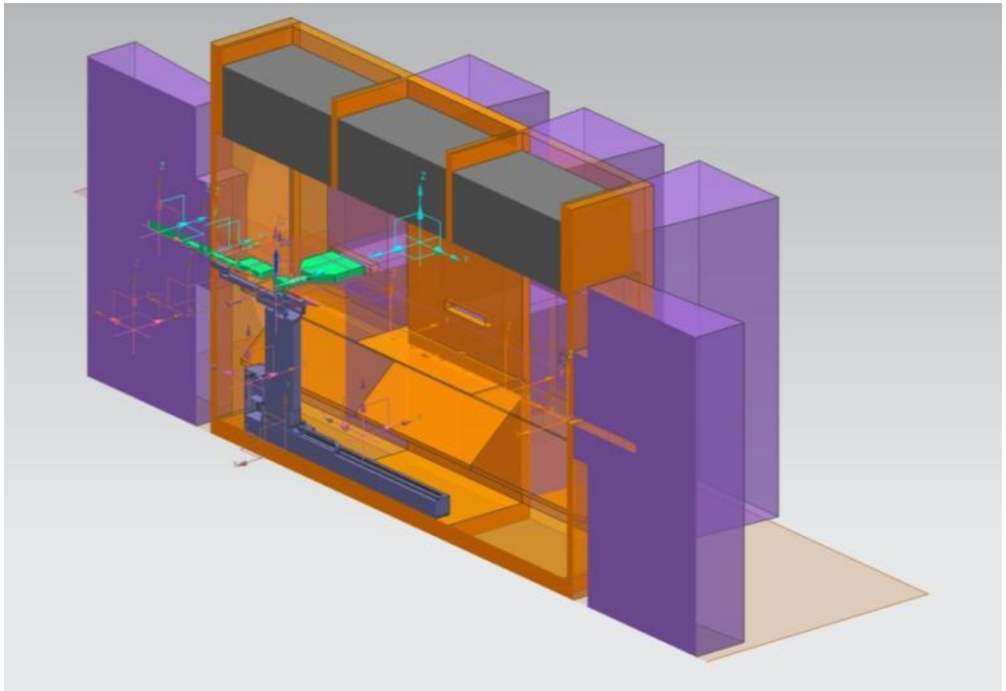
Shared Development Platform for Particle-Free Reticle Handling

- Roland van Vliet – Program Director Semicon

- September30, 2012 - MASK TWG Brussels

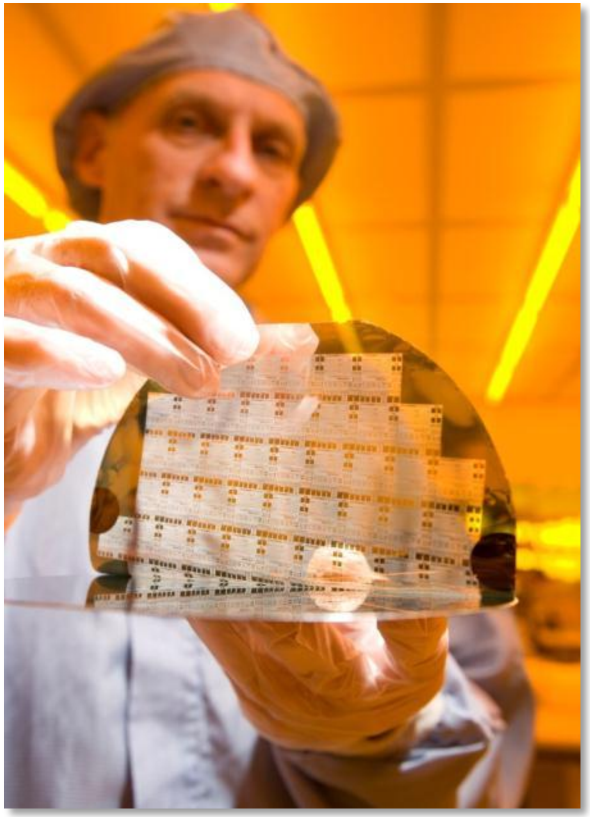



TNO for High Tech Industry

- TNO uses a number of expertise (e.g. mechatronics, optics, contamination control, materials science, nanofabrication, system architecture) to develop new production technologies, enhance quality, reduce costs and improve efficiency.

