Issues of Reticle Coatings and Reticle Edge Tolerance in Pod

OTA Kazuya, Nikon Corporation | MIYAKE Akira, Canon Inc.

October 16, 2011 @Miami

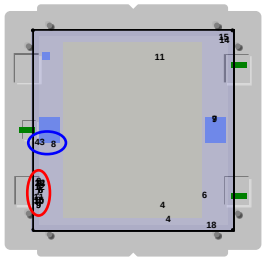
Nikon

Canon

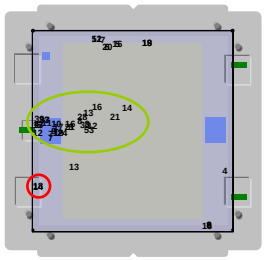
Reticle grounding requirements

- Reticle grounding may reduce particle generation due to discharge.

IRAI Vacuum Handling Result Details <FRONT> Selete



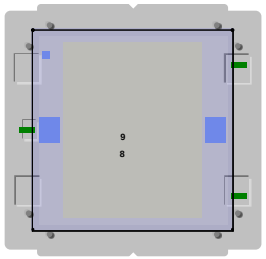
Proto/#1



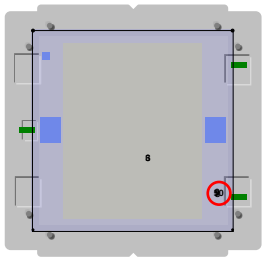
Proto/#2

- Close to the pocket edges.
- Close to the window edges.
- Near the left gripper (M3350).

Upper: before window replacement
Lower: after window replacement



Pre-Prod/#3



Pre-Prod/#4

Influence of the enlarged reticle location tolerance? M3350 was not designed based on ±0.55mm.

K. Ota

20100224 SPIE Advanced Lithography 18

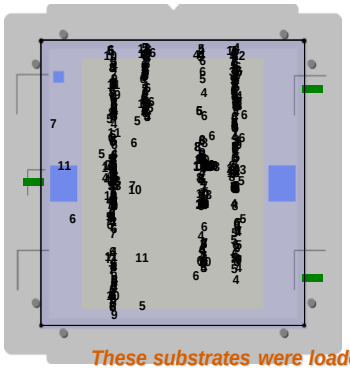
"Evaluation Results of a New EUV Reticle Pod based on SEMI E152", SPIE Advanced Lithography 2010

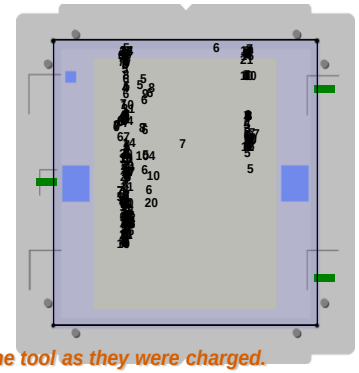
IRAI Selete

3-3. Particle adders in a particle inspection tool

Single side coated substrates were used.

cnPod/Trial 1 — Not cnPod-ESD — cnPod/Trial 2





These substrates were loaded into the tool as they were charged.

M3350 grippers

46nm PSL Eq., M3350

Many particles were added along the robot hand of the inspection tool.

K. Ota

20110302 SPIE Advanced Lithography 2011 10

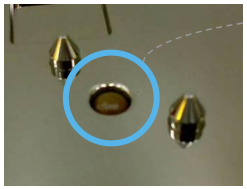
"Evaluation Results of a new EUV Reticle Pod having Reticle Grounding Paths", SPIE Advanced Lithography 2011

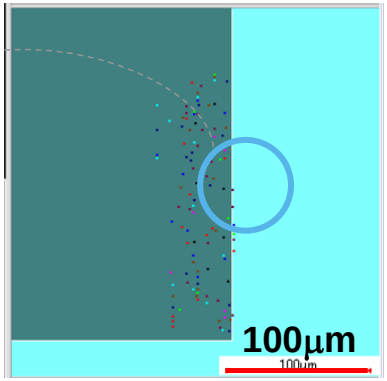
TaBO film never allows clean grounding

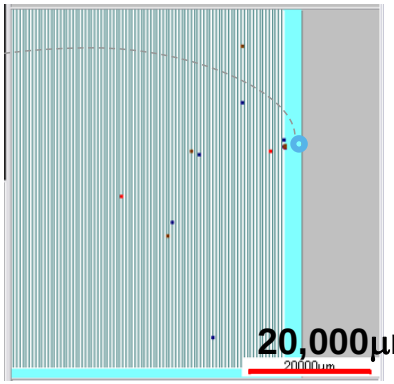
IRAI Selete

2-1. Evaluation of grounding mechanisms

- Soft-grounding
  - Conductive polyimide spheres
  - Contact resistance
    - Very good <1kΩ: Ru, CrN
    - Good <10kΩ: Si, Cr
    - **Bad ∞: LR-TaBN (=TaBO)**
  - Contact marks on the reticle but no scattered particles observed.
- Hard-grounding
  - Metal stylus
  - Contact resistance
    - Very good <1kΩ: all
  - **Particles scattered within range of several cm.**







