SW Test Workshop
Semiconductor Wafer Test Workshop

# Analysis for Pre-Mature Worn-out of Vertical Probe Needle


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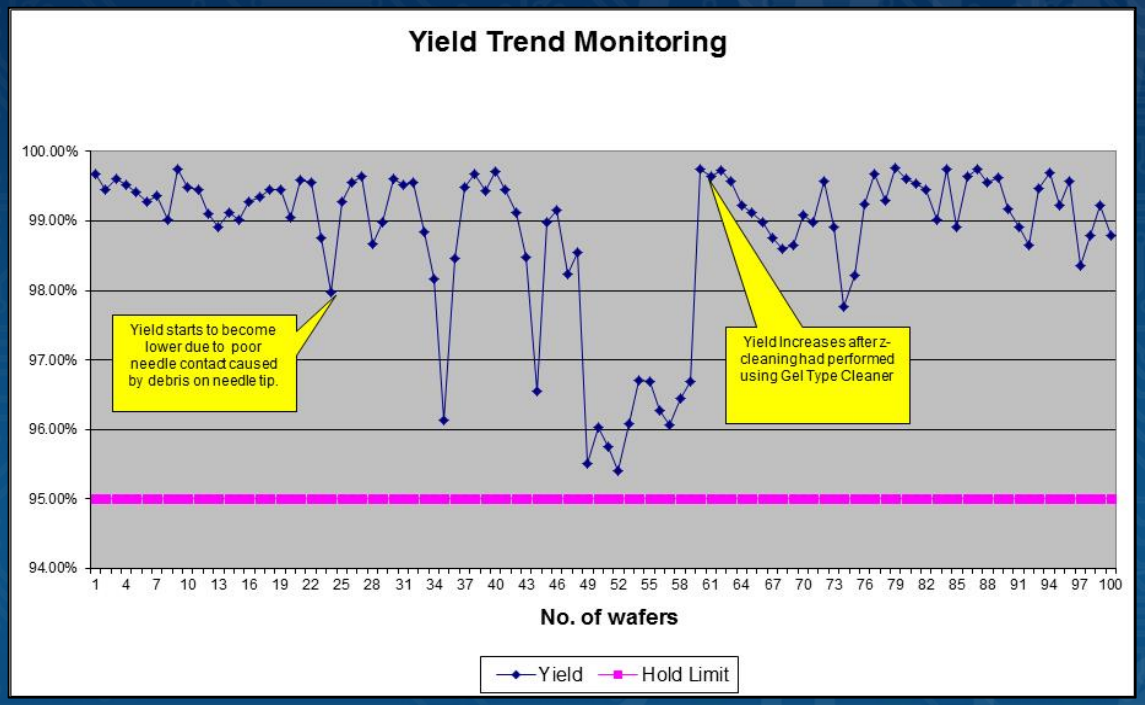
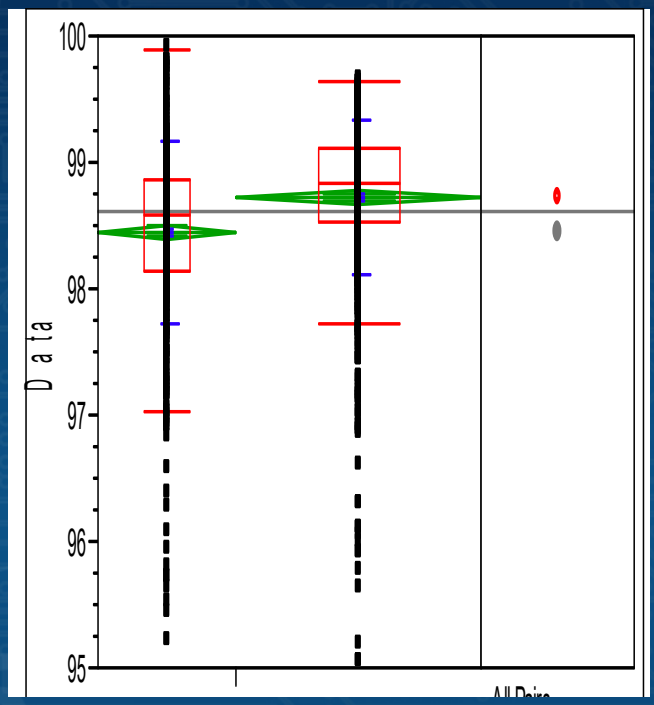
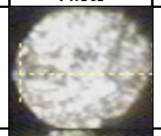
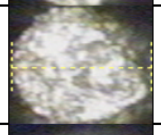
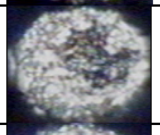
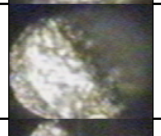
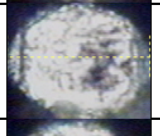
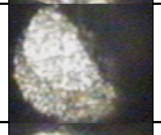
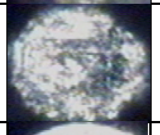
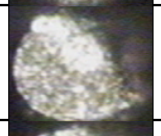
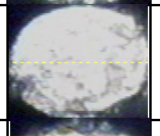
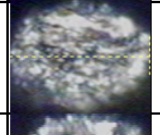
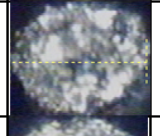
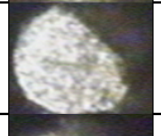
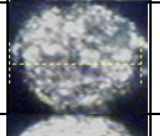
# Introduction

