OF FAB: CHEMICAL STORAGE VENTS AND WASTE TANK VENTS (IN SOME CASES ABATED - DUE TO RCRA FOR HAZARDOUS SOLVENT WASTE AND WET SCRUBBER FOR HIGH CONCENTRATION HYDROCHLORIC ACID STORAGE).
EXHAUST MANAGEMENT

MORE INFORMATION

- DRAFT SEMI F5-90 REVISION
- CONTACT MIKE SHERER

Materials Lifecycle Solutions
POINT-OF-USE (POU)
EXHAUST CONTROL DEVICES
WHY USE POU DEVICES?

1. PREVENT EXHAUST DUCTWORK RESTRICTIONS.
2. PREVENT DUCTWORK FIRES OR EXPLOSIONS.
3. PREVENT DUCT CORROSION.
4. PREVENT EXPOSURE TO PERSONNEL.
5. PREVENT AMMONIUM COMPOUNDS FORMATION.
6. AIR REGULATORY REQUIREMENTS.

Materials Lifecycle Solutions
SELECTING POU DEVICES

1. TYPE OF SEMICONDUCTOR EQUIPMENT USED.

2. COMPOUNDS EMITTED FROM THE SEMICONDUCTOR EQUIPMENT DURING ALL OF THE PROCESSES.

3. COMPANY PHILOSOPHY.

4. COST OF OWNERSHIP.

Materials Lifecycle Solutions
1. WET SCRUBBING SYSTEMS.

2. OXIDATION SYSTEMS.

3. COLD BED SYSTEMS (ADSORBER/CHEMISORBER).

4. HOT CHEMICAL BED SYSTEMS.

5. REACTOR SYSTEMS (E.G. PLASMA, MICROWAVE).

6. PARTICULATE REMOVAL SYSTEMS.

7. RECYCLE OR RECLAIM SYSTEMS.

Materials Lifecycle Solutions
TYPICAL PROCESS APPLICATIONS

- 1. WET CLEAN HOOD
- 2. WET SPRAY ETCHER
- 3. SILICON EPI - HYDROGEN VENTED
- 4. SILICON EPI - HYDROGEN ABATED
- 5. ION IMPLANT
- 6. POLY DEPOSITION/CLEAN
- 7. DOPED POLY DEPOSITION/CLEAN
- 8. METAL ETCH
- 9. NITRIDE DEPOSITION (SILANE)/CLEAN
- 10. NITRIDE DEPOSITION (SiH2Cl2)/CLEAN
- 11. OXIDE DEPOSITION/CLEAN
- 12. TUNGSTEN DEPOSITION/CLEAN
- 13. TUNGSTEN SILICIDE DEPOSITION/CLEAN
- 14. BPSG OXIDE DEPOSITION/CLEAN.

Materials Lifecycle Solutions
EXPECTATIONS FOR POU DEVICE SUPPLIERS
1. Understand semiconductor processes, hazards and gases.

2. Understand POU device products.

3. Understand site-specific issues (e.g. facilitation needs such as water, DI water, natural gas, hydrogen, electricity, etc.).

4. Propose the best POU device technology for the process/gases.

5. Emissions characterization - have measured inlet/outlet data for specific process/gases.
6. S2 review done and understand company-specific safety/IH requirements.
7. Provide detailed information in bid specifications.
8. Identify competent local support (24 hours/day; seven days per week).
9. Guarantee the POU device.

Materials Lifecycle Solutions
1. Properly install POU device (if contracted to do so). If not, review final installation for any concerns.

2. Provide O&M manuals (including preventative maintenance) and training.

3. Provide local spare parts storage.

4. Competent local support (24 hours per day; seven days per week).

5. Understand the failure rates of each POU device and develop quick solutions to these failures.
CENTRALIZED WET SCRUBBERS
AND CENTRALIZED VOC CONTROL EQUIPMENT
CENTRALIZED WET SCRUBBERS

- ACID SCRUBBER (SEVERAL SUPPORTING FAB).

- AMMONIA SCRUBBER (ONLY IF FAB EXHAUSTS ARE SEGREGATED INTO ACID AND AMMONIA).

- HIGH ACID SCRUBBER (VERY RARE)
CENTRALIZED WET SCRUBBERS

- **HORIZONTAL CROSS-FLOW (MOST COMMON)**

- **VERTICAL COUNTER-CURRENT**

- **VERTICAL CO-CURRENT**

*Materials Lifecycle Solutions*
CENTRALIZED WET SCRUBBERS

- GENERALLY 10,000 CFM TO 50,000 CFM

- LOW INLET CONCENTRATIONS INTO ACID SCRUBBERS (USUALLY <1 PPM TO 5 PPM FOR HCl AND HF).

