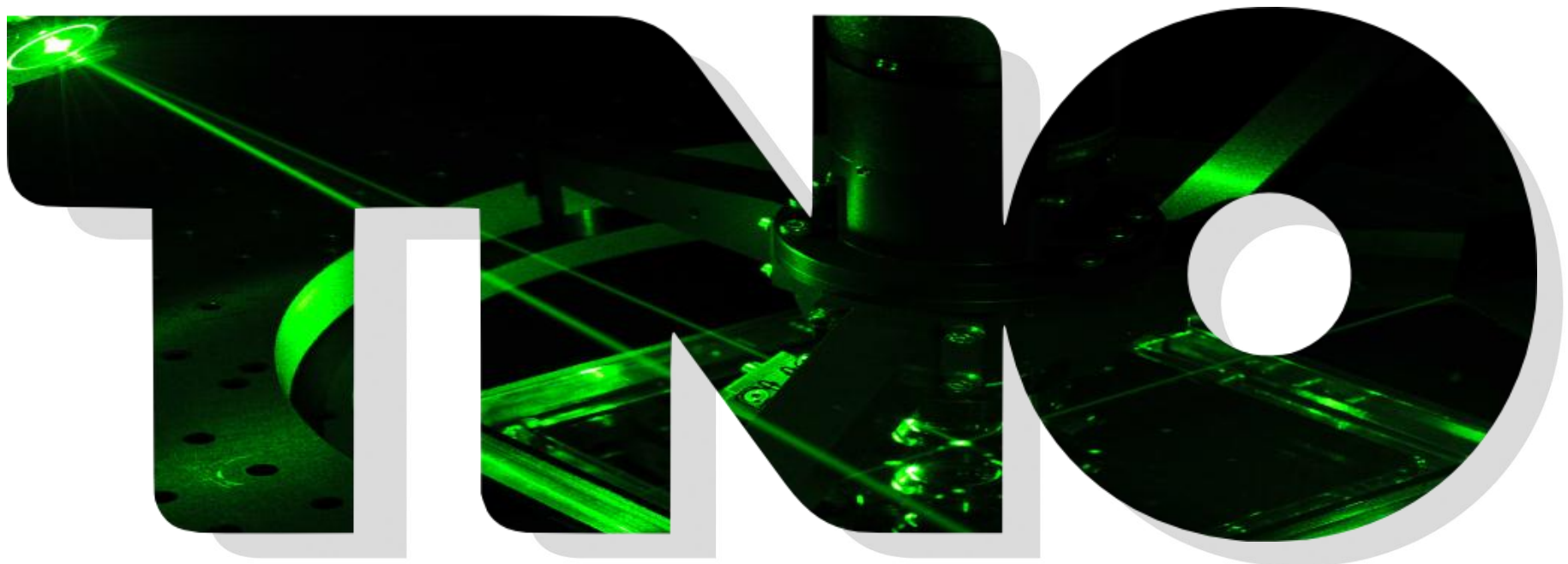




Qualification of particle free EUV equipment

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Jacques van der Donck, Sjoerd Oostrom,
Peter van der Walle, Bert van der Zwan





Contents

- › Background
- › Qualification set-up
- › Root Cause Analysis
- › Summary



Examples from HamaTech InSync tool

- › Examples will be shown from the qualification procedure of the HamaTech InSync tool.
- › Several stages of development
- › Data are not representative for final performance



See also: O. Brux, P. van der Walle, J.C.J. van der Donck, P. Dress, “Investigating the intrinsic cleanliness of automated handling designed for EUV mask pod-in-pod systems”, SPIE Vol.8166-95, 2011



Background

Particles have a high impact on EUV reticle functionality (yield/overlay) and scanner uptime.

Equipment for handling of EUV reticles must meet strict requirements on cleanliness.

The equipment must be qualified and monitored to guarantee performance.



