EUV Pellicle TWG, San Jose, CA
Feb 21, 2016

EUV Pellicle Experience

Ted Liang

Intel Mask Operations

Santa Clara, CA USA

Main Messages:

- **Progress is being made in EUV pellicle development (as in ASML presentation)**
- **Intel wants to use EUVL for production as soon as possible (as it is ready to support technology development)**
- **Concerns exist about the extendibility of the current solution with respect to high volume manufacturing (HVM) and throughput**
- **For HVM, we need a robust and commercial pellicle platform that improves transmission, lifetime, and other key performance parameters**

Copyright © 2015, Intel Corporation. All rights reserved.
*Other names and brands may be claimed as the property of others.

Messages for 2016:

- **Good progress has been made in EUV pellicle development in materials, tooling and infrastructure**
  - Pellicle exposure with global transport and handling demonstrated
  - Basic EUV pellicle infrastructure and capability exist today for pellicle materials development and quality control

- **Pellicle films capable of long lifetime at 250W EUV remain a critical gap in pellicle implementation for HVM**
  - Rapid innovation/invention and development are necessary to intercept schedule
  - Great opportunities exist for engagement in pellicle film production and commercialization

Copyright © 2015, Intel Corporation. All rights reserved.
*Other names and brands may be claimed as the property of others.

Pellicle Film Performances

- **Lifetime: commensurate with source power and WPH throughput of NXE in production**
  - Transmission >90%
  - Thermal load: equivalent to 250W
  - Tens of thousands of wafers
- **Uniformity: T <0.2%**
- **Defects in and on the film**
  - Particle inspection tools exist today to support process development
  - Development of mechanically robust pellicle films might allow particle blow-off
  - Methods for removal of fall-on particles on thin film membranes desired

Copyright © 2015, Intel Corporation. All rights reserved.
*Other names and brands may be claimed as the property of others.

Status of Pellicle Integration

- **Significant progress in multiple fronts has been made**

Components	Status @1st Pellicle TWG (Oct. 2015)	Status @2nd pellicle TWG (Feb. 2016)
Pellicle film	• 40W film: single NXE imaging test • 125W film: feasibility demonstrated*	• 40W film: multiple NXE imaging tests; lifetime exceeding expectations • 125W film: full sizeprototyped
Mounting	• Mock-up mounting with test frame • Tool set designed	• Reticles pelliclized with detachable, HVM-compatible frame/studs • Rev 0 tool sets in use
Metrology/tools	• Limited to lab tools at pellicle supplier	• Full pellicle EUV transmission measured; tools exist • Pellicle particle inspected; tool exists
Shipping & handling	• Basic flow/procedure tested	• Fully pelliclized reticles shipped across continents • PODs and process flow appeared healthy
Integration tests	• Limited test with mock-up assembly • None on fully assembled HVM-compatible pellicles	• Exposure >200 wafers on Intel NXE scanner with full-field pelliclized reticles • Initial printability results validated ASML frame design

* Carmen Zoldesi/ASML, EMLC June 2015

Copyright © 2015, Intel Corporation. All rights reserved.
*Other names and brands may be claimed as the property of others.

intel

Focus Areas to Enable EUV Pellicle for HVM

Key components	Current status	Remaining challenges
Pellicle film	• Full-size film demonstrated for thermal load at 125W	• Transmission >90% • Scale up to high-yield production
Mounting	• Tool set designed & prototyped*	• Particle-free mounting process
Film inspection & Metrology	• Measurement and tool demonstrated	• Integration into process flow
Mask pattern inspection	• Need for actinic pattern mask inspection thru-pellicle defined	• APMI is not a show-stopper • Timely tool development needed

Color	Legend
Red	Show-stopper
Orange	C&F/prototyped, not commercialized
Yellow	Prototyped, production path clear
Green	Ready for implementation

* Dan Smith/ASML, 1st Pellicle TWG, Oct 2016

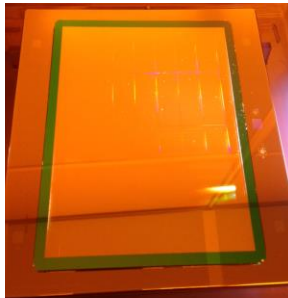
Copyright © 2015, Intel Corporation. All rights reserved.
*Other names and brands may be claimed as the property of others.