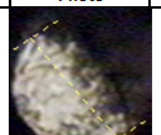
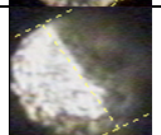
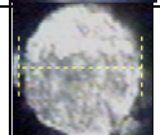
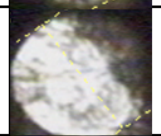
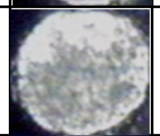
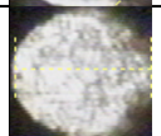
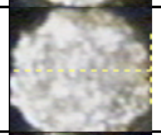



- As shown in the graph below, yield started to go below 95% after the13th wafer.
- Yield becomes more inconsistent on wafer #24 to #59.
- Yield improve on the 60th wafer after z-cleaning perform using Gel Type Cleaner

# Introduction

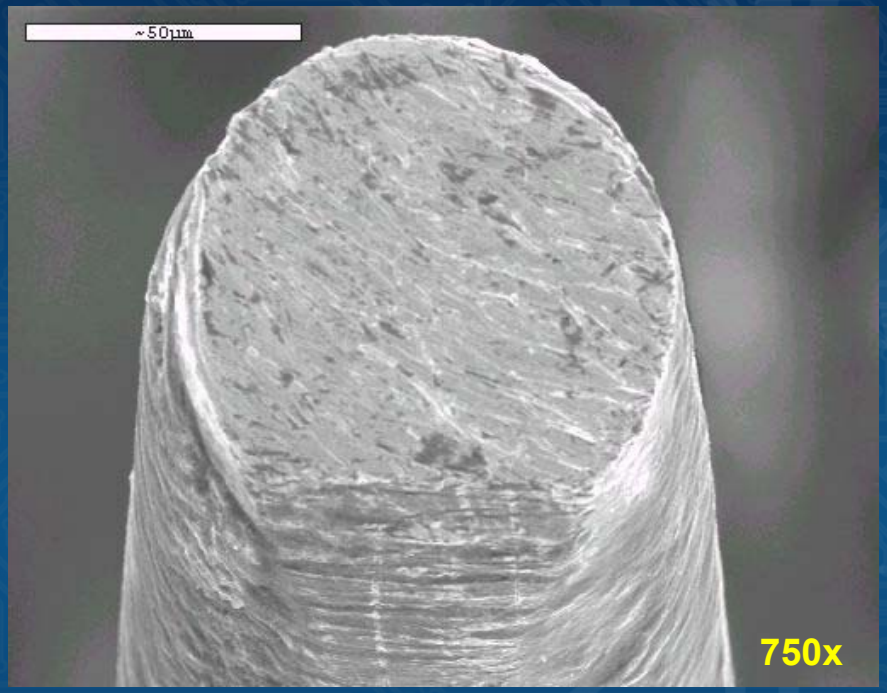
| Pad # | Pin | Configuration/Function | Before Z-Cleaning | | After Z-cleaning | |
|---|---|---|---|---|---|---|
| | | | Photo | Diameter | Photo | Diameter |
| Bondpad1 | 1 | FB |  | 0.743 |  | 0.972 |
| bondpad2 | 2 | CT |  | 0.807 |  | 1 |
| Bondpad3 | 3 | Control |  | 0.926 |  | 1.156 |
| Bondpad4 | 4 | CS |  | 0.964 |  | 1.137 |
| Trimpad1 | n/a | n/a |  | 0.908 |  | 1.055 |
| Trimpad2 | n/a | n/a |  | 0.816 |  | 1.037 |
| Trimpad3 | n/a | n/a |  | 0.835 |  | 1.156 |
| Trimpad4 | n/a | n/a |  | 0.813 |  | 0.991 |
| Bondpad5 | 5 | ZCD |  | 0.771 |  | 0.991 |

| Pad # | Pin | Configuration/Function | Before Z-Cleaning | | After Z-cleaning | |
|---|---|---|---|---|---|---|
| | | | Photo | Diameter | Photo | Diameter |
| bondpad6 | 6 | GND |  | 0.813 |  | 0.871 |
| Bondpad7 | 7 | GND |  | 0.82 |  | 0.826 |
| Bondpad8 | 8 | DRV |  | 0.792 |  | 0.982 |
| Bondpad9 | 13 | VCC |  | 0.844 |  | 1 |
| Bondpad10 | 14 | VCC |  | 0.771 |  | 0.963 |
| Trimpad5 | n/a | n/a |  | 0.725 |  | 0.908 |
| Trimpad6 | n/a | n/a |  | 0.817 |  | 0.936 |
| Trimpad7 | n/a | n/a |  | 0.733 |  | 0.945 |

