Scribe Line Self Reference Targets to enable Accurate and Robust After-Etch Overlay Metrology of Active layer

Jimmy Chang[a], Junjun Zhang[a], Wei Zhang[a], Panpan Wang[a], Xiaofang Zhou[a], Rui Qin[a], Silva Hu[a], Shaowen Qiu[a], Yunsheng Xia[a], Giacomo Miceli[b], Sylvia Yuan[b], Natalia Drabik[b], Pavel Izikson[b], Giulia Argento[b], Bas van den Broek[b], Elton Bitincka[b], Hao Jing[c], Shaun Dai[c] , Yvon Chai[c], Yu Liu[c], Justin Jiang[c]

Presenter: Wei Zhang
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[a]Changxin Memory Technology Co., Ltd., 388 Tianzhushan Boulevard, Hefei, Anhui, China
[b]ASML B.V, De Run 6501, 5504 DR Veldhoven, The Netherlands
[c]ASML China, 2889 Jinke Road, Shanghai, China

Outline

- IDM & ASR introduction
- Benefit for active layer
- Conclusion
- Q & A

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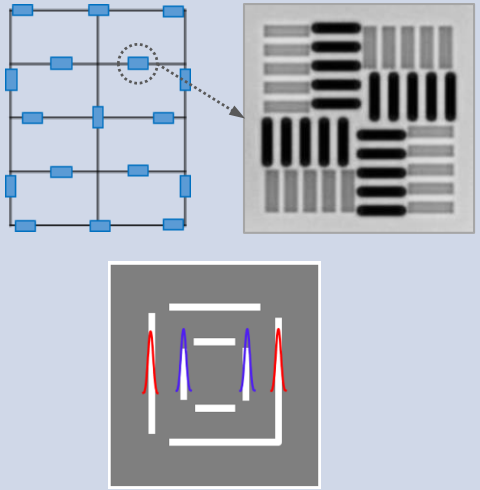
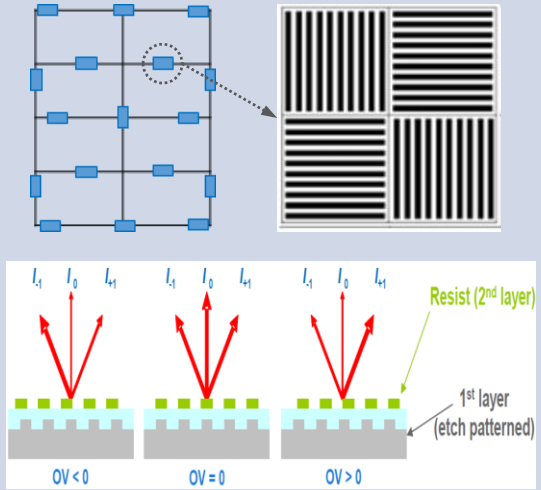
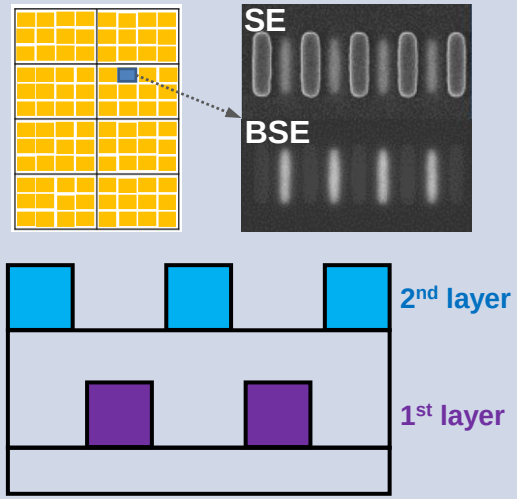
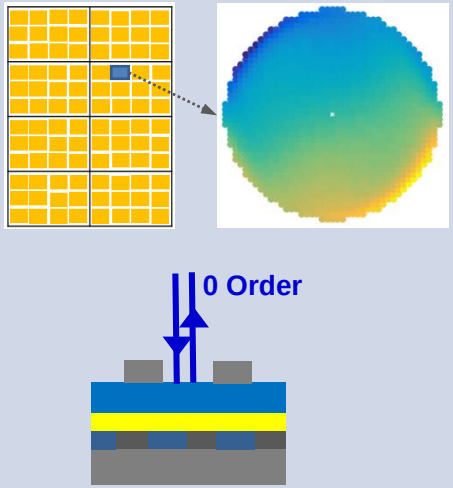
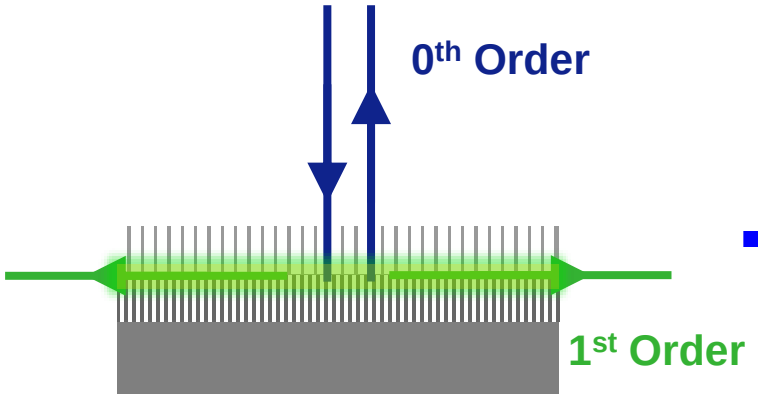
The classification of Overlay(OVL)