Qualification procedure

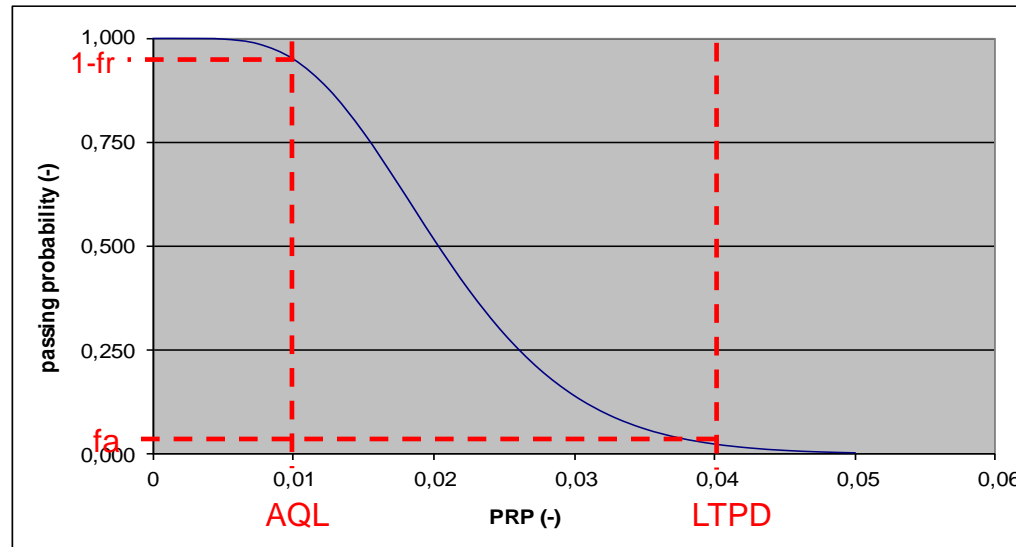
The following items should be covered before actual testing commences:

1. Set requirements
2. Arrange equipment
3. Map routing & identify critical steps
4. Measure environment contribution
 - Transport and handling between inspection equipment and tool to be qualified
5. Determine test plan from routing



Set Requirements

- › Define max PRP number, particle size
- › Average PRP level, define uncertainty levels



HamaTech InSync < 2 particles / 25 cycles

→ $PRP_{\max} < 0.08$, $PRP_{\text{average}} = 0.01$



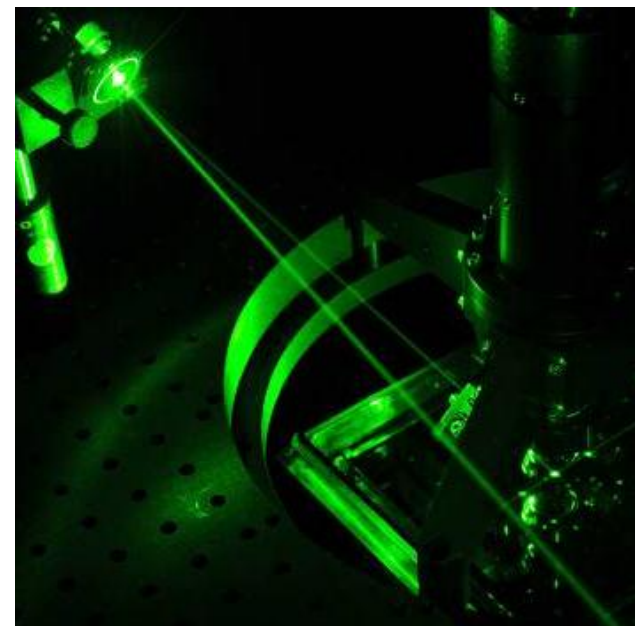
Arrange equipment

All qualified on cleanliness

- Cleanroom
- Particle measurement equipment
- Dual Pod carrier
- Reticle substrate

Hamatech InSync tool

- RapidNano1
- DualPod type A
- ML blank (courtesy Rik Jonkheere, IMEC)