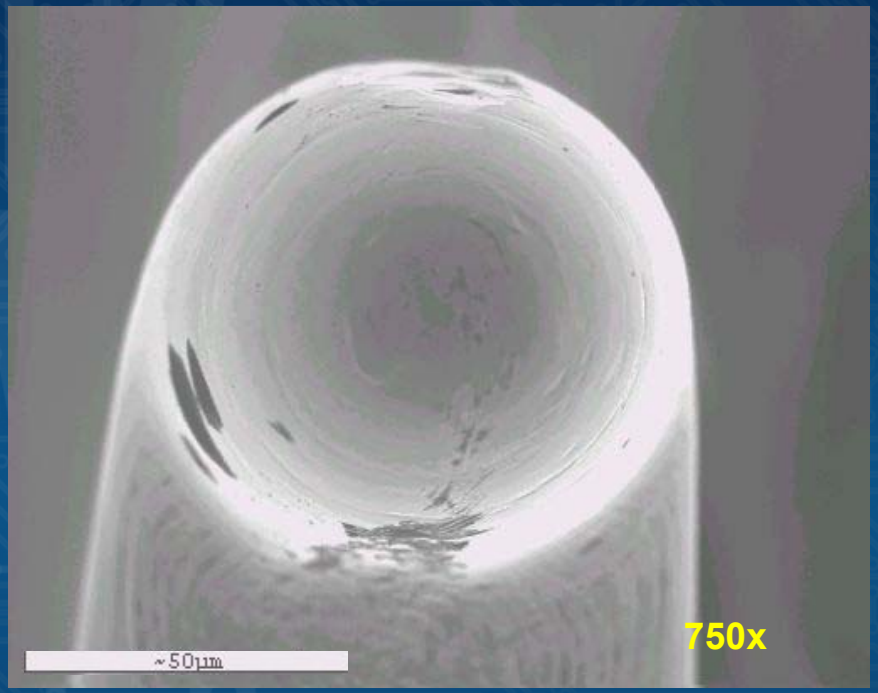
# Introduction

- Vertical needle verified to have a performance deterioration which is evident on the wafer yields.
- This deterioration is caused by needle tip deformation and debris accumulated on the needle tip which is not been removed by brush alone.
- Brush can only remove the cloudlike dirt but cannot re-shape and remove the debris on needle tip
- Yield deterioration is due to poor probe tip condition.