- INLET CONCENTRATIONS GENERALLY MUCH HIGHER INTO AMMONIA SCRUBBERS AND HIGH ACID SCRUBBERS.

Materials Lifecycle Solutions
SCRUBBER DESIGN RECOMMENDATIONS

- KNOW THE INLET GAS COMPOSITION
- DESIGN THE BED DEPTH FOR THE MOST DIFFICULT COMPOUND YOU WANT REMOVED.
- SEGREGATE AMMONIA FROM ACID GASES
SCRUBBER DESIGN RECOMMENDATIONS

- Set blowdown rate and chemical addition use (if necessary) to meet control efficiency objectives.

- Provide instrumentation to monitor scrubber performance.
TYPICAL SCRUBBER DESIGN VARIABLES

- AIR FACE VELOCITY THROUGH SCRUBBER: 300 - 500 FEET PER MINUTE.

- PACKING LIQUID WETTING RATE: 6 - 10 GPM PER FT².

- LIQUID-TO-GAS RATIO: 10 - 20 GPM LIQUID PER 1000 CFM

Materials Lifecycle Solutions
ONE TO A FEW VOLATILE ORGANIC COMPOUND (VOC) CONTROL SYSTEMS IN EACH FAB.

GENERALLY 10,000 CFM TO 60,000 CFM

SEVERAL TYPES AVAILABLE

HIGH AIR FLOWRATE, LOW INLET CONCENTRATIONS (GENERALLY 20 PPM TO 200 PPM TOTAL VOC’s MEASURED AS PROPANE).
VOC CONTROL TECHNOLOGIES

- OXIDATION SYSTEMS
- CAPTURE/OXIDATION SYSTEMS
- CAPTURE/DISPOSE OR RECYCLE SYSTEMS
- OTHER TECHNOLOGIES (E.G. ELECTRIC-GENERATING TURBINES)

Materials Lifecycle Solutions
Oxidation Systems

- Thermal, thermal with catalyst, or other oxidizing agents.
- By-products include carbon monoxide and oxides of nitrogen.
- Energy usage (e.g. natural gas)
- Usually no liquid or solid wastes

Materials Lifecycle Solutions
VOC’s IN AIR STREAM ARE CONCENTRATED IN ADSORPTION MEDIA AND THEN DESORBED INTO MUCH LOWER AIR FLOWRATE STREAM.

SUITED WELL FOR HIGH AIR FLOW RATE WITH LOW INLET CONCENTRATION STREAMS.
LOW ENERGY USAGE AND CARBON MONOXIDE/OXIDES OF NITROGEN EMISSIONS THAN OXIDATION. USUALLY NO LIQUID OR SOLID WASTE.

DIFFICULTY IN REMOVING SMALL MOLECULAR WEIGHT COMPOUNDS (E.G. METHANOL).
CAPTURE/DISPOSE OR RECYCLE SYSTEMS

- VOC’s are captured by adsorption media, desorbed and then condensed into liquid for disposal or recycle.

- Suited well for high air flow rate with low inlet concentration streams.

- Lower energy usage
USUALLY INSIGNIFICANT CARBON MONOXIDE AND OXIDES OF NITROGEN EMISSIONS.

DIFFICULTY IN REMOVING SMALL MOLECULAR WEIGHT COMPOUNDS (E.G. METHANOL).

GENERATES A LIQUID THAT REQUIRES HANDLING AND DISPOSAL/RECYCLE.

CARBON MAY BE FIRE ISSUE.
SELECTION OF VOC CONTROL EQUIPMENT

- ACTUAL VOC’s REMOVED AND INLET CONCENTRATIONS.
- PURCHASE, SHIPPING, INSTALLATION AND OPERATING COSTS.
- AVAILABLE UTILITIES AND WASTE DISPOSAL (IF APPLICABLE).
SELECTION OF VOC CONTROL EQUIPMENT

- CONTROL EQUIPMENT SUPPLIER’S LOCAL SUPPORT, TRAINING AND AVAILABLE SPARE PARTS.
- REGULATORY REQUIREMENTS
- COMPANY PREFERENCES
- OTHER (SAFETY, ETC)