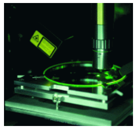
- TNO focusses on
  - Productivity, Performance, and Lifetime of equipment for the semicon industry

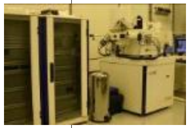
- One of the grand challenges 2005-2015:
- Handling and storage of reticles for EUVL

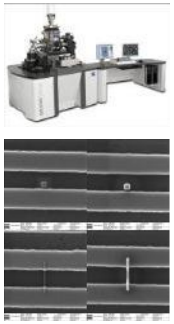


The life cycle of an EUVL reticle: TNO contributions

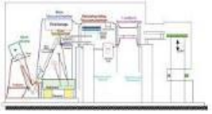
- blank production
- patterning
- pattern repair
- pattern inspection
- cleaning
- transport
- handling
- clamping
- conditioning in stepper

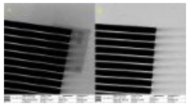


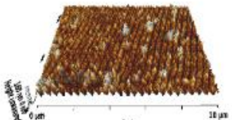


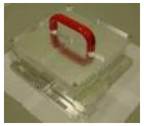


(SPIE 2011)









A history in reticle handling at TNO

Erik Ham[1], Jacques van der Donck[1], Bas Mertens[1], Rob Snel[1], Michiel Oderwald[1], Rob Lansbergen[1], Hans van den Berg[1], Hans Meiling[2], Henk Meijer[2], Ton Nabben[2], Roel Moors[2], Brian Blum[2],

Progress in particle-free handling of reticles in the ASML EUV program

Introduction

Controlling particle contamination of reticles is one the major challenges for EUV lithography. Within the ASML EUV program, TNO and ASML have co-developed strategies to prevent particle contamination on reticles during handling and storage near the tool and during reticle loading inside the tool. This poster presents a status overview.

Strategy to develop particle contamination control in the ASML EUV tool

- Minimize particle generation:
  - Minimize number of contacts (by design: use a frame)
  - Choose materials that produce low numbers of particles through contact (get knowledge through basic experiments)
- Prevent particle migration
  - By design
  - Proper pumping / venting sequences (develop through experiments)
- Build test rigs and FuMos before doing the final hardware

Reticle Handler for ASML EUV tool

Experimental results are turned into hardware

Particle contamination control experiments results

Procedure:

1. Measure # of particles on reticle [particle scanner]
2. Transfer reticle from particle scanner tool to storage box *[manual action]*
3. Load/ unload reticle in EUV tool
   - open Storage Box & LL pumpdown
   - robot transfer from LL to RH chamber
   - move to AD Main Chamber RS load position
   - clamp to AD RS & scan
   - return to LL & close storage box
   - vent LL to atmosphere
4. Transfer reticle from storage box to particle scanner tool *[manual action]*
5. Measure # of particles on reticle