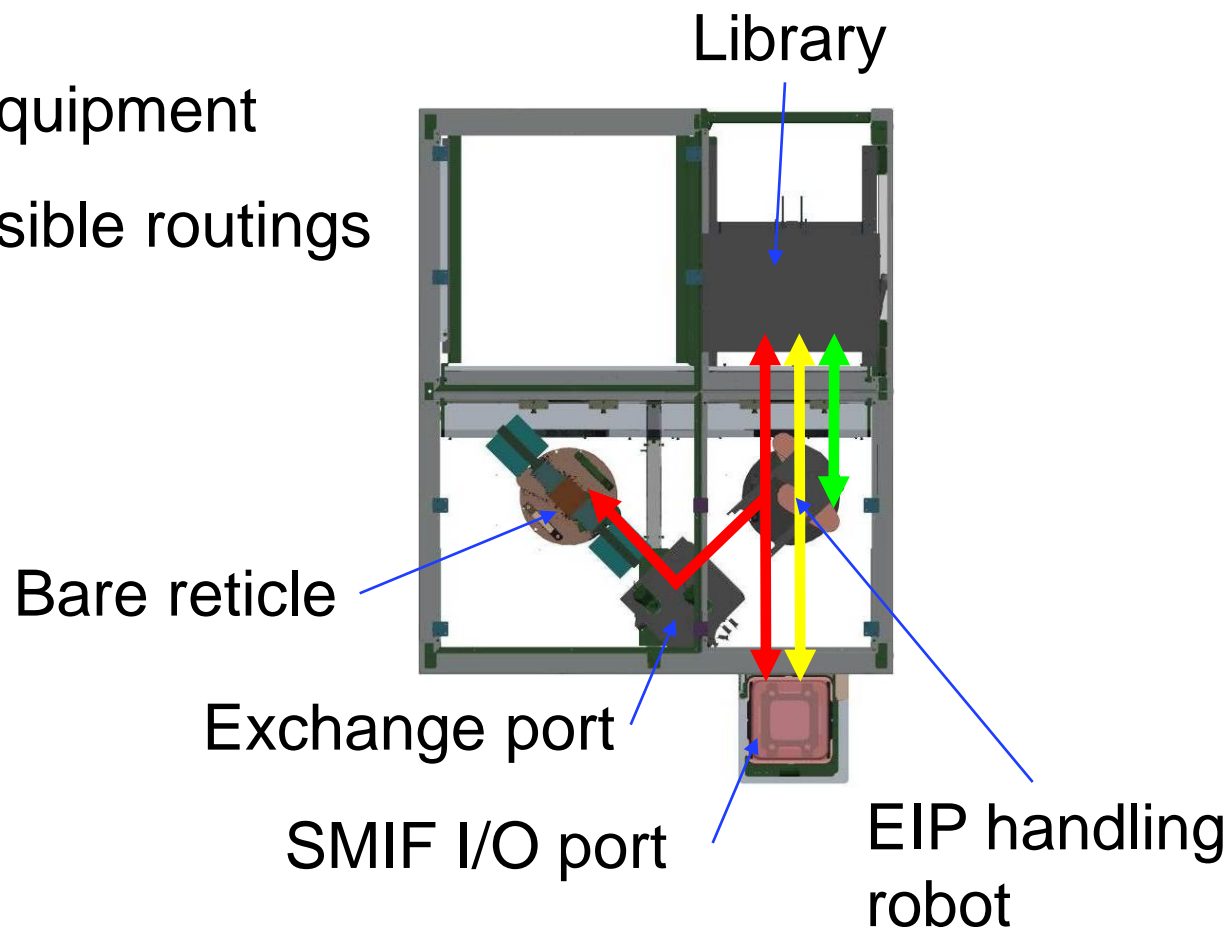




Map Routing

- Describe equipment
- Define possible routings

HamaTech InSync

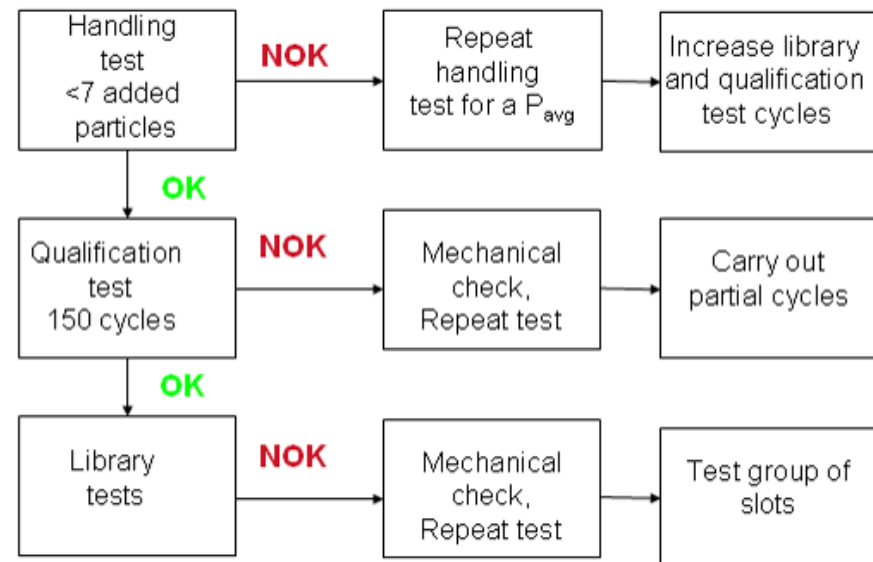




Test plan

- Select most relevant routings and determine test sequences
- Make a decision tree