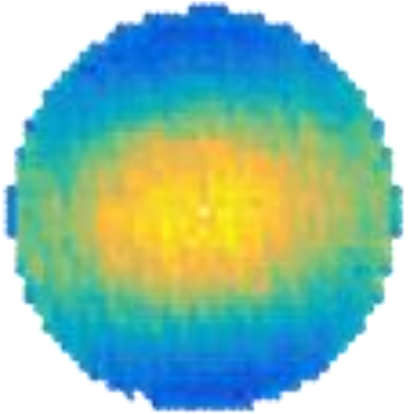
	IBO (Image Based OVL)	DBO (Diffraction Based OVL)	SEM (E-Beam)	IDM (In Device Metrology)
Diagram				
Application	Optical / ADI		E-beam / ACI	Optical / ACI
Comment	Scribe lane and chip bias; ADI/ACI bias		Limited by throughput	New technique

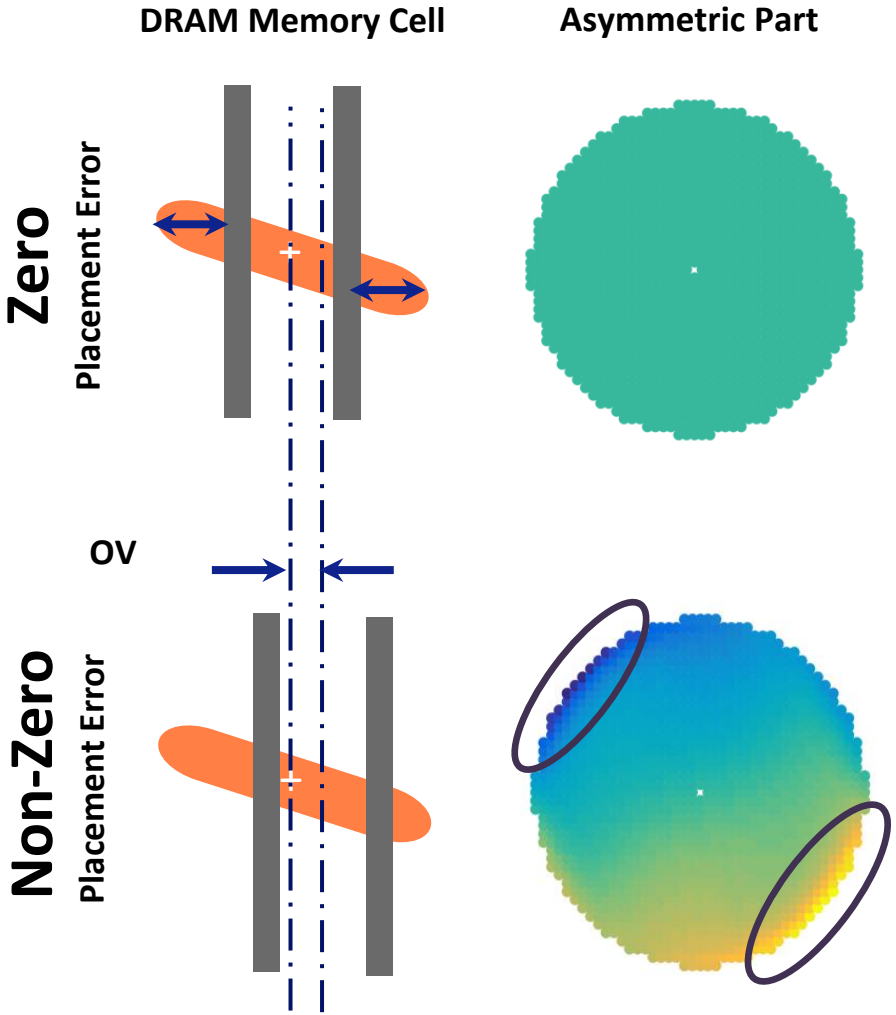
cxmt ASML

The principle of IDM



Measured Pupil

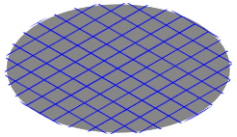




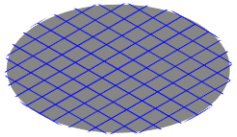
The use of IDM

Data collection

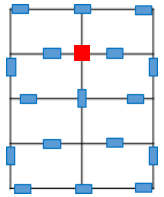
Data base



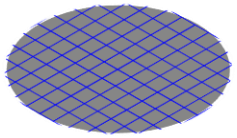
SEM → **SEM OVL**



IDM → **Pupil**



Design ASR mark → **- OVL Bias** | **0 OVL Bias** | **+ OVL Bias**



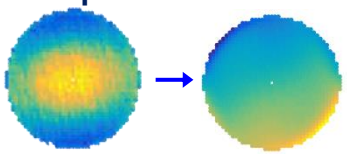
IDM → **Pupil**

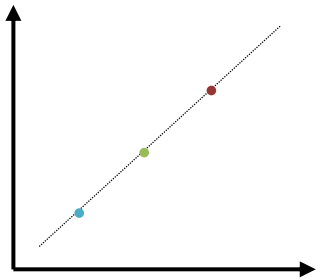
