Fiducial Marks for EUV mask blanks

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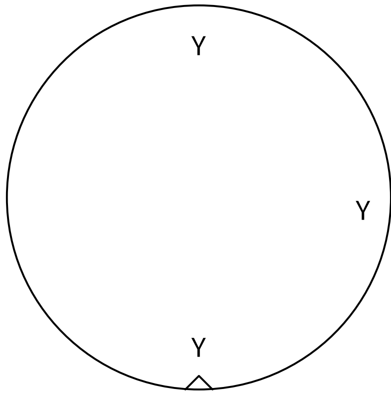
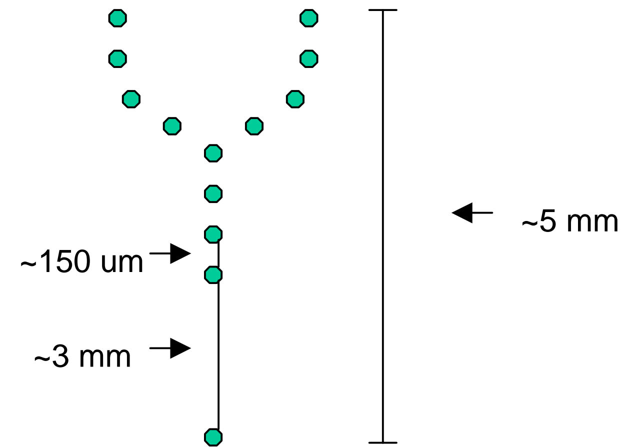
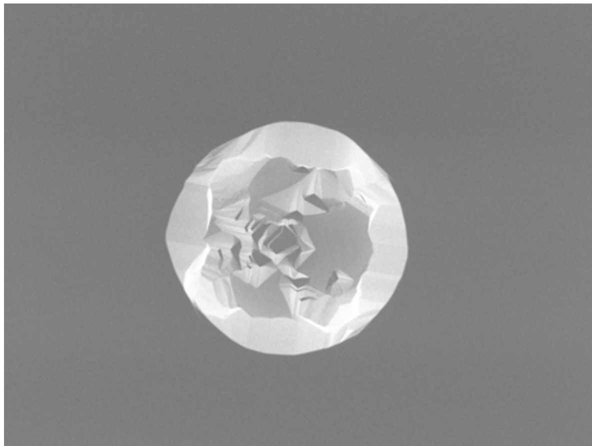
Fiducial marks are laser scribed on 200 mm wafers to enable defect registration on metrology tools



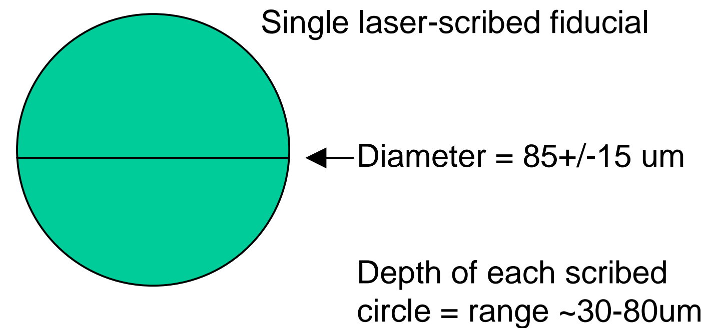
Fiducials are located in the 12, 3 and 6 o'clock position with respect to the wafer notch, in the shape of a "Y"



