Humidity Control in a FOUP by Laminar Air Curtain (LAC) When FOUP Door is in Open Condition

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1. Introduction

**Fan Filter Units**

Clean Room (CR) Core

**Mini-environment (ME)**

FOUP (wafer box)

Cleanliness (#Part/m³)

$D_{P_{ME-CR}} : 2 \text{ [Pa]} \quad (PF)$

Clean Room (CR) Core

$V_{FFU}$

Si-wafer

FOUP Door Open

Pressure

Robot
Cu+O_{2}+H_{2}O \rightarrow \text{Oxidized Cu}

Cu loss

Diffuser-Purge Inlets

Clean Dry Air

Mini-environment (ME)
2. The Problems

- Tool arrangement and ME configuration cases

**Case 1**
Dead Zone (Blank Panel)
Lack of FFU coverage. A solid plate covers the FFU surface.

**Case 2**
Dead Zone & Eyelid
Lack of FFU coverage and vertical plate between FFU and Dead zone

**Case 3**
Objects in front of the FOUP
Perforated plate that reduces the cross section below the FOUP’s interface.

**Case 4**
Tool Exhaust suction (Reduced Outlet)
Outlet cross section is reduced due to tool’s exhaust that forces air to escape from one specific zone of the floor.
Door open without purge

1. Door Closed. AMC on wafer evaporated and deposited on FOUP surfaces.
2. Door Open. Chemical reaction takes place by AMC and moisture.
3. Door Closed. Chemical reaction takes place by AMC and moisture.
Perfect Scenario: No down-flow air invades to the FOUP when door is open (by diffuser only)

Door Closed. AMCs on wafer evaporated and deposited on FOUP surfaces.

Door Open condition. AMCs are expelled by purged CDA via diffuser. (Flow rate is limited by possible particle suspension on wafer surfaces and vibration of diffuser holder)

FOUP is purged with CDA
Reality: down-flow air invades to the FOUP when door is open (by diffuser only)

Door Closed. AMCs on wafer evaporated and deposited on FOUP surfaces.

Door Open condition. AMCs can not be expelled by purge air and moisture invades, as the sectional purge air velocity is less than 0.015m/s. The purge flow rate of diffuser is limited to 130 L/min.

Door closed. AMCs still reside in the FOUP.
Combine diffuser & air curtain

Door Closed. AMCs on wafer evaporated and deposited on FOUP surfaces.

Air curtain with purge air acts 3 seconds before door open.

Door Open. Combined purge air by diffuser and purge air & air curtain can effectively keep the invasion of down-flow moisture and expel the residual AMCs.

Air curtain with purge air de-acts 3 seconds after door close.

Q=75 LPM

Q=200LPM

off
3. Methods:

Equipment: FOUP & Purging Devices

FOUP (wafer box) & Porous Diffuser

Slot 25

Slot 1

Al-Wafer & RH sensors (Top View)

Slots Location:
25
19
13
7
1

Air Curtain

Clean Dry Air

RH sensors location (Top View)
**Purge by diffusers only** with $Q_{DP}=130$ L/min. Slots 1 ~13 are influenced.

- **Left diffuser**
- **center**
- **Right diffuser**

**empty**

**Full slot**
Purge by diffusers only with $Q_{DP}=130$ L/min. Slots 1 ~13 are influenced

<table>
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<th>slot01</th>
<th>slot13</th>
<th>slot25</th>
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<tbody>
<tr>
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Full loaded
Purge by air-curtain. No slot is influenced

Left diffuser  |  center  |  Right diffuser

empty

Full slot
Purge by air-curtain only. No slot is influenced

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Full slot
RH trend chart at center of wafers of slot 1, 13, and 25
(Flow rate of XCDA: $Q_{\text{Air Curtain}}:300\text{L/min}, Q_{\text{diffusers}}:0\text{L/min})$
Total Wafer Q’ty: 24 pcs of wafers inside the FOUP
Conclusions

• Air-Curtain can effectively keep the invasion of down-flow moisture based on operation conditions of down-flow.

• Lower ownership: mount on each LPU vs. install two diffusers in each FOUP.

• Purge by diffusers only can not provide very low RH%, it reaches to about 30% even in good condition of EFEM. If EFEM is in a bad condition (i.e. the 5 scenarios), it won’t reach to 20%.

• Air Curtain speeds up the decreasing of RH% and keeps the EFEM humid air from invading into the FOUP.

• Combine air curtain with conventional FOUP purge approach, the purge flow rate can be optimized to reduced the risk of particle re-suspension in the FOUP, while keep the FOUP in low RH levels.
Thank you for your participation!

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