ASR: Absolute and Self Reference

Recipe setup

Machine leaning

Measured Pupil → **Asymmetric Part**





1. **SEM OVL**
2. **ASR set OVL bias**

- **Major regression KPI:**

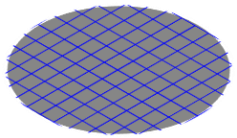
  Slope: sensitivity to overlay variations (**1**)

  Spread: explains the signal purity (clean signal → low value)

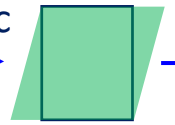
  R^2: how close the data are to the fitted regression line(>0.9)

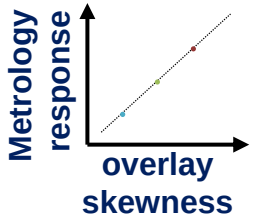
  Repro: come from several repeated measurements. (lower is better)

Skew verification



Specific shots →





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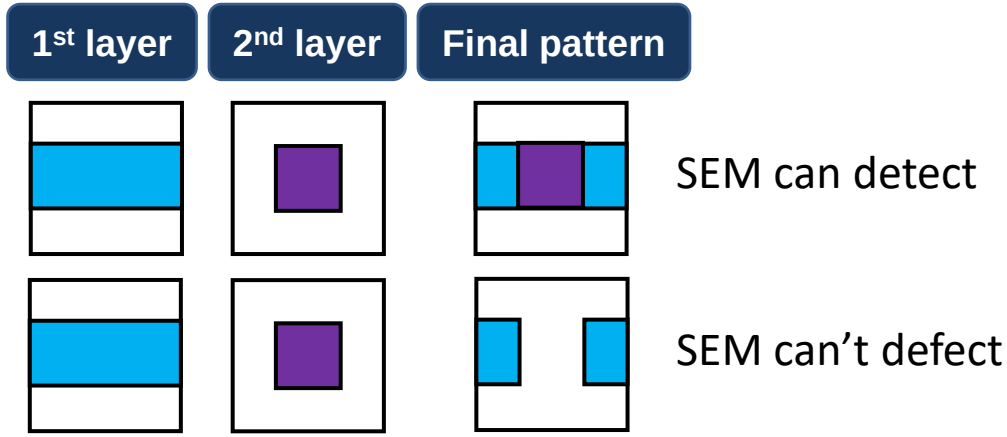
Dedicated ASR target design to capture the low signal strength of Active Cut to Active