# Introduction

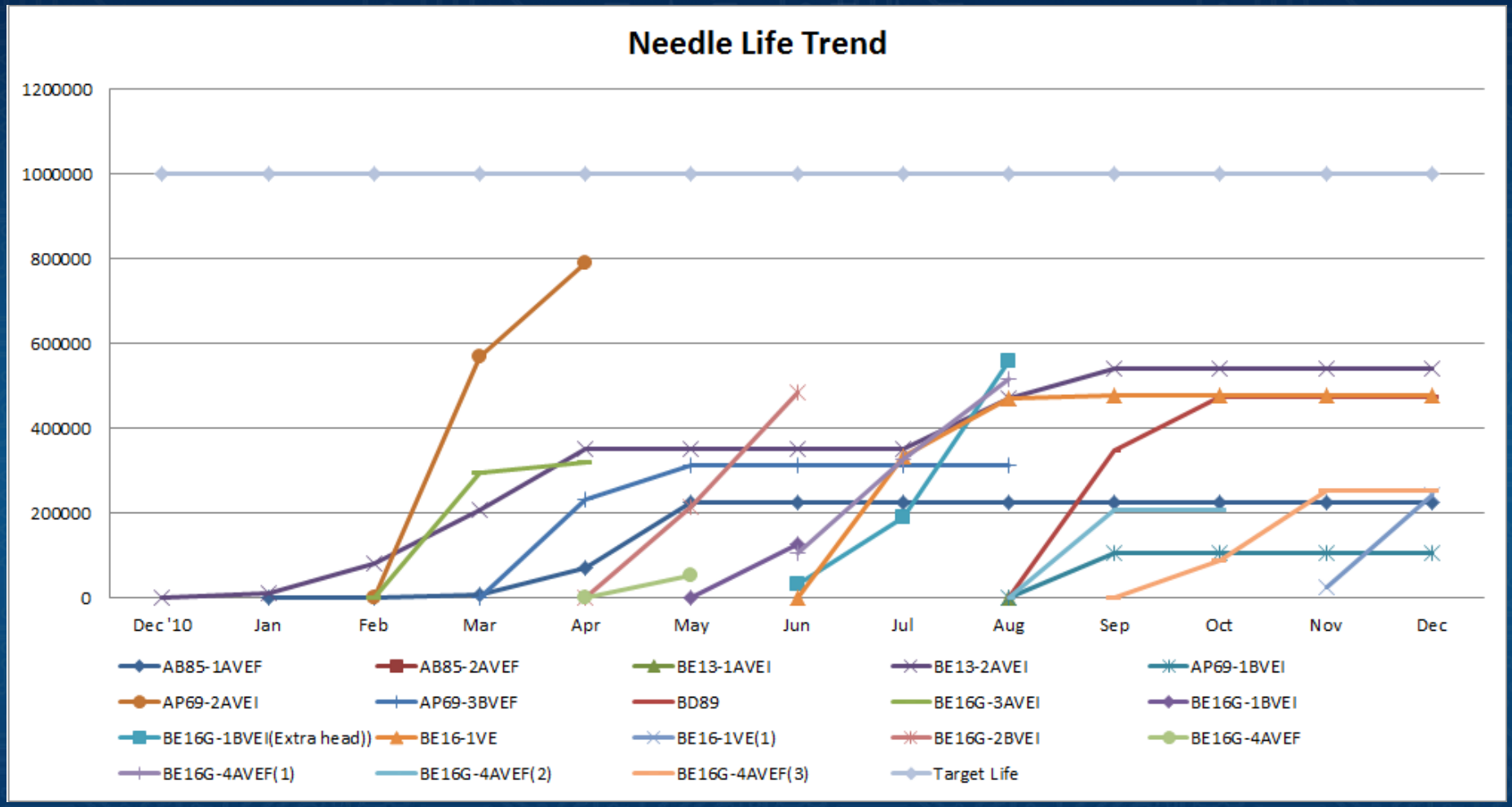



Used Probe Needle




New Probe Needle

# Introduction




**Maximum needle life recorded so far for Vertical Needle is ranging from 57,063 to 790,022 TD Count.**

# Objective/Goals

- To verify if the 1 million touchdown that OEM committed is achievable
- To determine what causes the Pre-Mature Needle Worn-out
- To formulate a solution to improve the touchdown count.

# Methodology

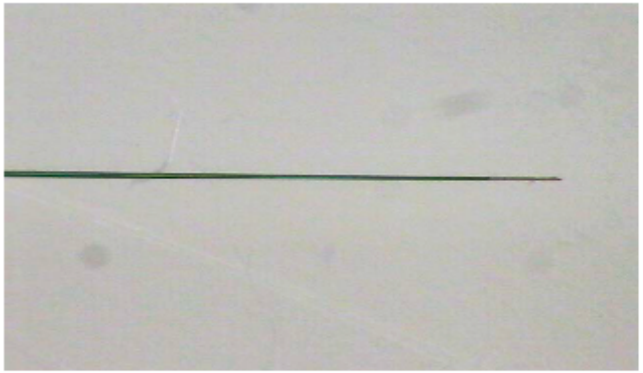
- Implement a Touchdown Monitoring System that will count the Touchdown from the Needle Start Life and End Life
- Implement In-Process Monitoring focusing on Yield and Needle Mark Quality.
- Secure the worn-out needle then submit for Material Analysis.

# Material Analysis Result for Normal Wearing

## Summary

- Probe Pins were submitted to the Material Analysis and Evaluation Laboratory for Scanning Electron Microscope + Energy Dispersive X-ray (SEM+EDX) Analysis. This is a follow up analysis w/c Pins from Site (1) and Site (2) were reported w/ early wearing problem. Pins from sites (4) and (7) were considered. SEM+EDX will verify any difference between the pins thru morphological and elemental composition analyses.

- The samples were analyzed using SEM+EDX. SEM morphologies showed no wearing problems on pin sites (4) and (7). EDX spectroscopy showed elemental composition of Silver (Ag), Palladium (Pd) and Copper (Cu) on all pins. Pins from Site (7) showed presence Aluminum (Al) w/c may actually coming from the Bonding pads of the die during testing. No Silicon (Si) were detected on Pins from sites (4) and (7) meaning the early wearing problem of pins from sites (1) and (2) were caused by the Silicon.