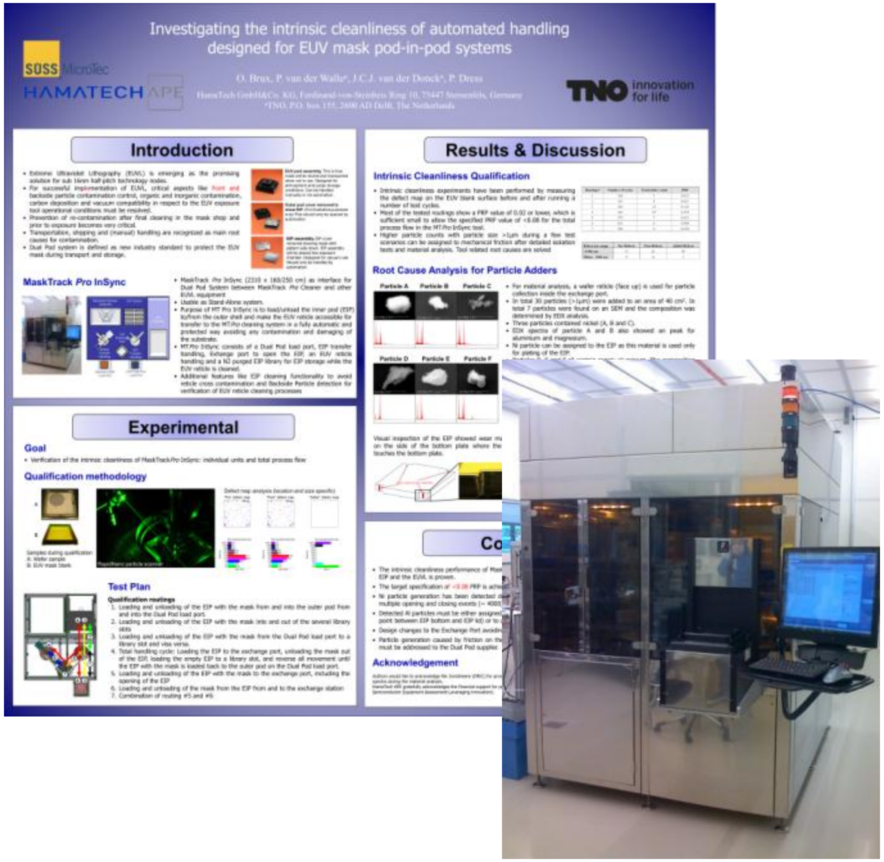
Particle Scanner

A particle scanner is developed to detect particle contamination at a reticle. The scanner detects particles of 75 nm and larger. Imaging software determines number, size and location.

Future work

- Collect more data for stat
- centre of reticle
- Use real reticle blanks
- Improve particle scanner
- (scan 60nm particles on
- Perform reticle transport

TNO Science and Indu



Investigating the intrinsic cleanliness of automated handling designed for EUV mask pod-in-pod systems

O. Brux, P. van der Walle*, J.C.J. van der Donck*, P. Dress

Introduction

MaskTrack *Pro* InSync

Results & Discussion

Intrinsic Cleanliness Qualification

Root Cause Analysis for Particle Adders

Experimental

Goal

Qualification methodology

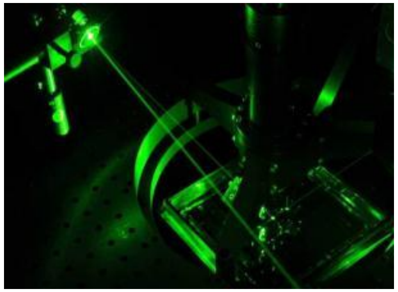
Test Plan

Acknowledgement

EUVL 2005 → SPIE 2011

Our experience…

Particle Detection:
- *RapidNano*

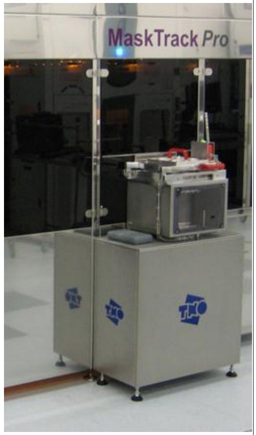


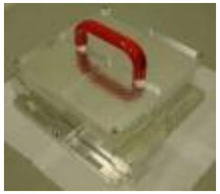
3. Monitoring

1. System Analysis

2. Prevention

4. Cleaning



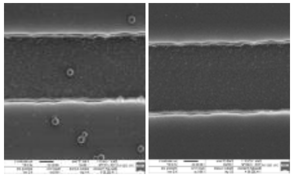


Storage boxes

Reticle handlers:
- *ADT*
- *Hamatech InSync*

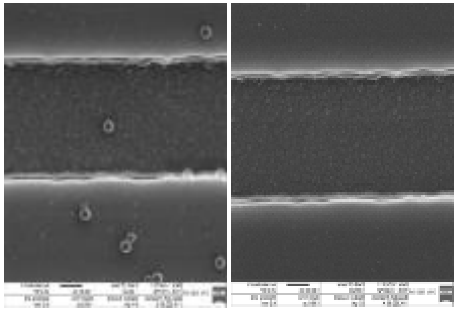
Critical components have a cleanliness level of PRP = 0.02

- *(Miniature) plasma heads, CO_2 snow*



…and feedback from industry..