Detailed view of a fiducial-marked region with dimensions

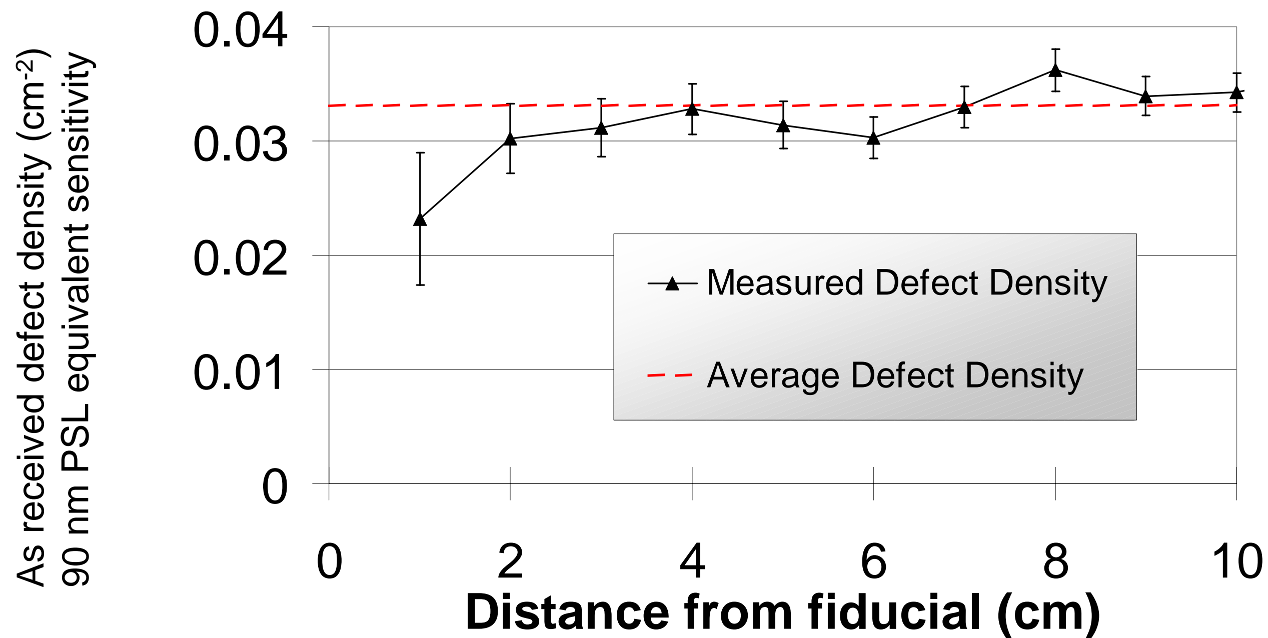


SEM image of a single laser-scribed fiducial mark



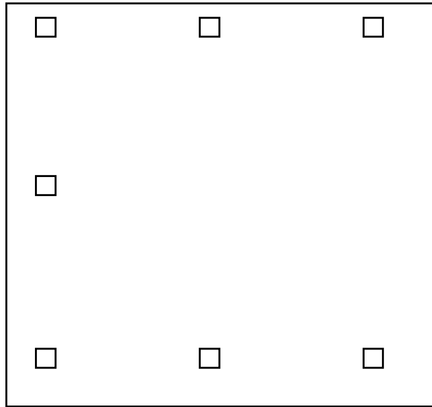
No evidence was found of fiducial mark writing creating defects on 200 mm wafers

A study of 616 200 mm wafers as received from the supplier showed no evidence of contamination from the fiducial writing process.*

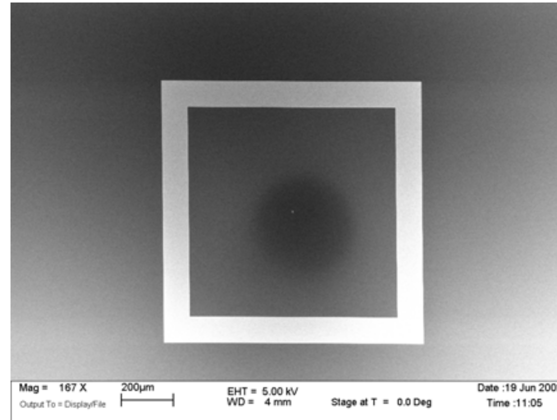


*Current (July 2002) inspection excludes defects closer than 7mm from the fiducial from detection, so this data cannot rule out adders closer than 7mm from the fiducial.