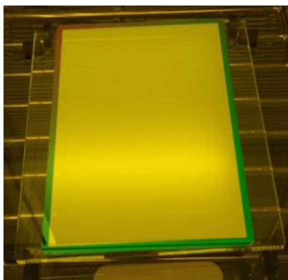
EUV Pellicle Metrology Infrastructure

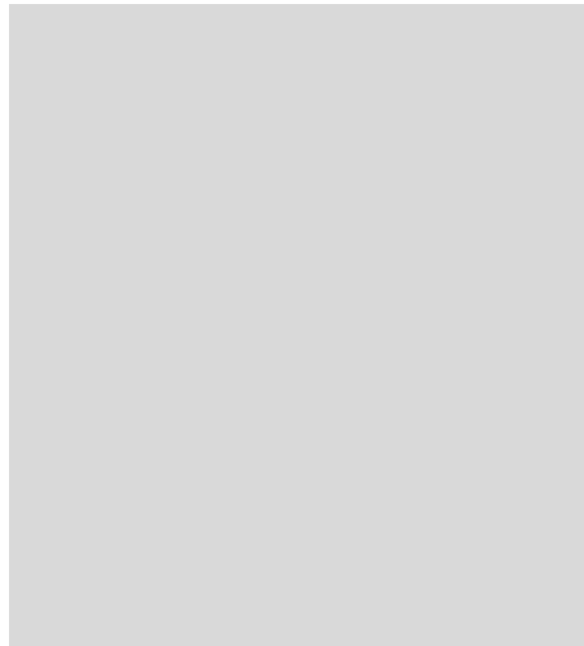
- **Basic tool and capability exist today to support pellicle materials development and quality control**

Pellicle film inspection

– Inspections demonstrated on multiple pellicles mounted on reticles





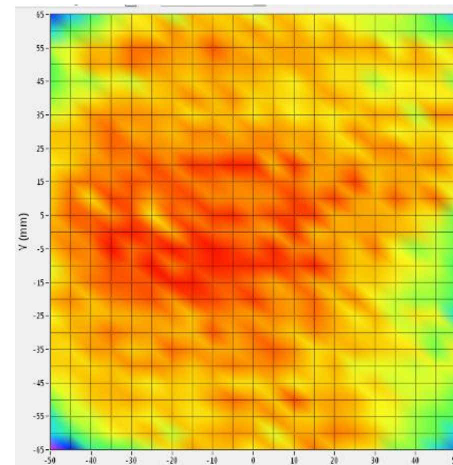


Uniformity measurements

– Tool is available for accurate and precise transmission uniformity measurement

– Demonstrated measurements of full-size pellicle @13.50± 0.03nm

100mm x 130mm
Measured in every 5mm



Courtesy of EUV Tech

Copyright © 2015, Intel Corporation. All rights reserved.
*Other names and brands may be claimed as the property of others.

Summary

- **EUV pellicle technology and process flow have been demonstrated with wafer printing on NXE scanner with standard EUV mask and exposure flows**
  - Pellicle exposure with global transport and handling demonstrated
  - 40W prototype pellicle lifetime >200 wafers demonstrated
  - Initial results indicate only small fraction of particles on pellicle are killer defects for wafer
- **EUV pellicle infrastructure and capability exist today for pellicle materials development and quality control**
  - Pellicle film inspection and metrology
  - Pellicle mounting tools
- **Availability of quality pellicle films is the highest risk to timely EUV pellicle implementation**
  - There are opportunities for industry engagement to develop pellicle films to meet HVM requirements
- **Inspection of pelliclized reticles is needed to ensure predictable yield. APMI is not a show-stopper, but without it yield and cost may be an issue.**

Dr. Britt Turkot/Intel: Keynote Session 9776-1 'EUV Progress Toward HVM Readiness' Monday 11:00am

Copyright © 2015, Intel Corporation. All rights reserved.
*Other names and brands may be claimed as the property of others.

intel

Thank you for your attention!