CASE STUDY 4

HARD DISK DRIVE MANUFACTURER

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PURAFIL PREVENTS CORROSION
4 A HARD DISK DRIVE MANUFACTURER

THE PROBLEM

Though disk drive manufacturers have been aware of airborne molecular contamination (AMC) for some time, they have only recently focused on the effects chemical contamination has on drive components, manufacturing processes, and drive performance. Exposure to various acid gases can lead to corrosion of disks and drive components and therefore slowed production and lost revenue.

A leading hard disk drive manufacturer was concerned about the effects of AMC on potential upgrades to its manufacturing facility. Located in an urban area within a couple miles of the ocean, the manufacturer was concerned about exhaust from heavy, constant vehicular traffic and many other manufacturing companies. Sulfur and nitrogen oxides, chlorine, and ozone levels in the air surrounding the facility were anticipated to be especially high.

PURAFIL PROVIDES THE SOLUTION

Purafil, the leading manufacturer of gas-removal air filtration systems, met with representatives from the manufacturer to implement a three-step process to control AMC. The service is designed to characterize the reactive potential of an environment.

ASSESSMENT:

As part of the assessment of the facility, multiple sets of Purafil's Environmental Reactivity Coupons (ERCs) were placed in each area of concern to determine the corresponding reactivity level. The ERCs employ copper and silver sensors that react with airborne contaminants to form corrosion reaction products. Unlike direct monitoring technologies, Purafil's coupon technology makes it possible to observe and predict the synergistic effects of AMC on manufacturing processes. Multiple sets of ERCs were used to establish baseline data for the specification, design, and operation of a chemical filtration system.

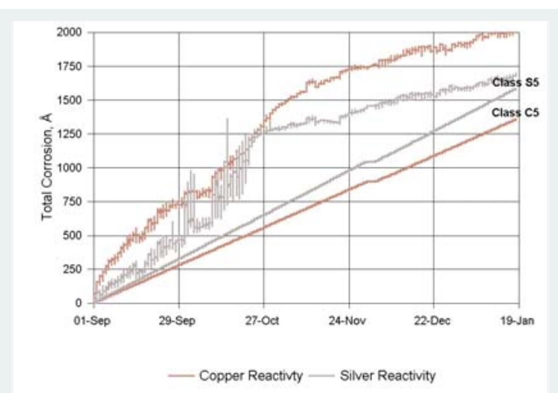

FIGURE 1 - ERM DATA - FRESH AIR INLET

Seven of Purafil's Environmental Reactivity Monitors (ERMs) were also used in the facility. A quartz crystal microbalance sensor plated with copper or silver continuously measures in real-time the mass accumulation of the corrosion films formed. These monitors continuously transmit data to the facility monitoring system and are sensitive enough to measure AMC levels as low as 1 ppb.

Data from the ERCs and ERMs allowed Purafil engineers to categorize the contamination level of the facility. A classification system has been developed for correlating the film thickness to the air quality of the environment. The classification levels are the result of studies performed with a number of microelectronics manufacturers and reflect what are considered to be acceptable levels inside a facility.

Based on ERC and ERM data, the outdoor air used for ventilation showed copper and silver reactivity rates indicative of a Class C5/S5-Severe environmental classification. (See Table 1 at the next page for environmental classifications of semiconductor cleanrooms.) This air, if left untreated, would pose an immediate threat to fabrication processes. (See Figure 1 for ERM results of outdoor air being used for ventilation.) High levels of sulfur and chlorine contamination were evident. The air was estimated to have concentrations in the ranges of 10-50 ppb for active sulfur compounds, 10-100 ppb for sulfur oxides, and >10 ppb for chlorine. All ERC measurements indicated extremely high levels of corrosive AMC for a disk drive manufacturing environment.

ADDITIONAL INFORMATION ON BACK

CONTROL:

To remove specified contaminants and those identified in the assessment, a Purafil Side Access system was placed on the fresh air inlet that supplies ventilation air to a mechanical room housing a recirculation air handler. The two-stage chemical filtration system houses Purafil's PK-18 MediaPAK™ disposable modules, which contain Purafil Select in the first stage and Puracarb in the second stage to control acid gases and volatile organic compounds. Purafil installed CPS-500/85 Purafilters™- pleated combination chemical-particulate filters capable of removing acid gases and volatile organic compounds. These filters replaced the existing particulate filters in the recirculation air handling units.