HamaTech InSync



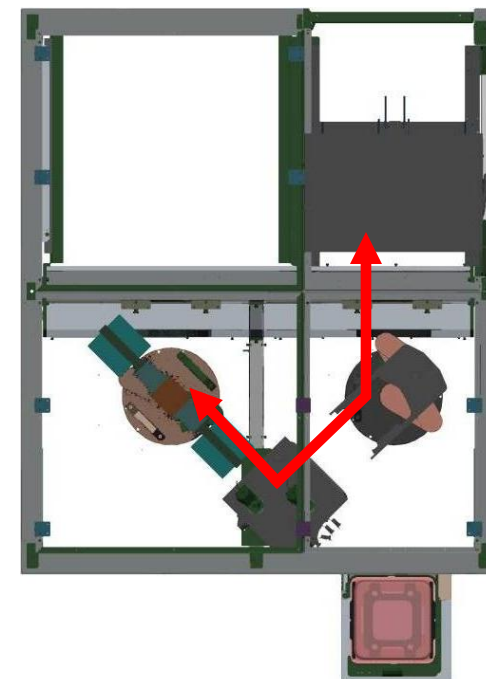
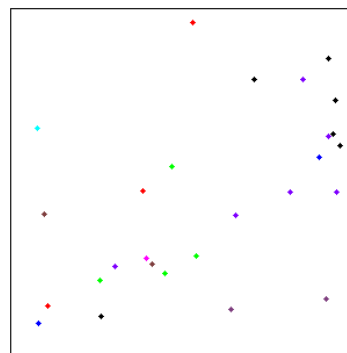
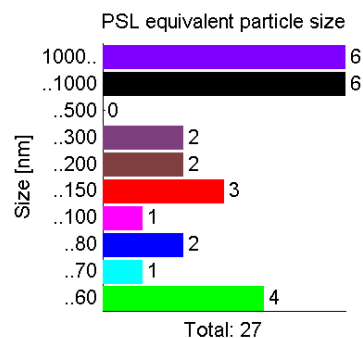


Root Cause Analysis

- Goal: identify particle sources
- Methods:
 1. Visual inspection
 2. Isolation tests
 3. Particle analysis

HamaTech InSync

Added particles
after 144 cycles





Root Cause Analysis (2)

1. Visual inspection of units and alignments

Observation:

Exchange port door closed too fast.

Cause:

Defect locking pin caused release of a nut and misalignment of exchange port door.

Solution:

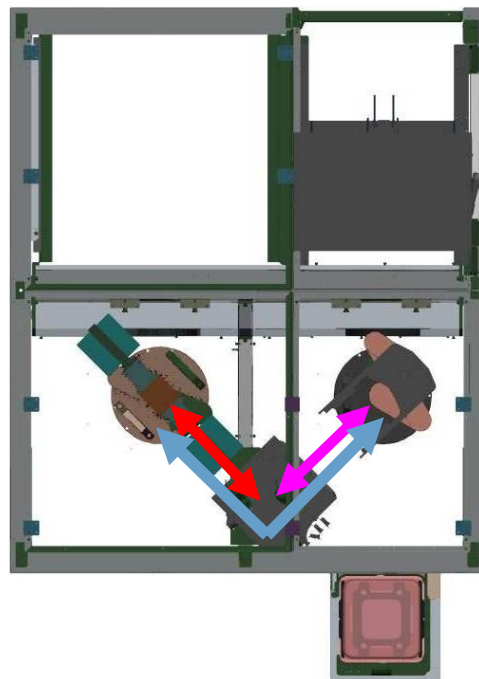
Mechanical fix of locking pin and realignment of exchange port door.



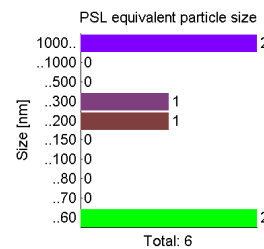
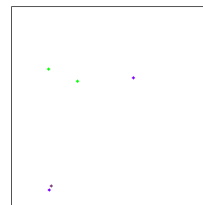
Root Cause Analysis (3)

2. Isolation tests

Issue solved

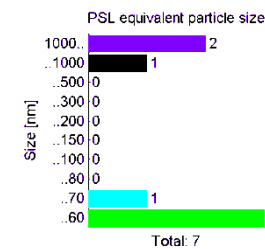
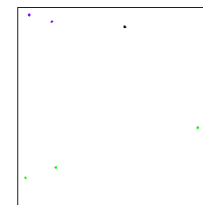