- No standard in handling equipment
- No qualified atmospheric robot
- No qualified vacuum robot (only proprietary)
- No generic knowledge on particle-free design
- No generic knowledge on material selection
- No generic solution for contamination-free storage
- No independent qualification facilities

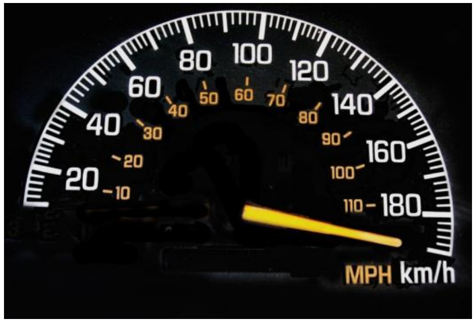


…lead to a TNO initiative

- Set an open standard in reticle handling and storage

- Open for partners to join
  - in development and application
  - in qualification of their equipment and processes

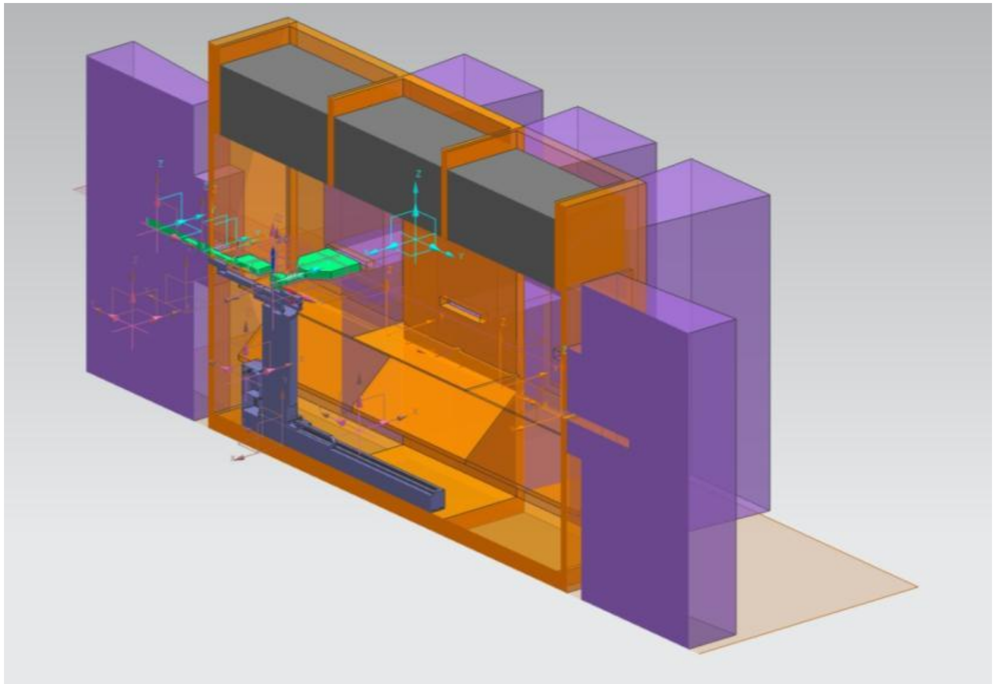
- Leading to
  - Shorter time to market
  - Reduced risk
  - Reduced development cost
  - Increased independent expertise/knowledge