# Material Analysis Result for Normal Wearing

## SEM+EDX Results

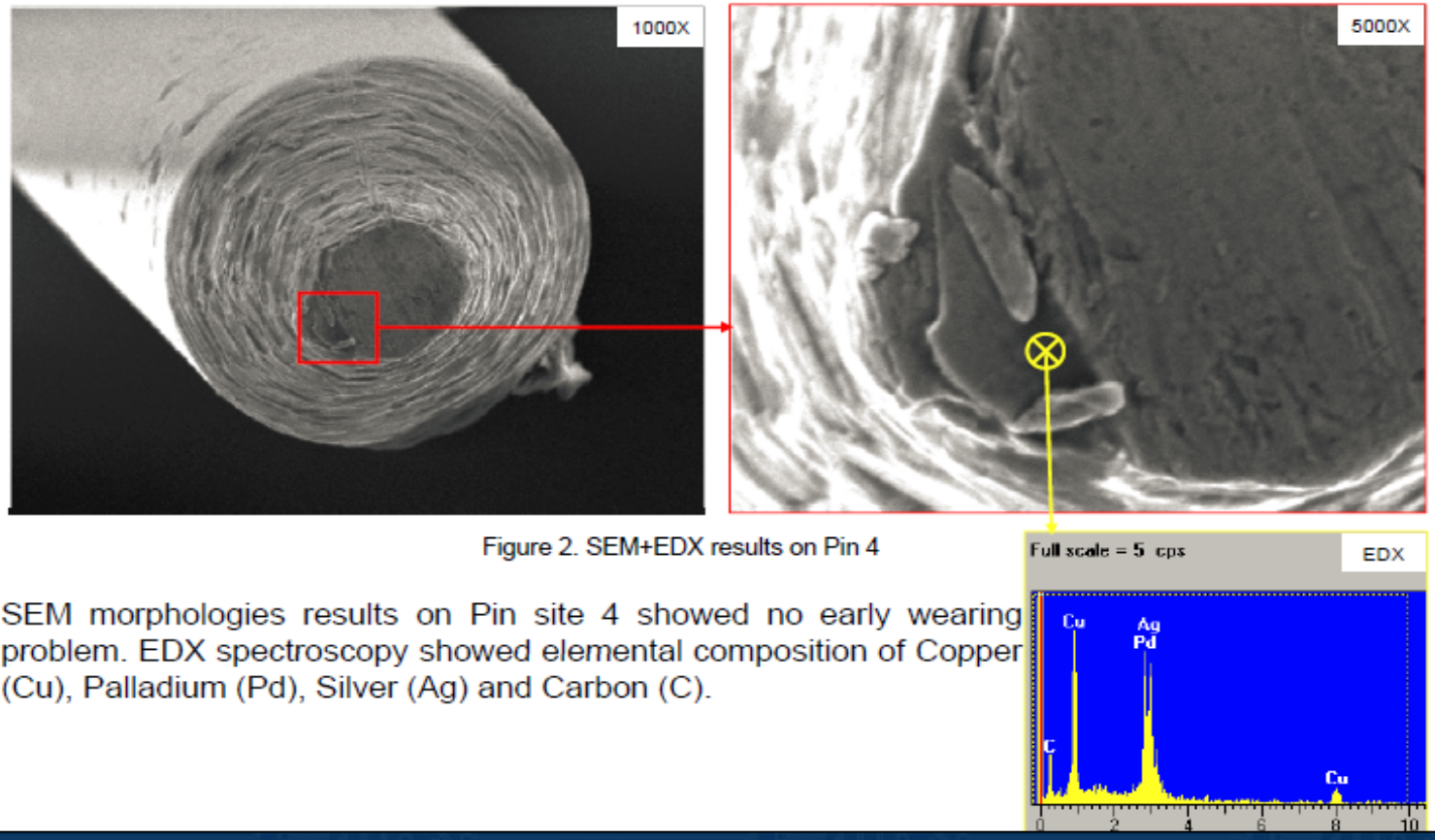



Figure 2. SEM+EDX results on Pin 4

SEM morphologies results on Pin site 4 showed no early wearing problem. EDX spectroscopy showed elemental composition of Copper (Cu), Palladium (Pd), Silver (Ag) and Carbon (C).