K. Ota

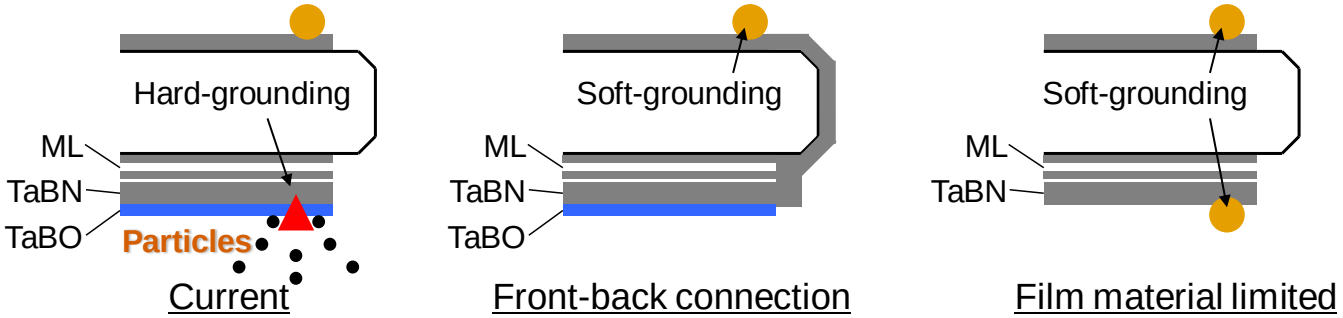
"Evaluation Results of a new EUV Reticle Pod having Reticle Grounding Paths", SPIE Advanced Lithography 2011

Potential modification of SEMI standards

IRAI Selete

4. Potential modification of SEMI standards

1. Locations for grounding
   - Grounding locations should be specified in SEMI P37(Mask) and E152 (Pod).
2. Film properties at the grounding locations
   - Film properties at the grounding locations should be specified in SEMI P37 so that the soft-grounding mechanism can be used.
3. Necessity of an electrical connection between the front and back sides of EUVL reticles
   - If EUVL reticles have an electrical connection between the front and back sides, the reticles can be grounded only from the back side and the requirements for film properties on the front side of the reticles can be relaxed.



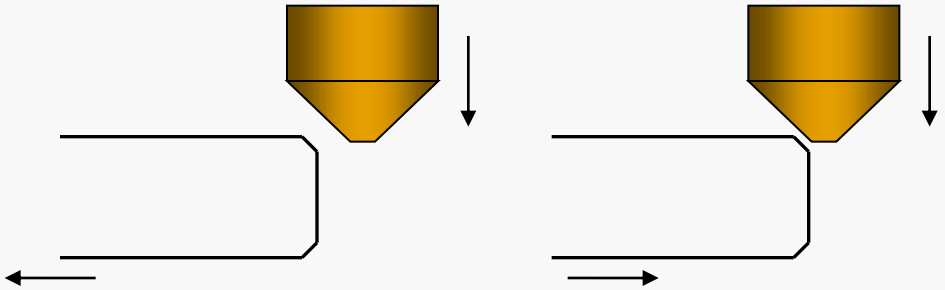
20110302 SPIE Advanced Lithography 2011 13

K. Ota

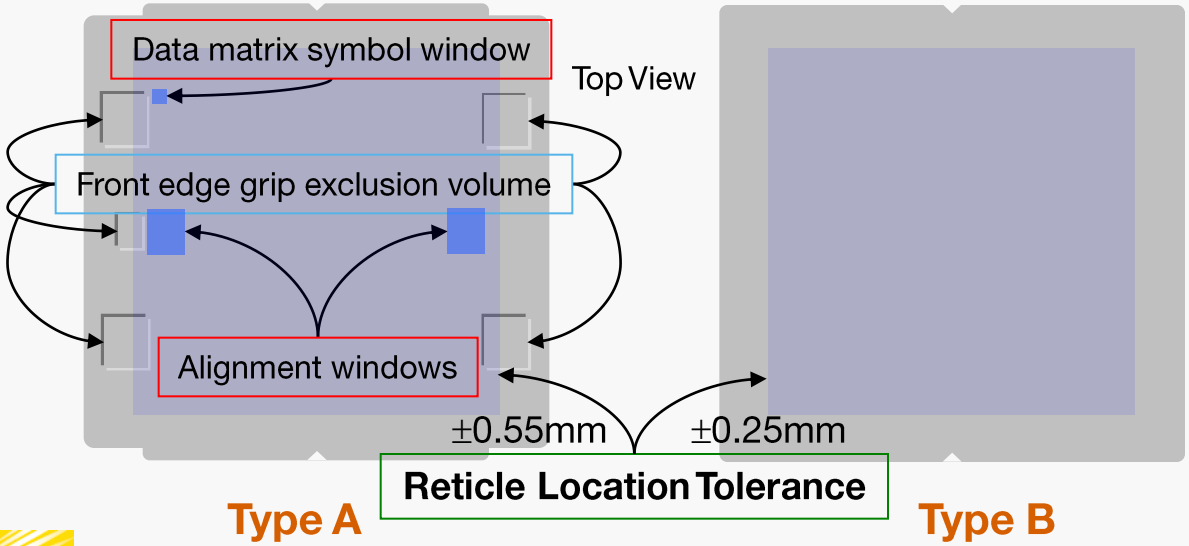
"Evaluation Results of a new EUV Reticle Pod having Reticle Grounding Paths", SPIE Advanced Lithography 2011

