Accelerating the next technology revolution

- Pellicle Discussion
- Key Pellicle Requirements

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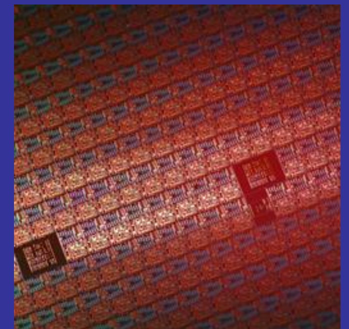

Acknowledgements:

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Discussion - Do We *Absolutely* Need Pellicle?

- **The answer may depend on how well pellicle-less handling does.**
  - What's the Mean Time Before Contamination (**MTBC**) of masks, current performance, HVM projection?

    (how many wafers can be printed before an added-defect shows up on mask?)
  - Pellicle lifetime must be **>> MTBC** for pellicle to make sense.
  - If pellicle, need to act now especially for potential **impact to mask infrastructure**.

    (such as E152 standard may not accommodate 5 mm pellicle stand-up)
- **But, even pellicle-less reticle handling went fairly well, the costs to implement it would be so high that EUV pellicle is much more cost effective and needed.**
  - Increased mask cost from many cycles of inspection and re-clean
  - Costs related to no real-time reticle monitoring, such as increased wafer inspection, wafer line-yield loss, scanner tool time loss, etc.

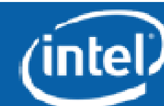
Yashesh, et. al., Recommended Requirements *(2008 EUVL Symposium)*

Motivation & Goal

- The aim of this research is to create an EUV pellicle as a backup to pellicle-less operation
  - Operating within litho tool without added particles
- Mesh based pellicle's target performance:
  - EUV transmission: double-pass loss < 30%
  - Robustness: HVM capable operation
  - Imaging: minimal contrast and uniformity loss

EUV Pellicle Specifications	
Frame length/width	149/122mm
Height	5 mm
Transmission	>70%
Film thickness	50nm ± 2nm
Illumination non-uniformity	± 0.6%
Film stress	Tensile (<50MPa)
#wafers/pellicle	> 2000
Stiffness	193nm frame

"EUVL Pellicle Development", Yashesh Shroff, Pei-Yang Yan, F. Salamassi, Eric Gullickson
EUVL Symposium 2008, Lake Tahoe



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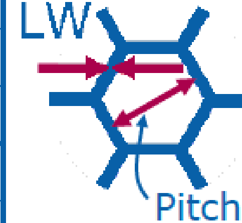
Impact on reticle plane non-uniformity

- Non-uniformity scales with mesh linewidth. Modeled results:

		Mesh1	Mesh2	Mesh3
Linewidth (LW)		10u	3u	1u
Pitch		250u	100u	35u
Non-uniformity	5mm	1.4%	0.25%	0.08%
	2mm	7.4%	0.50	0.14%
Mesh only txm		94%	94%	98%



- Decreasing stand-off distance dramatically impacts uniformity due to the severely increased apodization of the pupil by the mesh
- We recommend minimum stand-off distance of 5mm, consistent with current DUV technologies.

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"EUVL Pellicle Development", Yashesh Shroff, Pei-Yang Yan, F. Salamassi, Eric Gullickson
EUVL Symposium 2008, Lake Tahoe

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Initial Requirement Discussion

	EUV Pellicle Specifications	
1	Frame stiffness	(~ 193nm requirement)
2	Frame thermal expansion	
3	Pellicle size (including frame)	(~ 193nm requirements?)
4	Type (mesh vs freestanding)	
5	Support / frame thickness	
6	EUV transmission	
7	OOB transmission	
8	Film thickness	
9	Film stress	
10	Illumination non-uniformity	
11	Fab inspection	
12	Lifetime (wafers / pellicle)	
13	Pellicle stand-up height	(Intel paper recommended > 5um)
14	Outgassing limits	
15	AMC contaminations + more	
16	Compatibility with E152 standard	
17	Pellicle attachment material	
18	Pellicle purging	