# Material Analysis Result for Normal Wearing

## SEM+EDX Results

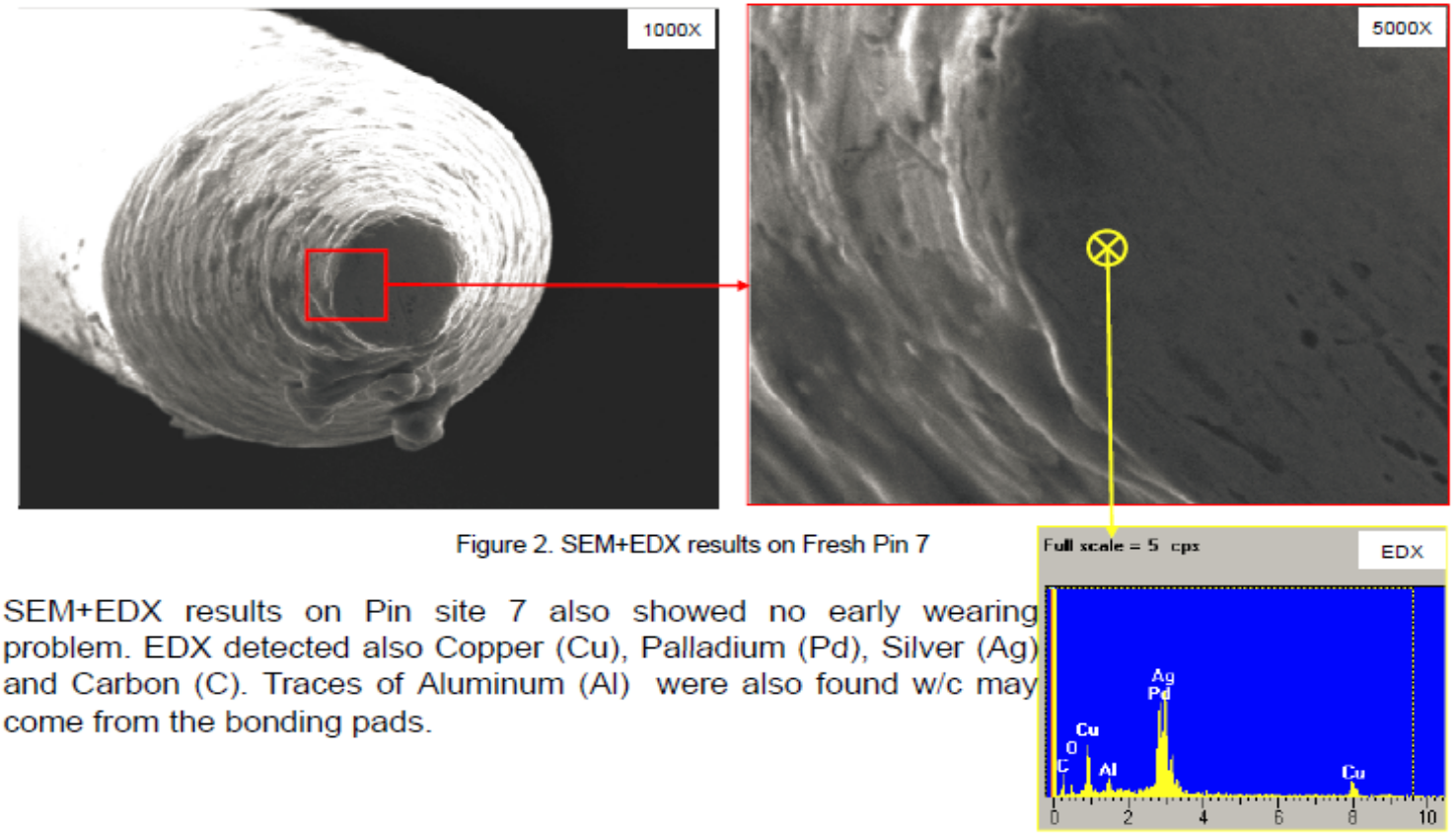



Figure 2. SEM+EDX results on Fresh Pin 7

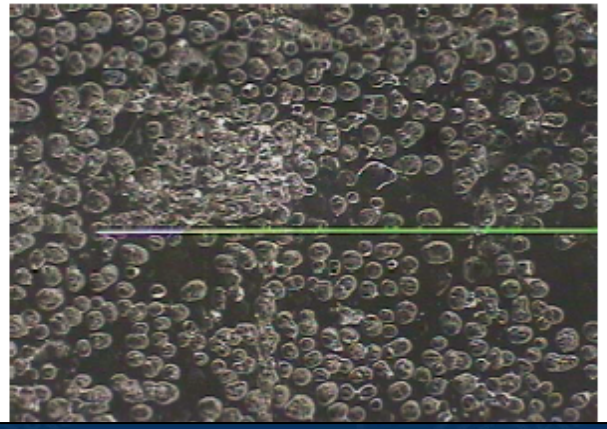
SEM+EDX results on Pin site 7 also showed no early wearing problem. EDX detected also Copper (Cu), Palladium (Pd), Silver (Ag) and Carbon (C). Traces of Aluminum (Al) were also found w/c may come from the bonding pads.

# Material Analysis Result for Early Wearing

## Summary

- Probe Pins were submitted to the Material Analysis and Evaluation Laboratory for Scanning Electron Microscope + Energy Dispersive X-ray (SEM+EDX) Analysis. Pins from Site (1) and Site (2) were reported w/ early wearing problem. A fresh pin was also submitted for correlation. SEM+EDX will verify any difference between the pins thru morphological and elemental composition analyses.

- The samples were analyzed using SEM+EDX. EDX spectroscopy showed elemental composition of Silver (Ag), Palladium (Pd) and Copper (Cu) on all pins. Pins from Site (1) and (2) showed presence of Silicon (Si) and Aluminum (Al) w/c may actually coming from the die during testing. Silicon in a form of glass or Silica (SiO2) is a harder material w/c can scratch the metallic pin during probe testing.



# Material Analysis Result for Early Wearing

## SEM+EDX Results – Fresh Pin

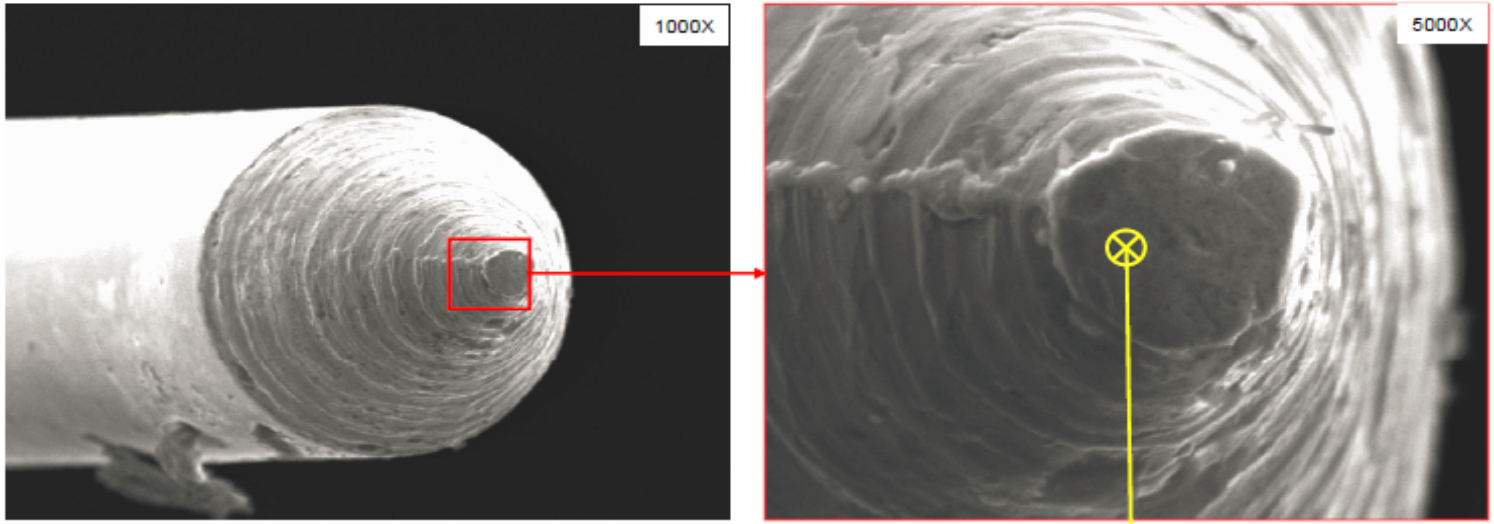
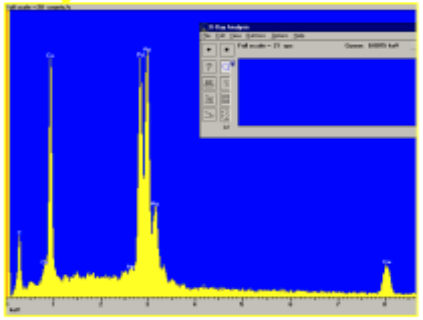