Large reticle location tolerance is an issue

- If a reticle positional corrector is installed in the pod, the contact pressure to the reticle may change according to the reticle edge position.
- Higher contact pressure can generate particles.



Two types of baseplates are specified in E-152.



(For all purposes)

(Other than exposure tools)

If the reticle has the maximum dimensional and drawing errors allowed by SEMI standards,
0.55 mm is the minimum requirement for secure handling using alignment marks thorough alignment windows in an exposure tool.

Scanner error estimation

Scanner suppliers' prospect of positioning accuracy

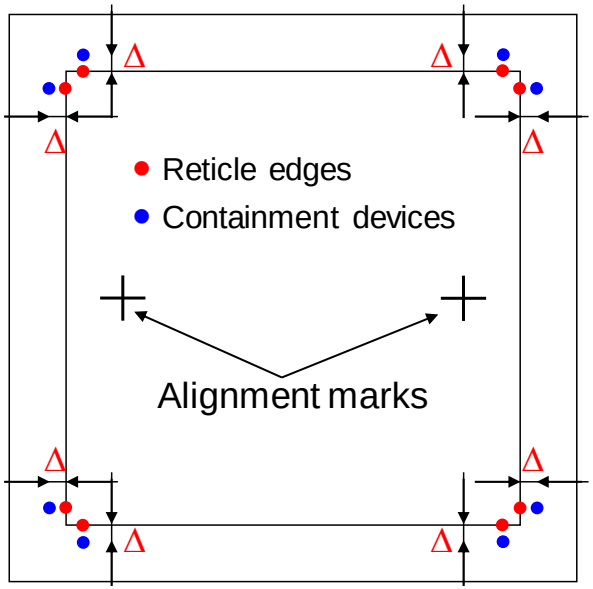
Selete

The positional accuracy of relative distances between the reticle edges and containment devices (● – ●) will be about 0.10 to 0.11mm.

Assumption:

1. Alignment mark positional errors neglected.
2. Reticle size variation neglected.
3. Some special positional detection of the baseplate needed.
4. The size and positional errors of the containment devices neglected.

If these errors are less than 0.15mm, the reticle edge offset tolerance can be less than 0.25mm.

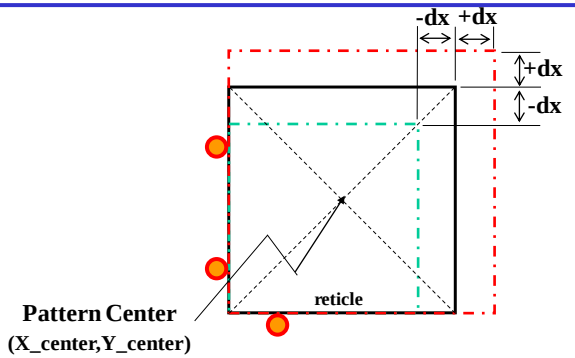


K. Ota

"Mask Positioning Error Analysis from the point of view of Exposure Tool Suppliers", EUV mask Standards Workshop 2008

Reticle error estimation

Influence of substrate edge length on reticle edge offset tolerance DNP



Reticle edge offset tolerance = substrate edge length/width error (+/- dx)

Photomask current performance = +/- 150 ~ 200 um

with substrate spec. of +/-400um

EUVmask : substrate spec. = +/- 100 um (SEMI P38)

***) not include substrate Squareness**

25 February 2008 *EUVL Mask Standards Workshop*

- Actual error is much smaller than SEMI standards, but further improvement is needed to accomplish 0.15 mm or less.

"Mask Positioning Error Analysis Current status & prospect", Naoya Hayashi, DNP, EUV mask Standards Workshop 2008

Conclusion DNP

- Actual edge distance error of current reticles is around +/- 150~ 200um
- There is a possibility for edge distance accuracy improvement in EUV reticle HVM generation.
- In order to achieve better reticle edge tolerance, more critial control of substrate size, EB writer accuracy have to be required.

8

25 February 2008 *EUVL Mask Standards Workshop*

Summary

Coatings

- We have to specify grounding locations in P37 and E152.
- It is desirable to specify film properties at the grounding locations for clean grounding.
- Backside grounding is enough if the reticle has a front-back electrical connection.

Reticle location tolerance

- Critical control of substrate size and EB writer accuracy is a key to reducing the reticle location tolerance.