To kick-start this

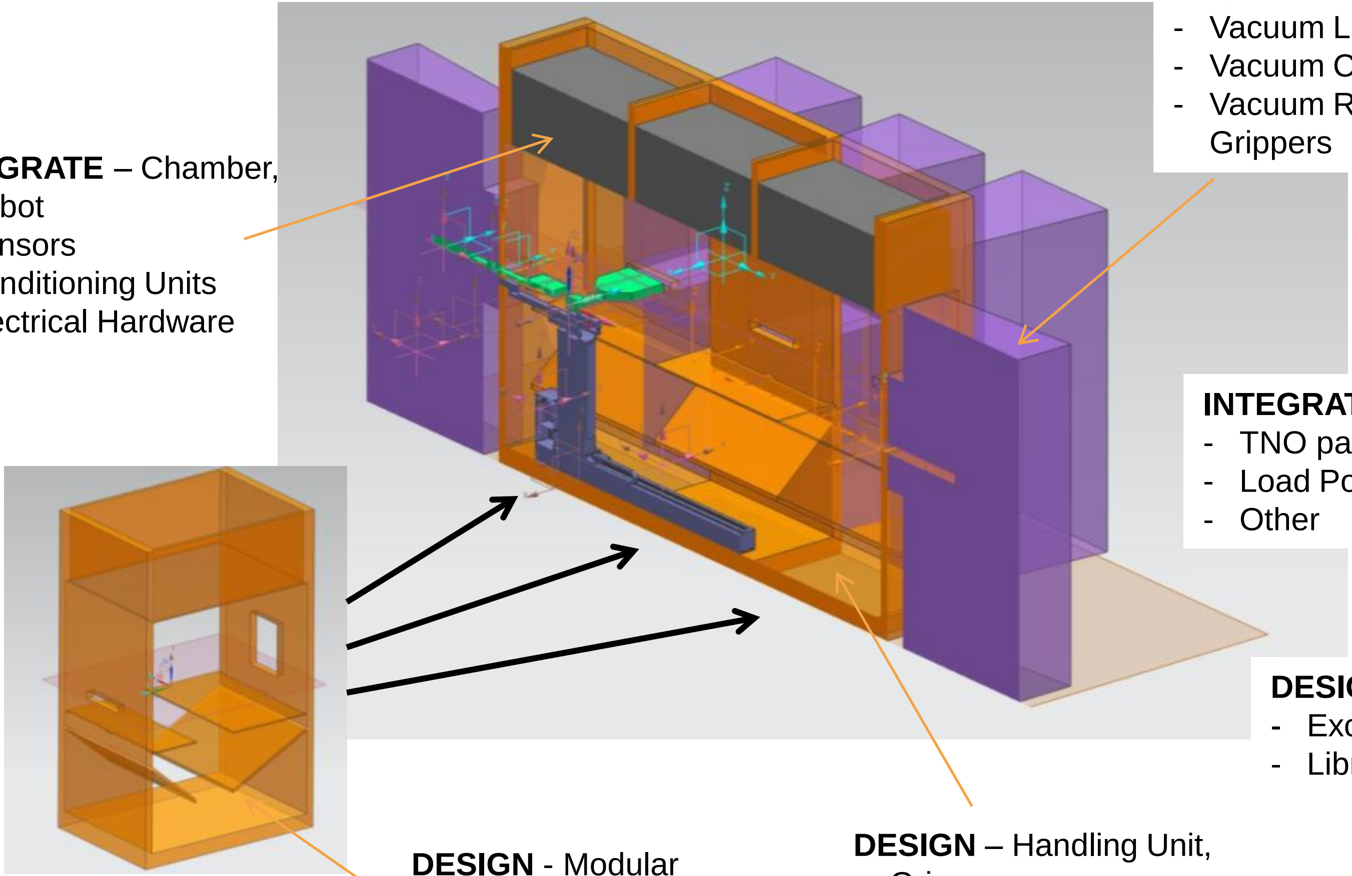
TNO invests in the development of a generic EUV reticle handler which

- can transfer an EUVL reticle from Single Pod or Dual Pod to processing unit and vice versa
- can in the near future easily be combined with other equipment for R&D and qualification (cleaners, load locks, vacuum robots, particle scanner…)



Concept design Particle-Free Reticle Handler

Design/Integration Activities



INTEGRATE – Chamber,
- Robot
- Sensors
- Conditioning Units
- Electrical Hardware

DESIGN – External Systems,
- Vacuum Load Lock (Phase 5)
- Vacuum Chamber (Phase 6)
- Vacuum Robot (Phase 7) + Grippers

INTEGRATE – External Systems,
- TNO particle Scanner (Phase 2)
- Load Port (Phase 2)
- Other

DESIGN – Internal Systems,
- Exchange Port (Phase 2)
- Library (Phase 3)

DESIGN - Modular chamber, allowing the chamber to be easily scaled.

DESIGN – Handling Unit,
- Grippers
- Chamber
- Doors
- Flip Tool

Phase 1 to be completed end Q1, 2013

Setting a standard on particle-free handling

- Translate general knowledge to practical design rules

1 System Analysis

- Performing a system analysis
- Contamination Error Budgeting
- Qualification
- COTS Equipment knowledge

2 Prevention

- Sources / Transport / Deposition
- Material Selection
- Wear, Making/Breaking Contacts, Sliding, Pressure
- Mechanisms, Bearings, hinges, actuators, Seals
- Environment (shock, velocity)
- Flow, Diffusion, Gravity

3 Monitoring

- Monitoring/Detection Techniques
- Designing for monitoring

4 Cleaning

- Molecular Cleaning Techniques
- Particle Cleaning Techniques
- Designing for cleanliness

Summary

- An open standard on particle-free reticle handling & storage is needed
  - Shorter time to market
  - Reduced risk
  - Reduced development cost
  - Increased independent expertise/knowledge

- Therefore TNO initiated a shared development program
  - generic EUV reticle handler which meets demands of 2016
    - first phase completed end Q1, 2013
  - Co-create and qualify equipment and processes

- You are invited to join this program!