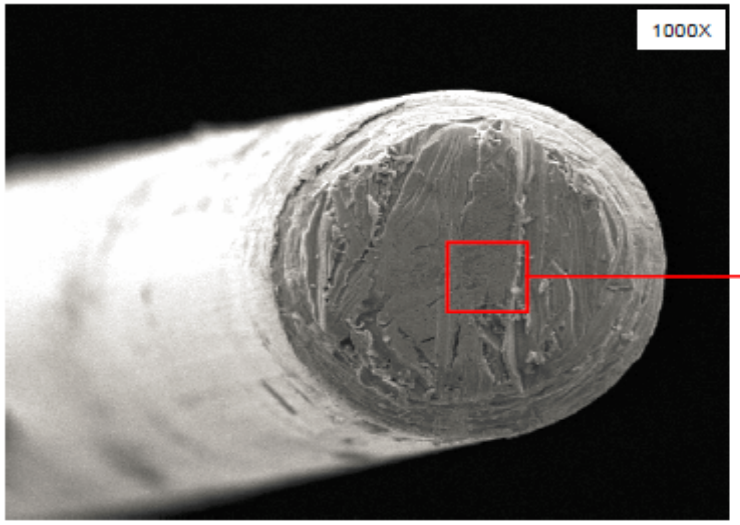

Figure 2. SEM+EDX results on Fresh Pin



SEM+EDX results on Fresh Pin showed elemental composition of Copper (Cu), Palladium (Pd), Silver (Ag) and Carbon.

# Material Analysis Result for Early Wearing

## SEM+EDX Results – Site (1) Pin



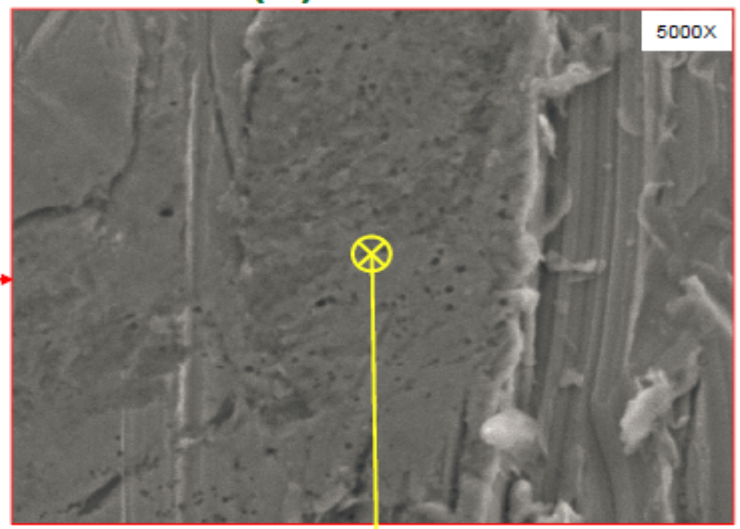
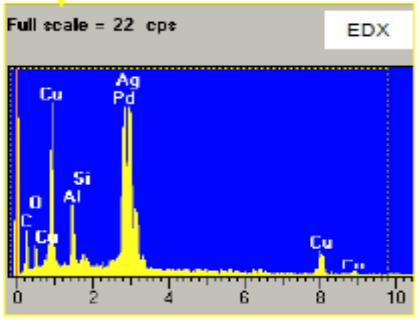




Figure 3. SEM+EDX results on Site 1 Pin

SEM+EDX results showed wear on Site (1) Pin. EDX detected presence of Aluminum (Al) and Silicon (Si) on the contact area of the pin.