TABLE 1

COPPER CORROSION

CLASS	AIR QUALITY CLASSIFICATION	REACTIVITY RATE*
C1	Pure	<90 Å/30 days
C2	Clean	<150 Å/30 days
C3	Moderate	<250 Å/30 days
C4	Harsh	<350 Å/30 days
C5	Severe	≥350 Å/30 days

* Å = angstroms

SILVER CORROSION

CLASS	AIR QUALITY CLASSIFICATION	REACTIVITY RATE*
S1	Pure	<40 Å/30 days
S2	Clean	<100 Å/30 days
S3	Moderate	<200 Å/30 days
S4	Harsh	<300 Å/30 days
S5	Severe	≥300 Å/30 days

* Å = angstroms

ERCs were placed at the fresh air inlet, between the first and second stages of dry-scrubbing media, at the discharge of the chemical filter system, in the mechanical room, and in the cleanroom supplied by the recirculation air handling unit to evaluate the system's ability to remove specific types of AMC.

ERMs were placed at the fresh air inlet, the discharge of the chemical filter system, and in the mechanical room to spot trends in outdoor air quality filter performance and to correlate with ERC data. (See Figure 2 for a diagram of the test setup showing the ERC and ERM monitoring locations.)

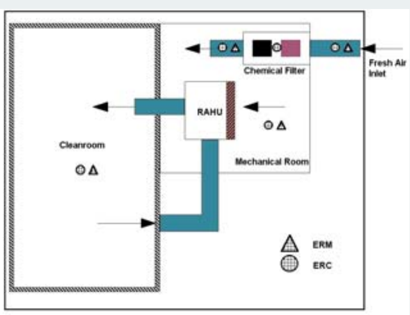

FIGURE 2: Diagram of chemical filter system evaluation

Monitoring data indicated that the chemical filter system completely removed active sulfur and chlorine contamination. Sulfur oxides were reduced by more than 87 percent. (See Table 2 at the bottom of this page for a summary of the chemical filter performance.)

MONITORING:

Purafil provides ongoing monitoring of the controlled environment and the performance of the AMC control system. Reactivity monitoring indicated an overall reduction in the total contaminant load. The chemical filter systems reduced the overall levels of AMC by more than 95 percent. ERC and ERM data was collected over a 90-day period and showed that the air quality improved from a Class C5/S5-Severeon the inlet side of the system to a Class C1/S1-Pure on the discharge side. (See Figure 3 for a representation of the effectiveness of the chemical filter system against the contaminants identified in the outside air.) Examination of the total and individual corrosion films data indicated the complete removal of active sulfur and inorganic chlorine contaminants within the AMC control system.

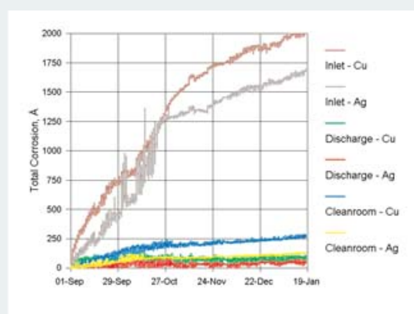

FIGURE 2: Chemical filter performance - ERM data

TABLE 2

ERM Monitoring Location	Copper Reactivity	Reduction	Class	Silver Reactivity	Reduction	Class
FRESH AIR INLET	579	n/a	C5	484	n/a	S5
CHEMICAL FILTER DISCHARGE	21	96.37%	C1	11	97.73%	S1
MECHANICAL ROOM	70	87.91%	C1	33	93.18%	S1
CLEANROOM	10	98.27%	C1	10	97.93%	S1

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CASE STUDY 4 SEMICONDUCTOR FACILITY

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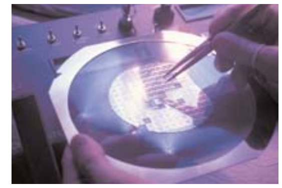

PURAFIL REDUCES AIRBORNE MOLECULAR CONTAMINATION 4 A SEMICONDUCTOR FACILITY

THE PROBLEM

As the size of semiconductor devices rapidly decreases, the concern over airborne molecular contamination (AMC) has become as pressing as particulate contamination. AMC can affect almost all facets of sub-micron device fabrication, from overall fab operation to final device performance.

A semiconductor facility specializing in memory products sought Purafil's help to identify and reduce the amount of AMC being introduced from nearby sources - an airport, a coal-burning power plant, a chemical plant, and a paper mill.

Under certain conditions the potential existed for elevated levels of corrosive gases, especially sulfur species, to be introduced into the facility through the makeup air handlers. Chlorine from site cooling towers and elevated levels of nitrogen dioxide and ozone were also potential AMC sources.

PURAFIL PROVIDES THE SOLUTION

Purafil, the leading maufacturer of chemical air filtration systems, met with representatives of the semiconductor manufacturer to implement a three-step program to control AMC. This program is designed to characterize the potential of an environment for damage to materials, products, and processes.

ASSESSMENT:
As part of the assessment of the semiconductor facility, Purafil's Environmental Reactivity Coupons (ERCs) were used both outside and inside the fab to determine the reactivity level of the environment. The ERCs employ copper and silver sensors that react with airborne contaminants to form corrosion reaction products. Unlike direct monitoring technologies, Purafil's coupon technology makes it possible to observe and predict the synergistic effects of AMC on semiconductor processes.