Run. A



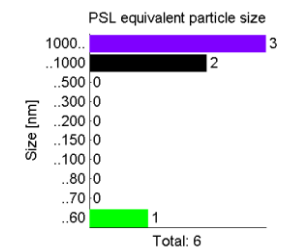
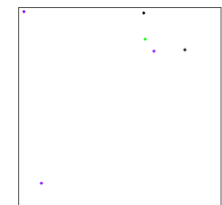
Cycle # = 641

Run. B



Cycle # = 575

Run. C



Cycle # = 296

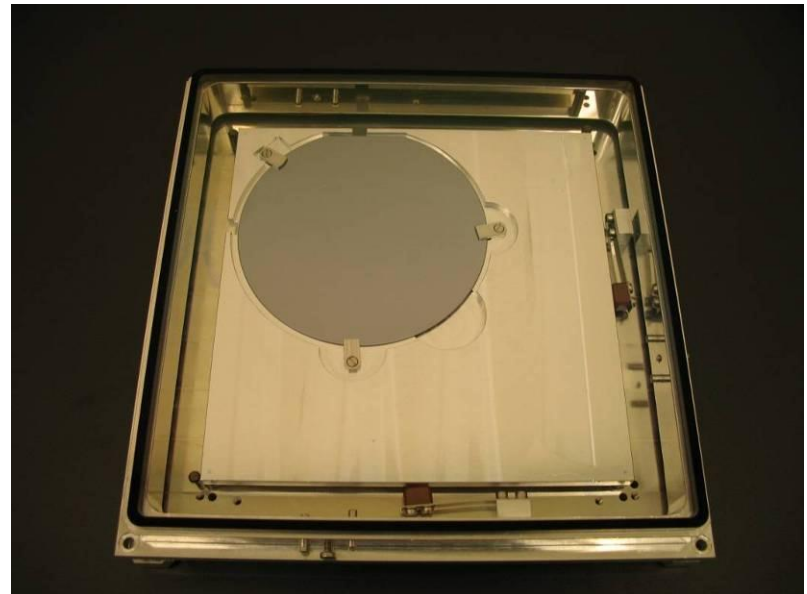


Root Cause Analysis (4)

3. Particle analysis

Dummy reticle with wafer was used to collect particle adders during cycling

- Material analysis of added particles by SEM-EDX





Root Cause Analysis (5) HamaTech InSync

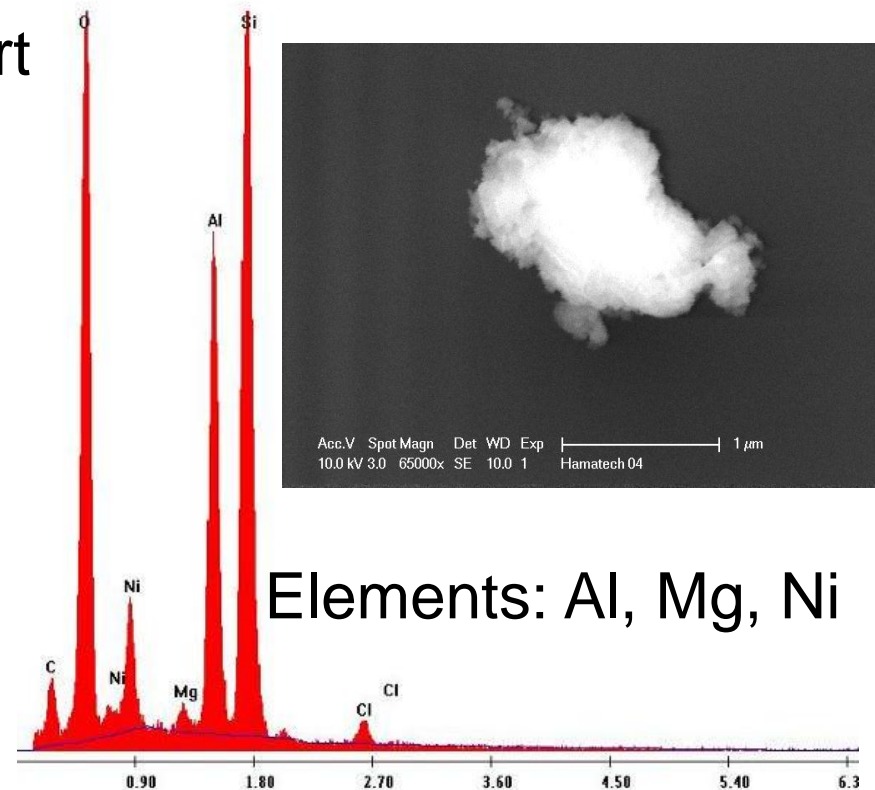
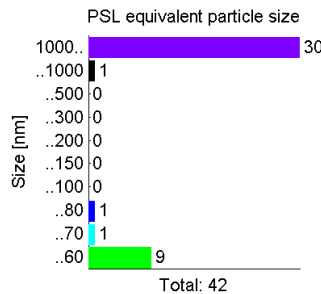
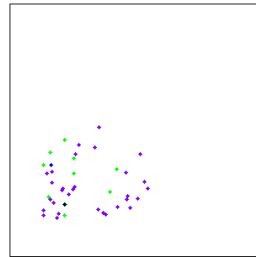
Observations:

