Fully Integrated Pellicle Solution for EUV HVM

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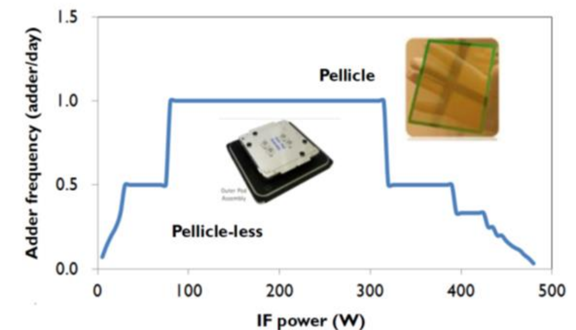
Does EUV Pellicle do it's job?

- *Optical pellicle has proved to be an essential, enabling technology*
- *Will the EUV pellicle be the same in it's current embodiment?*
- Differences between optical and EUV pellicle?

- **Optical-like infrastructure and operation: Integrated solution with current technology**
  - Minimal impact to current lithography operations and flows
  - HVM pellicle life-cycle (optical-like)
  - Minimal risk to mask, scanner, and associated toolsets
- Full EUV pellicle infrastructure development
- **Drive confidence and statistics in pellicle, tooling, and infrastructure**

Differences between optical and EUV pellicle?

- EUV failure will be more broadly catastrophic
  - Optical failure kills max of 1 mask), EUV failure may kill manufacturing line or tools AND mask)
- Not hermetically sealed
  - Ambient defects can migrate under pellicle for EUV with 200um gap
- Both have “reticle degradation” mechanism (haze, vs. Carbon deposition), which require demount and cleaning
- On-pellicle Defects much closer to focal plane in EUV (2mm)
  - Means that tools / process defectivity must be held to same cleanliness level with or without pellicle
  - On-pellicle defects may cause pellicle failure during exposure: localized heating
  - Detection of on pellicle defects
- EUV isn’t transparent
  - 20% power loss
  - Scaling to 250 W, emissivity of materials
- No Through-pellicle inspection
  - Requires demount to inspect → results of inspection are of questionable validity
- Pellicle removal is more “involved” in EUV
  - New tools, considerations (remove pins or not?)



Global alignment of commercialized EUV pellicle acceptance and qualification specifications

EUV Pellicle Use Case / Property Analysis

Characteristic	Optical	EUV	Comment
Storage	Foups,Pods, BRS	Dual-Pods	Dual-pods are best defect mitigate
Fab Exposure / Drop-on	Exposed to fab environment, during use, cleaning, inspection	None- In Dual pods or in tools	If “drop on” events occur, particles may get sucked in under 200um gap (EUV)
Scanner	Scanners not driven to 0 defect level	Scanners driven to ~0 adders, Pellicle prevent in-situ H cleaning of reticle	Defects from scanner may get
Shipping	10s of defect adders accepted	0 Adder goal	Difficult to achieve –In fab cleaning w/out pellicle
Handling	Protect against thumbs, etc	Automated handling, pattern down	There is no risk that Pellicle is protecting against
Pellicle Failure	Sticky – may destroy host reticle	Billions of fragments- contaminate tools, fab, destroy reticle	EUV masks are expensive, but cheap vs tools
Cleaning when defect found	Frame removal, Glue removal, repel infrastructure ugly, but works	Not clear that it’s workable - requires pin removal and replacement or pin-compatible clean	Cleaning / Repel becomes much more involved / difficult
Inspection	Inspect through, on pellicle	Requires removal of pellicle prior to inspection	Is inspection valid with remount required?

Driving toward an Optical Lithography-like Pellicle Solution (EUV)

Mask House

Blank Received
Blank Clean/Inspected
Mask Patterned
Mask Clean(s)
FS Inspected
Mask Clean(s)
FS+BS Inspected
Attach Pellicle frame studs

Mask Repair

Pellicle/Frame Received
Incoming Pellicle/Frame Inspection
Pellicle/Frame Storage
Pre-Mounting Pellicle/Frame Inspection
Pellicle+Frame Assembly

Pellicle+Frame Mounting to Mask
Pellicle dispo.
Mask Inspection (AIMS?)

Mask NOK/ OK

Mask Clean(s)
Pellicle Studs
Pellicle dispo.

SHIP

Mask+Pellicle Received
BS Inspected
Pellicle dispo.
FS Inspected (AIMS?)
Pellicle dispo.
FS+BS Cleaned
BS Inspected
Pellicle dispo.
FS Inspected (AIMS?)
Mask+Pellicle Stored

Mask Monitoring

BS Inspected
Pellicle dispo.
FS+BS Cleaned
Pellicle dispo.
FS Inspected (AIMS?)
Mask+Pellicle Stored (IVL)
Mask+Pellicle Exposed

NOK

Pellicle dispo.
Pellicle Studs
BS Inspected
FS+BS Cleaned
FS Inspected (AIMS?)
Pellicle Studs

Thank you

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