Data from the ERCs allowed Purafil engineers to categorize the contamination level of the manufacturer. A classification system has been developed for correlating the film thickness to the air quality of the environment. The classification levels are the result of studies performed with a number of semiconductor manufacturers, and they reflect what are considered to be acceptable levels inside a facility.

The air outside the semiconductor showed copper and silver reactivity rates indicative of a C5/S5-Severe environmental classification. (See Table 1 at the bottom of this page for environmental classifications of semiconductor cleanrooms.) The air quality being used for ventilation and pressurization at the facility contained levels of AMC that would pose an immediate threat to materials and fabrication processes. High levels of sulfur, sulfur oxides, and inorganic chlorine contamination were evident. This air was estimated to have concentrations in the ranges of >50 parts per billion for active sulfur compounds, 100-300 ppb for sulfur oxides, and >10 ppb for chlorine. (See Table 2 on the next page for ERC data of the outside air.)

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S5	Severe	≥300 Å/30 days

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ADDITIONAL INFORMATION ON BACK

All ERC results indicated extremely high levels of corrosion for a semiconductor environment. With these elevated levels of AMC, the facility potentially faced a multitude of problems, including corrosion on wafers, etch rate shifts, wafer and optics hazing, adhesion failure, and fab corrosion.

Inside the facility, ERCs were placed in etch bays and diffusion, film, and photolithography areas to determine the extent to which outdoor contaminants were being distributed into the cleanroom areas. Chlorine contamination was evident in every location monitored; corrosion was observed on wafers and ductwork. Even with dilution, the inside levels were still as high as 60% of the outside levels.

CONTROL:

To reduce the potential for AMC being introduced from outside the facility, chemical filters were installed in each of the make-up air handling units. Instead of retrofitting air handling units to accept bulk media trays or modules, the manufacturer was able to use two-inch deep, non-woven, adsorbent-loaded pleated media filters. These filters were installed in existing frames and were expected to remove chlorine, sulfur compounds, and various hydrocarbons.

MONITORING:

Ongoing monitoring of the controlled environment and the performance of the AMC control system is being performed with Purafil's ERC's and Environmental Reactivity Monitors (ERMs). ERMs were used outside and inside the facility to measure in real-time the overall reactivity level of the environment. A quartz crystal microbalance sensor plated with copper or silver continuously measures in real-time the mass accumulation of the corrosion films formed. This monitor continuously transmits data to the facility monitoring system and is sensitive enough to measure AMC levels as low as 1 ppb.

Over 40 ERMs were installed in makeup and recirculation air systems, and each monitored location indicated a Class S5 environment. The ERMs were able to identify internal sources of chlorine emissions by examination of the copper and/or silver reactivity monitoring data. For AMC-related incidents for which an incident was reported and logged, the ERM data showed an increase in the incremental reactivity rate in most cases before the event had been reported. (See Figure 1 for a visual representation of the incremental peaks corresponding to the reported AMC release.) Reactivity monitoring has indicated an overall reduction in total AMC levels. Data from the ERMs monitoring the chemical filter performance showed that the air passing through the filters contained lower levels of AMC than before it was treated.

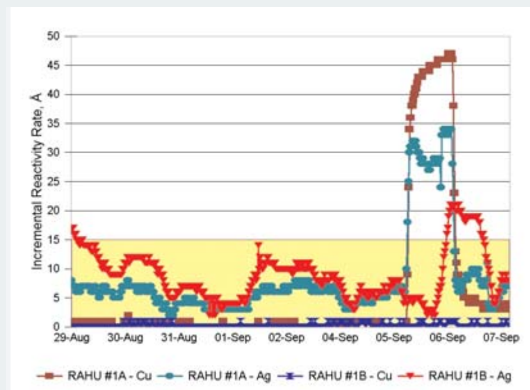

FIGURE 1: ERM NETWORK DATA

SITE SURVEY ERC DATA - OUTSIDE AIR

ERC Location	Copper Corrosion					Silver Corrosion				
	Total	Cu_2S	Cu_2O	Cu-Unk	Class	Total	AgCL	Ag_2S	Ag-Unk	Class
PROPERTY LINE (OUTSIDE AIR)	16,380	16,195	634	0	C5	275	192	83	0	S4
ROOFTOP AIR INTAKE	553	406	87	59	C5	163	116	46	0	S3
GROUND-LEVEL AIR INTAKE (1)	606	388	159	59	C5	416	378	38	0	S5
GROUND-LEVEL AIR INTAKE (2)	436	249	167	0	C5	442	247	66	129	S5
MUAH-INTAKE	15,698	15,348	350	0	C5	375	298	76	0	S5

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