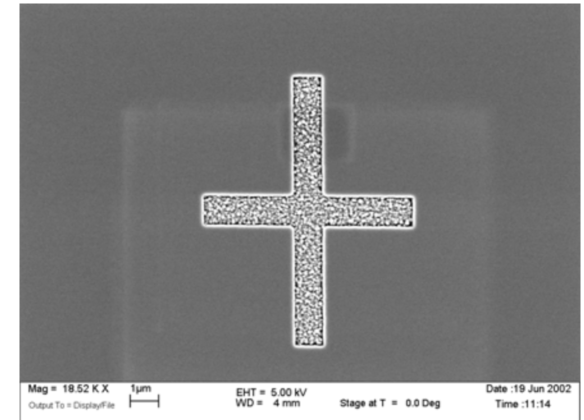
Etching fiducial marks on 6-Inch square quartz plates*



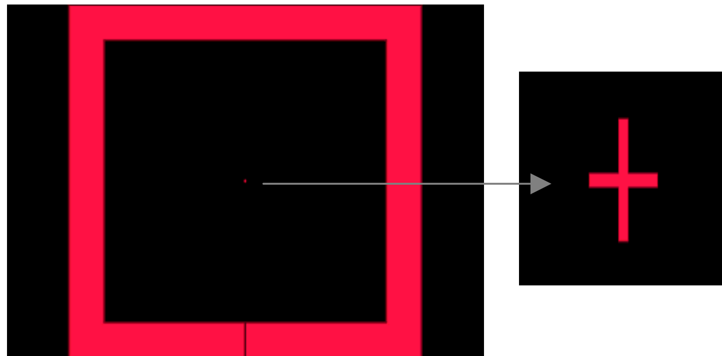
Design layout on 6 inch plate consists of 7 boxes with a cross feature in each, in the overall shape of a “C”.



SEM image of one of the boxes



SEM image of cross feature inside box



DIMENSIONS

Dimensions of the fiducials consist of a 1mm^2 box with 800um wide border. In the center is an asymmetrical cross, composed of two intersecting lines, 7um in *x*, 9um in *y*. Each is 1um wide.

PATTERNING PROCESS

The patterning process consists of the deposition of a thin Cu layer (90A) and a resist which is patterned with an ebeam writer. The pattern is transferred through the Cu layer using RIE etch, resulting in a 250nm trench in the quartz. Cu and resist are stripped, and the plate is given a final clean.

*Fiducial process developed at IBM, courtesy of K. Racette and E. Fisch

The current problem:

- Defect mitigation schemes are considered necessary for EUV masks already at the mask blank level (i.e. before patterning).
- Such strategies include blank inspection, defect characterization and repair.
- Reliable relocation of a defect in different tools is necessary.
- Substrate specifications not stringent enough to accomplish this.
- Reference marks necessary to establish a coordinate system.

