2009 iEUVi Mask TWG Panel Discussion topic:

Defect Printability Mask Standardization

Attributes and Possibility

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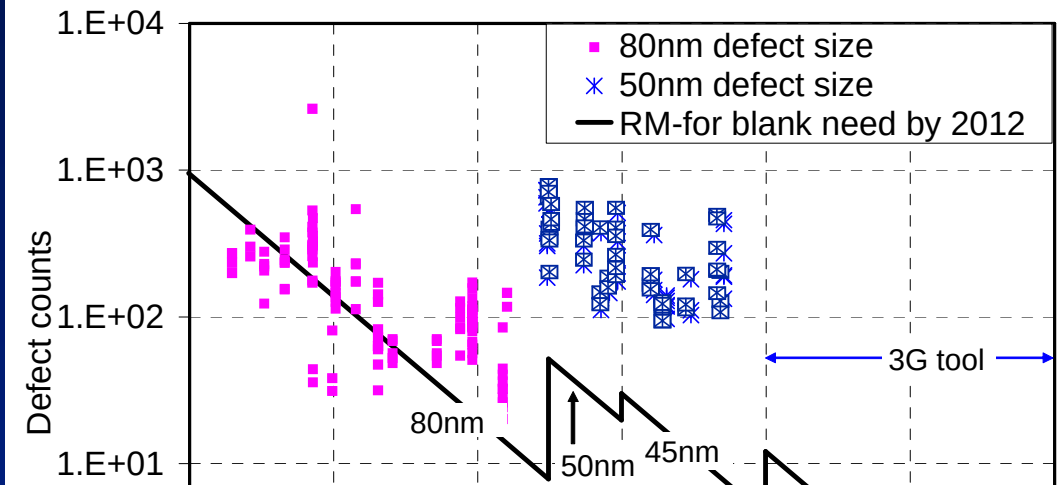
Oct. 22, 2009

#1 Problem for EUV Mask

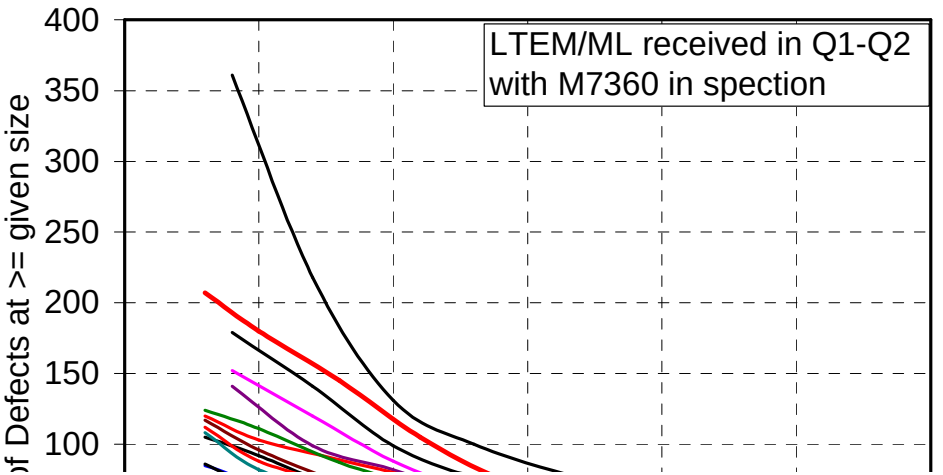
- **ML blank defect is #1 problem for EUV mask**
- **The industry's focus should be to eliminate this problem**
- **The iEUVi TWG work should serve the purpose of facilitating the industry's effort in resolving the #1 problem**
  - Reduce ML defect
  - Render ML defect
  - Mitigate ML defect – for example, fiducial mark

Blank ML Defect Trend

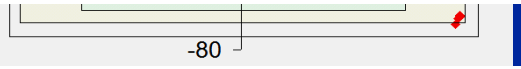
Total defect count



Size distribution



Majority of these defects detected today are printable for 22nm – 16nm hp line and space patterns



Ensuring Defect-free

- **Defect is a difficult ‘thing’ in yielding a mask**
  - Impact of defects on mask is binary – 1 defect kills the mask; there is no statistics here. Huge benefit for defect covering!
  - Impact of non-mask defects on wafer is scalar – defects kill 5% of the dies, you still can have 95% die yield
- **Defect detection must be 100% - at least this is what we want the tool suppliers to deliver**
- **Printability determines defect requirements through focus, not at best focus!!!**
  - Usually expressed in %ΔCD/CD as the criteria

Standardization or not?

- **What will be facilitated by such a standard?**
  - **???**
  - **This should not be a SEMI standard**
- **Can it be standardized?**
  - Printability is specific to device patterns
  - Users define their own defect requirements – pattern specific
  - Users select the tools that best meet their needs
- **It will be helpful, but may not be necessary**
  - Useful for benchmarking by a consortia where members can not share proprietary patterns/specs
  - For example, for inspection and imaging tools benchmarking
  - For example, for blank defects benchmarking

“ We would like to invite you as the panelists for this discussion. Each panelist is requested to present 2-4 pages on the following to stimulate discussions:

1) What specific problems we want to address in the printability study? What defects print on particular patterns at certain criteria

2) What attributes of the test blanks and masks should be addressed? E.g. size, shape, height, locations within stack, locations relative to device features. All of the above

3) What metrology or techniques are needed to support defect characterization? AIMS, SEM, AFM, spatially resolved composition tool for ‘native’ defects

4) The pros and cons of PDM versus native defects: They serve different functions which can not be substituted with each other. PDM - simple, well characterizable, unambiguously measurable, utilized as a reference for tool development and qualification; native – reality check and yield improvement through root cause analysis which can only be done with native defects.

5) What test patterns could be used for pattern defect mask printability? Availability? Patterns relevant to device and sensitive to defects

Two Related Suggestions

- **Define a reference/standard for sizing ML defect: must be measurable, quantifiable by %ΔCD/CD in the worst printability case, available for wide use by blank suppliers, users and tool suppliers**
  - SiO2 sphere-equivalent, SEVD, heigtt x FWHM, etc

- **Replace defect density with total defect count**
  - It was originally used when defects are in 1000s – 10,000s
  - It was used for gauging blank yields for suppliers
  - Now we should transition it to serve the purpose for blank users as a figure of merit per blank: if the defect count is n/blank, can it be used? For which layer? More meaningful.
  - Defect counts per plate is generally used by the mask industry today