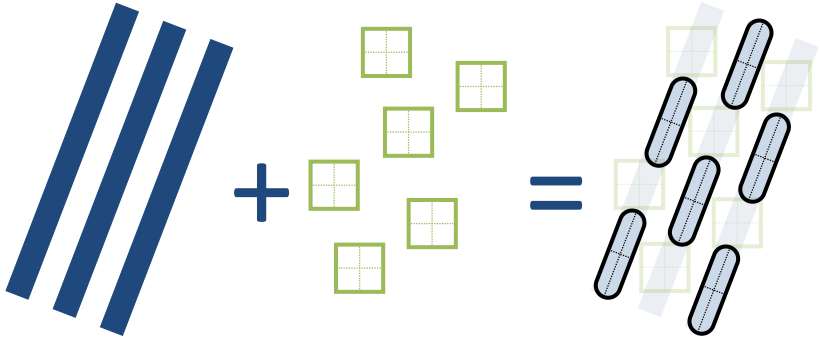
Challenge

- The active cut litho and etch process is meant to cut the slanted multiple-patterned Si lines, creating isolated Si regions from the active area of the device
- From theoretical point of view, it is not possible to distinguish cut etch overlay without an anchor point
- IDM exploits signal generated from full stacks to measure the cut etch overlay



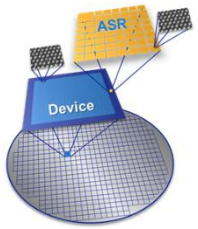
Rationale: Fundamentally impossible to observe cut shifts with conventional metrology solutions

- Same finale patterns can be achieved shifting cut layer in Y direction or with a different overlay in X direction



ASR target design: different shifted targets are proposed

ASR assisted recipe shows promising overlay performance
Image-based method confirms successful IDM performance

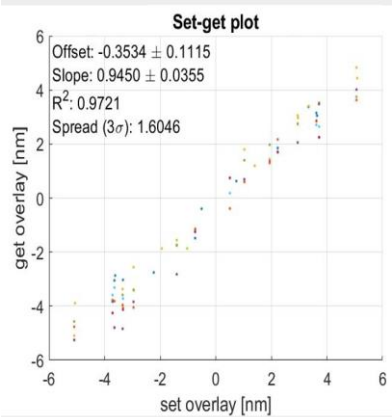


Recipe setup

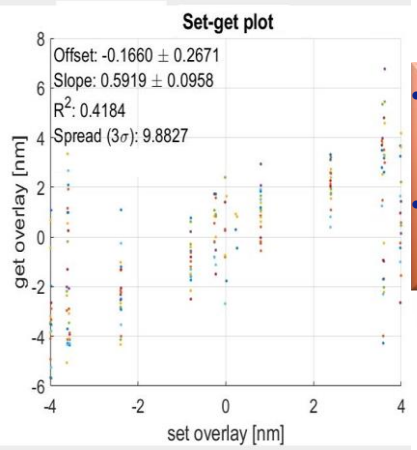
	Slope (0.9<spec <1.1)	Spread	R^2 (spec <0.95)	Repro (customer spec)
Recipe	1.00	1.23	0.99	0.21

- YS IDM ASR assisted recipe shows accurate results:
  - ASR sub targets dial-in training overlay follows scanner programmed overlay

Skew verification

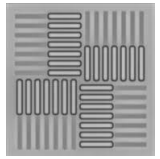


- **Slope =0.95**
  (spec: 0.9 < slope < 1.1)
- **R2 = 0.97**
  (spec: 0.95)



- **Slope = 0.59**
  (spec: 0.9 < slope < 1.1)
- **R2 = 0.42**
  (spec: 0.95)

Image based method skew verification



- Image based method is used for monitoring purposes and requires a dedicated wafer with under-etch active cut needs to allow in-device overlay control

Due to over coverage and mark deformations, the image-based method shows worse skew performance w.r.t. IDM

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Conclusions

- **IDM is able to achieve good accuracy and reliable overlay measurement, which is better than current image-based OVL monitoring method**
- **IDM positions itself as an alternative solution for Active cut layer monitoring and OVL control**
- **The possible use of IDM removes the need for a sacrificial after etch metrology method and allows a cost-effective approach in HVM**

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