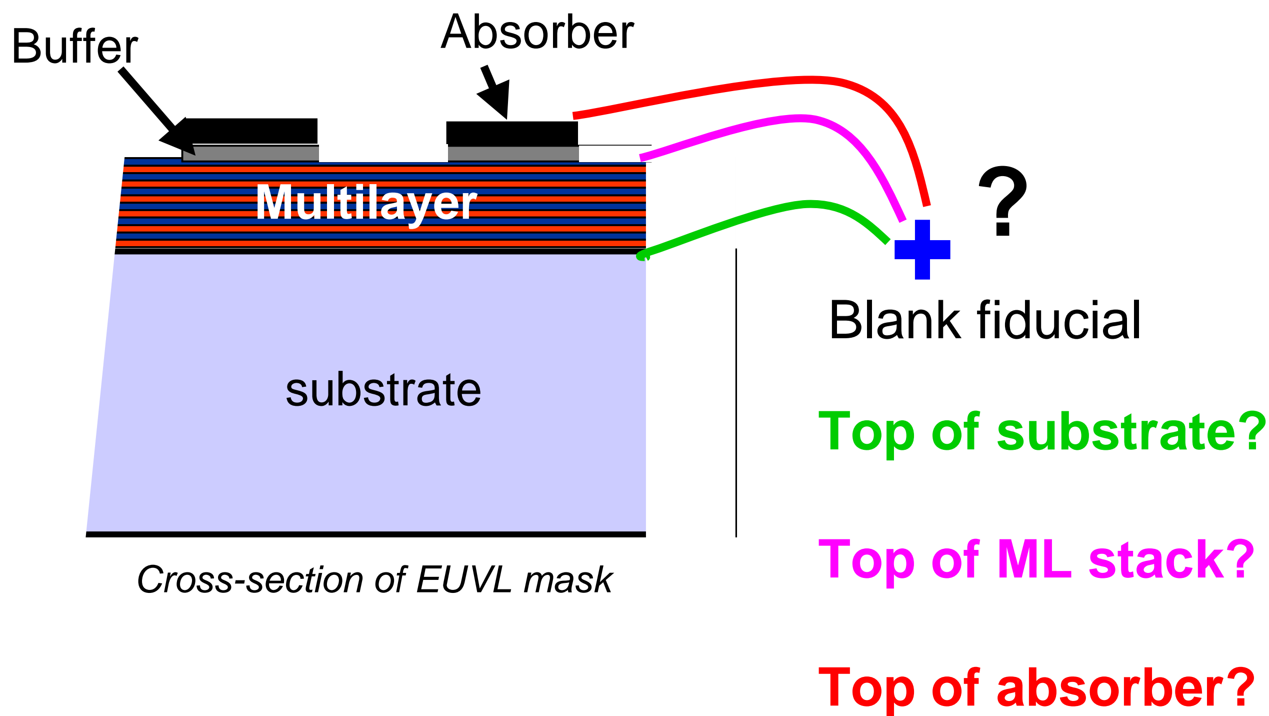
Requirements:

- At least two marks to align mask.
- Three marks to remove rotational component.
- Well defined positions with respect to substrate.
- Sufficient contrast for various techniques (e.g. optical, EUV, e-beam, others).
- Pattern and contrast suitable to meet defect location accuracy, >1μm?
- Easy to manufacture.

Questions:

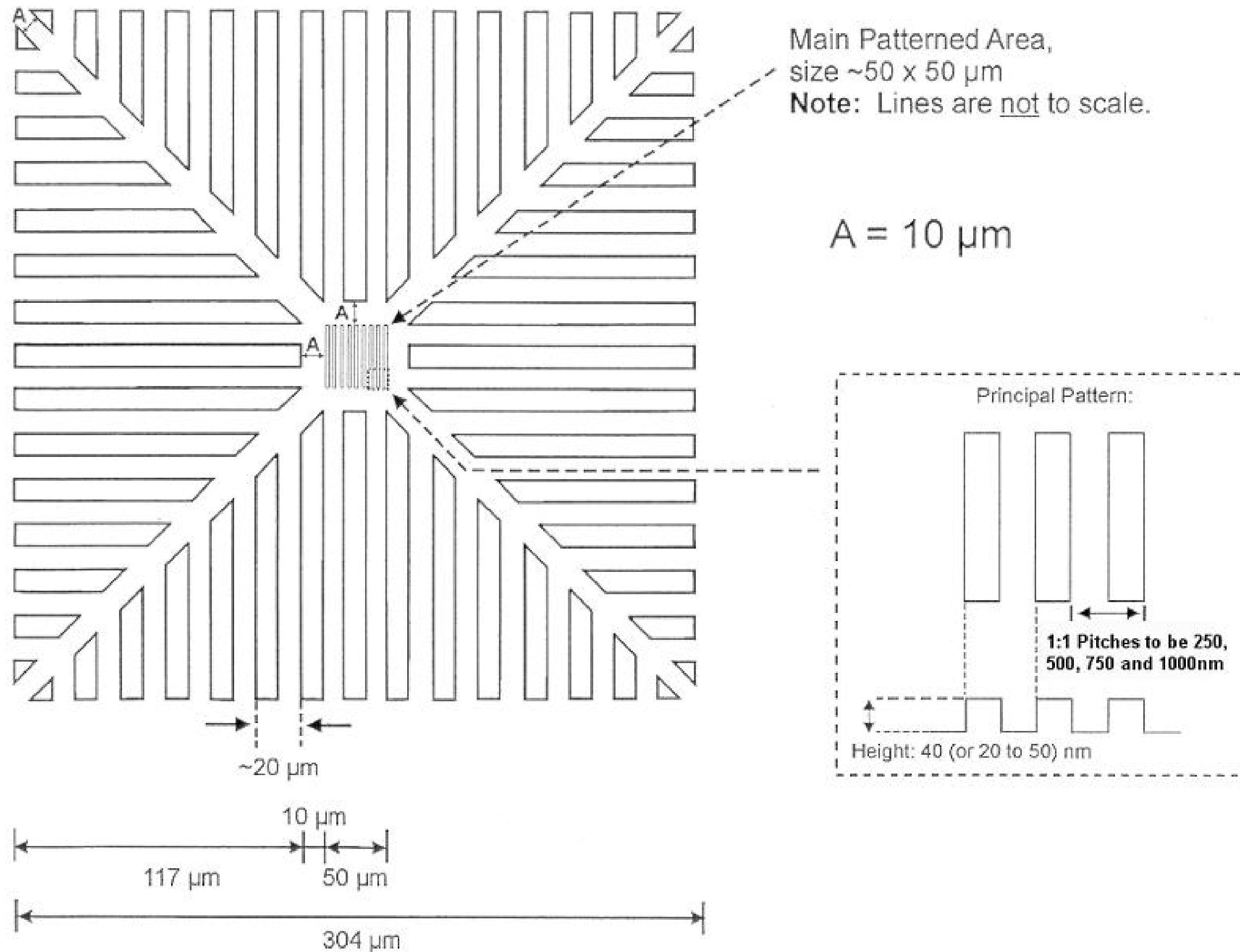
- Introduce at what level (at least on top of ML stack but on substrate might be beneficial?)
- “Visible” up to which level?
- Should they be used during patterning process as well (e.g. pattern generator, patterned inspection and repair)?
- Required defect relocation accuracy?
- Fiducials needed on the mask backside?

Where to introduce?

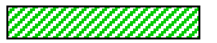


Cross-section of EUVL mask

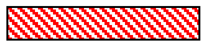
Preliminary Design of NIST SRM 2089



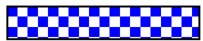
Possible locations for fiducial marks.



Not reserved



Reserved



Suggested
-Data Matrix ID
-Fiducial marks (1-2-4 or 2-3-5)
Alternatives:
-DM placed at #5
-DM placed where a barcode may be removed

Fiducial Mark Summary

- **Laser scribed fiducial marks on 200 mm Si wafers did not appear to increase defect levels - at a baseline of 0.03/cm^2 at 90 nm PSL equivalent sensitivity.**
- **Fiducial marks were etched on quartz plates to enable defect registration.**
- **Fiducial marks used in the ISMT experiment were never carrier forward (not a planned outcome of the project).**
- **EUV mask blanks will need some fiducial approach to map defects during inspection and re-locate defects during repair.**
- **Permanent fiducials can be used for other applications in the mask lifetime flow (patterning registration, mask registration on the exposure chuck w/o kinematics).**
- **Positions, positional tolerances, and mark quality throughout the deposition process must be determined.**
- **Locating frame similar to NIST needed; something human-visible?**
- **Introduction step must be determined (substrate?) – this will be a new operation.**
- **Pilot experiment at ISMT-N will assess if substrate marks can propagate during the film deposition processes.**