- Particles added on backside
- Added in Exchange Port

SEM-EDX

Collect particles:

- dummy reticle
- face up
- 605 cycles

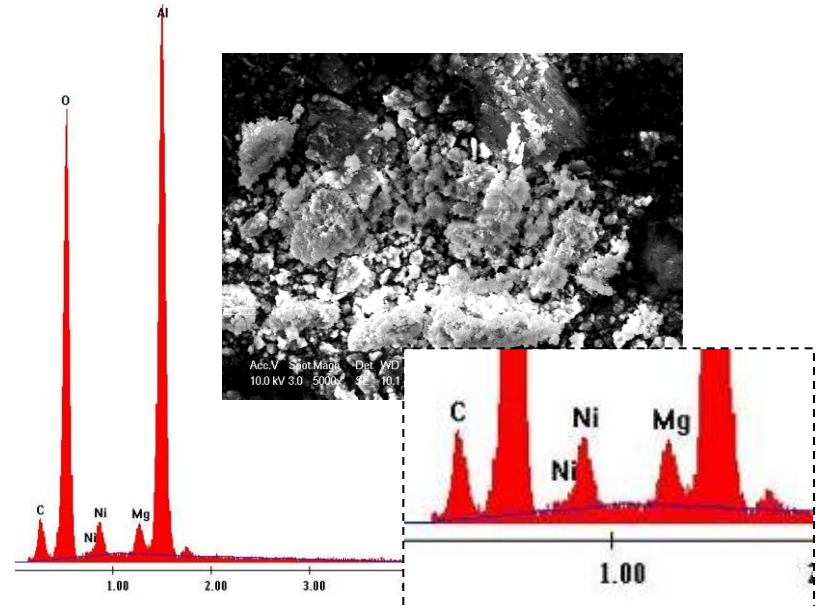
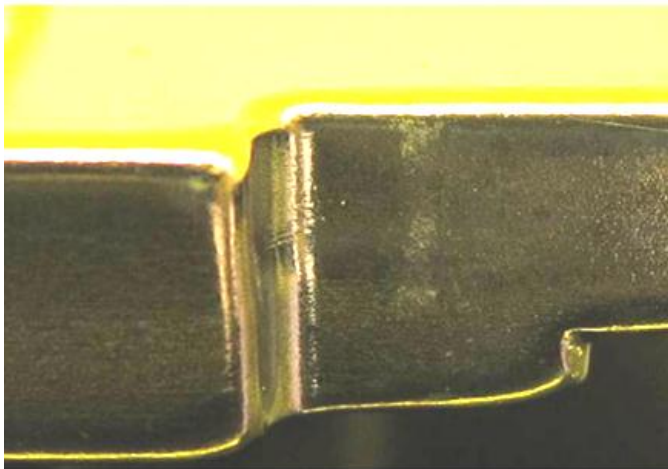




Root Cause Analysis (6) HamaTech InSync

NO Ni-containing components in InSync Exchange Port

Wear marks on EIP bottom Particles from wear marks



- Same Al/Mg ratio and Ni
- Match between particles and material of EIP
 - Wear of Inner Pod causes particle deposition on reticle backside



Summary

Method for particle qualification has been presented

1. Set requirements
2. Arrange equipment
3. Map routing & identify critical steps
4. Measure environment contribution
5. Determine test plan from routing
6. Run tests

Have a strategy and (access to) required tools for
root cause analysis / particle source analysis



Acknowledgement

Süss HamaTech is thanked for releasing data which were used as examples.

Thank you for your attention