Contamination Control of Manufacturing Practices Using Critical Wipers

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**Agenda**

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- Introduction to Clean Manufacturing
- Contamination Sources
- Value of Critical Wipe Test
- Critical Wipe Test Procedure
- Case Studies
- Contamination Mapping
- Contamination Risk Assessment
- Summary
Why is Clean Manufacturing Important?

- Clean Manufacturing (Operation) is a **prerequisite** to successful manufacturing.
- It is often **overlooked** because it is a culture and it is considered a hindrance to the production process and schedule.
- But it is important because it can **impact**:
  - Product line down time
  - Quality and delivery issues
  - Not sharing of Best Practices
  - Planning delays
  - Overtime cost

Clean Manufacturing is a culture of doing it right when no one is looking or checking.
What is Needed for Clean Manufacturing?

- **Analytics** provide insight to cleanroom operation and manufacturing that are affecting product quality

- **Monitor and understand the sources of contamination** during cleanroom operations, procedures and activities

- **Contamination control systems** for effective control of physical and environmental parameters and process-to-process interactions

- **Effective wipe down** to improve surface cleanliness by removing contaminants that can originate from
  - People
  - Environment
  - Parts and equipment
Primary Contamination Sources

- **Facility** - gas, water, chemicals and infrastructure
  - Cleanroom environment - cleanroom, laminar flow hood
  - Cleanroom consumables – garments, gloves, bags, wipes, packaging
- **People** - contamination generator and mechanism for transfer
- **Manufacturing materials** – lubricants, detergents, polishing agents.
- **Supplier** – in addition, any process steps completed by an external supplier must also be evaluated
Value of Critical Wipe Test

- IC devices vary greatly in complexity and application.
- When processing advanced IC devices it is important to know the cleanliness state of normal cleanroom operation, before and after facility upgrade and process tool PM.
- Critical wipe monitoring can provide valuable insight to the cause of a contamination event affecting the product quality; contamination sources have unique signatures.
Value of Critical Wipe Test

The metals monitored by Critical Wipe Test can be associated with People, Process Equipment and the condition of the Facility.

**People**

<table>
<thead>
<tr>
<th>Element</th>
<th>RL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sodium (Na)</td>
<td>10 Total ng/wipe</td>
</tr>
<tr>
<td>Potassium (K)</td>
<td>50 Total ng/wipe</td>
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</table>

**Process/Equipment**

<table>
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<th>RL</th>
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</thead>
<tbody>
<tr>
<td>Nickel (Ni)</td>
<td>10 Total ng/wipe</td>
</tr>
<tr>
<td>Iron (Fe)</td>
<td>50 Total ng/wipe</td>
</tr>
<tr>
<td>Copper (Cu)</td>
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<td>Chromium (Cr)</td>
<td>10 Total ng/wipe</td>
</tr>
<tr>
<td>Aluminum (Al)</td>
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**Facility**

<table>
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<tr>
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<tbody>
<tr>
<td>Magnesium (Mg)</td>
<td>10 Total ng/wipe</td>
</tr>
<tr>
<td>Calcium (Ca)</td>
<td>50 Total ng/wipe</td>
</tr>
</tbody>
</table>

**Contaminants**

- Galvanized steel
- Fe, Ni, Zn
- People, Na
- Gypsum = CaSO₄, Ca/MgCO₃, Na/KCl, FeS₂
- Dirt = SiO₂ (quartz), CaCO₃, limestone, Na, K, Mg, P, S, Fe, and Mn
Critical Wipe Test Procedure

- Balazs pre-cleaned wipers are used for critical wipe test
- A surface should be swiped two (2) times in the same location using a fresh wipe surface
- Target surface area sampled is 16 cm²
Critical Wipe Test Procedure

Double glove. Clean outer glove using IPA.

1. Control wiper to sample cleanroom environment
2. Sample surfaces using the Sample Wipers
3. Return wipers into their containers

Critical wiper bottle containing wiper for Control and Sampling

Wipers ready for ICP-MS analysis
Critical Wipe Test Results from the Wall

- Based on this critical wipe test result, one can establish usage and activity levels; adherence of protocol, e.g. if frequency of wipe down was performed; and track contamination carry over.

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<td>2300</td>
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<tr>
<td>Na</td>
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<tr>
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Gypsum = CaSO₄, Ca/MgCO₃, Na/KCl, FeS₂

Lights On in cleanroom, C100
Gap in ceiling grid

Lights Off in cleanroom, C100
Light from plenum above the ceiling
The critical wipe test result of inspection scopes can establish usage and activity levels; adherence of protocol, e.g. if frequency of wipe down was performed; and contamination carry over.
After PM, critical wipe testing revealed that locations F and J had the highest levels of Sodium and Potassium, while location E had the lowest metals.
Critical Wipe Test Results of Process Tool Assembly

- Critical wipe testing identified key areas of operations contributing to cross-contamination

Critical Surface Wipe Testing can be used to determine the CAUSE during Chamber Assembly

- **Steps of Chamber Integration**
  - Parts Receiving
  - Chamber Assembly
  - Chamber Testing
  - Chamber Shipment

**Check For Contamination Sources During Chamber Assembly**

- Poor cleanroom protocols: gowing, contact with chamber
- Contaminated tools: dirty wrenches, tools to lift chamber
- Contaminated environment: walls, workbenches, hoods
- Airborne molecular contamination
- Poor Clean Manufacturing practices

**GAP ANALYSIS**

Before and After graphs showing significant reduction in contamination levels.
Contamination Mapping of Facility and Operation

- Contamination Control using Critical Wipes

- August 22, 2010
  Start: 5:55 pm (Thu)
  End: 9:15 am (Fri)

- BALAZS™ The MicroContamination Experts
Gap Analysis recommendations and action items concluded from Critical Wipe tests should be reviewed with the intent to calculate their risk posed to the product.

The “Risk” is likelihood of the occurrence multiplied by the “Effect” of the contamination hazard on the assembly or process step.

![Risk Assessment Diagram]

- **High risk** – remedial action needed – likely to be a Control Point
- **Medium risk** – remedial action needed – probably a Point of Concern
- **Low risk** – remedial action probably not needed
Summary

With knowledge of the cleanroom use and how it is maintained, **Critical Wipe Testing is capable of:**

- Rapid on-site testing for metals on critical surfaces
- Being performed in a wide range of environments
- Detect changes in surface metals on a part before and after it undergoes a process, after handling and after cleaning
- Determine the surface metals on multiple components in wafer processing equipment
- Quantify metal contamination at various locations in a cleanroom

Once a historical **Critical Wipe Test data base** has been established, a contamination event (source and cause) will reveal itself.