Mask maintenance cycle for EUV masks with pellicle
Cleaning tool supplier perspective

EUV Mask Pellicle TWG
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Jens Krümberg, Oliver Brux, Peter Dress, Uwe Dietze
+ Introduction
+ Pellicle related mask maintenance challenges
+ Summary
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+ Summary
+ From 2009 to 2012, SUSS, in close cooperation with other industry partners, developed solutions for pellicle less EUVL mask maintenance. Project names were EXEPT and SEAL.
Advantages
+ Fast turn-around
+ Decreased risk of particle adders
+ No environmental trace deposition
+ In-line data collection, analysis and use

Maximized MTBC & Increased Reticle Life → Reduced Cost
Mask maintenance cycle for EUV masks with pellicle

Introduction

+ Mask cleaning challenges for EUV masks without pellicle
  + EUV mask front-side cleaning process (100x) without influencing the mask printing quality (→ EXEPT)
  + EUV mask back-side cleaning (→ SEAL)

EUV mask backside cleaning

- Backside particles cause mask distortion and image placement errors (IPE)
- Backside Inspection is necessary to eliminate scanner contamination
- Particle size detection of < 500nm @ a dynamic capture rate > 95% is critical
- Inspection of entire backside (152mm x 152mm) is a prerogative

EUV Mask Maintenance Infrastructure

+ Maintenance cell

RISK OF BACKSIDE PARTICLE CONTAMINATION

EUVL MASK MAINTENANCE INFRASTRUCTURE
Mask maintenance cycle for EUV masks with pellicle

Agenda

+ Introduction
+ Pellicle related mask maintenance challenges
+ Summary
Pellicle on EUV mask introduce additional challenges for mask cleaning

Cleaning of EUV masks without pellicle is solid background and prerequisite for addressing new challenges

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**Mask maintenance cycle for EUV masks with pellicle**

Pellicle related mask maintenance challenges

- **EUV mask with pellicle**
  - Front side cleaning
  - Backside cleaning
  - Pellicle removal
  - Pellicle mounting stud & glue removal
  - Pellicle debris cleaning
  - Pellicle maintenance

- **EUV mask w/o pellicle**
  - Known front side cleaning process
  - Known backside cleaning process

**Additional challenges**

**Solutions available today**

- Pellicle mounting stud & glue removal
- Pellicle debris cleaning
- Handling solutions & front side protection
- Pellicle surface cleaning
Mask maintenance cycle for EUV masks with pellicle

Pellicle related mask maintenance challenges

+ Pellicle design (material, layout) introduces further cleaning challenges
  + In one dimension the pellicle size equals the mask size
    → New mask handling solutions required
  + Material of the pellicle is Si: in case of pellicle is damaged → debris is deposited onto the mask surface
    → Mask and debris have chemical similar properties → physical cleaning methods only
  + Connection of the pellicle to the mask surface by four studs
    → After demounting the pellicle a mask front side cleaning process is required

+ New challenges for **front side cleaning** of EUV mask after removing the pellicle

Are studs still present?

<table>
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<tr>
<th>YES</th>
<th>NO</th>
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Cleaning challenges with studs on the mask
- Material compatibility of studs & glue to cleaning liquids/process/features
- Back splash from the studs into the device area especially during rinse and drying
- Studs trap particles on the mask surface
- Collision points between studs and cleaning nozzles, e.g. surface to surface megasonic, 172 nm VUV, ISUV, etc.

Cleaning challenges w/o studs on the mask
- Studs glue removal
Pellicle on EUV masks introduces additional challenges

- SUSS PE is addressing those challenges on equipment and process side: e.g. as participant of the European SeNaTe consortia (2015 – 2018)

- Equipment compatibility for handling EUV masks with pellicle

- Backside cleaning of EUV masks with pellicle

- EUV mask front side processing
  - Debris cleaning after the pellicle was damaged
  - Cleaning of the front side with studs after pellicle removal
  - Glue removal

- Pellicle maintenance

Prototype for EUV pellicle

R. Merritt: It’s crunch time (again) for EUV lithography; EETimes, 7/6/2015
Introduction

Pellicle related mask maintenance challenges

Summary
The maintenance of EUV masks with pellicle introduces new challenges in EUV mask cleaning

EUV mask cleaning processes need specific solutions for mask front side and backside

EUV mask cleaning equipment need handling adaptations

SUSS is addressing these challenges, e.g. by joining the SeNaTe consortia

The SUSS mask cleaning platform will address all specific solutions and infrastructure in order to enable full EUVL pellicle compatibility

EUVL pellicle related solutions provided by SUSS will be well aligned with worldwide key player in EUVL arena
Thank you!

SÜSS MicroTec Photomask Equipment GmbH & Co.KG
Ferdinand-von-Steinbeis Ring 10
75447 Sternenfels
Germany
www.suss.com