# Material Analysis Result for Early Wearing

## SEM+EDX Results – Site (1) Pin

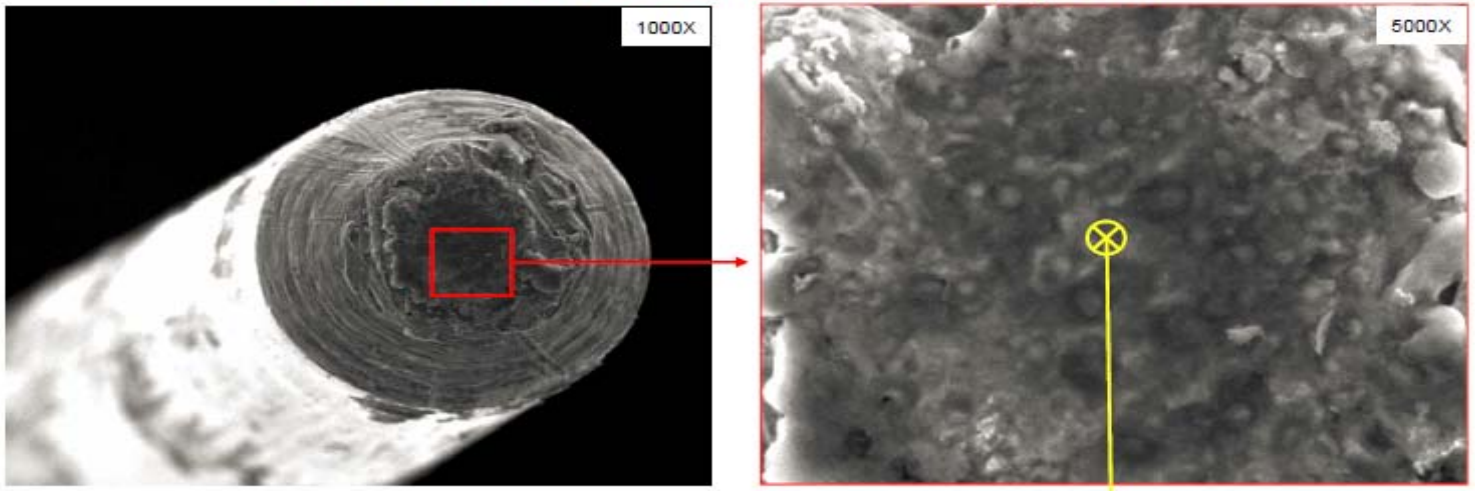
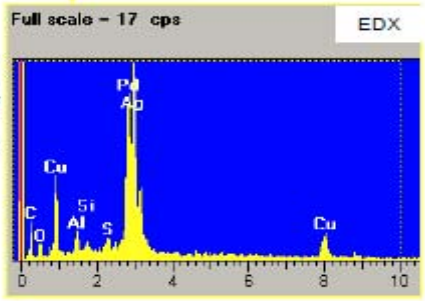



Figure 3. SEM+EDX results on Site 2 Pin




SEM+EDX results also showed wear on Site (1) Pin. Aluminum (Al) and Silicon (Si) are also present Silicon in the form of passivation/glass ($SiO_2$) is a harder material comparing to the metallic pins. The passivation can cause wear on the pins during contact.

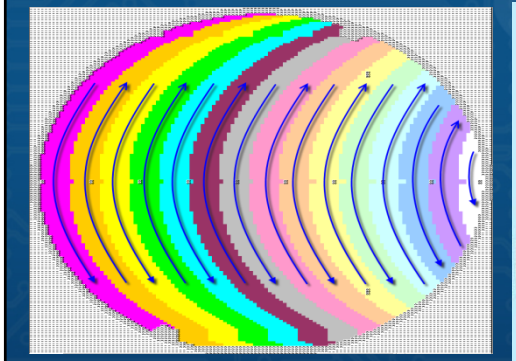
# Summary

- **Fresh Pin**
  - SEM+EDX results on Fresh Pin showed elemental composition of Copper (Cu), Palladium (Pd), Silver (Ag) and Carbon.
- **No Early Worn-out**
  - SEM+EDX results showed wear on Site (1) Pin. EDX detected presence of Aluminum (Al) and Silicon (Si) on the contact area of the pin.
- **With Early Worn-out**
  - SEM+EDX results also showed wear on Site (1) Pin. Aluminum (Al) and Silicon (Si) are also present Silicon in the form of passivation/glass ($SiO_2$) is a harder material comparing to the metallic pins. The passivation can cause wear on the pins during contact.

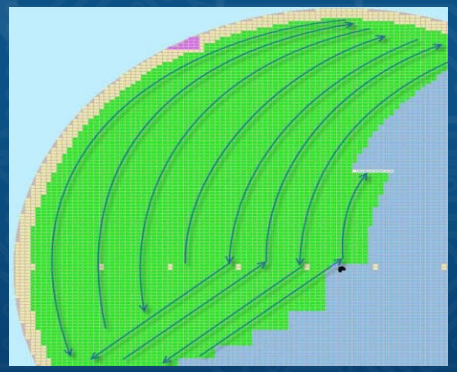
# Follow-on Work Alternative Probing Pattern

**Simulation using an Alternative probe pattern/stepping:**

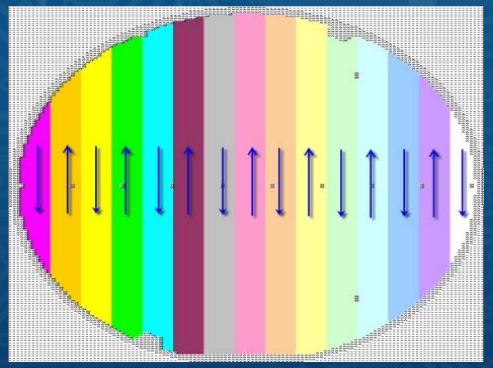
- Using an alternative probing pattern that supported by Mapping System
- Probing pattern now stepping on the y-direction but following the contour of the wafer edge



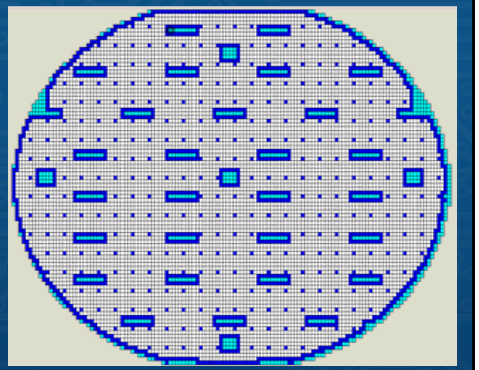
Crescent Pattern 1



Crescent Pattern 2



Column-Block



Smart Sampling