

Real-World Printing of EUV Mask Defects

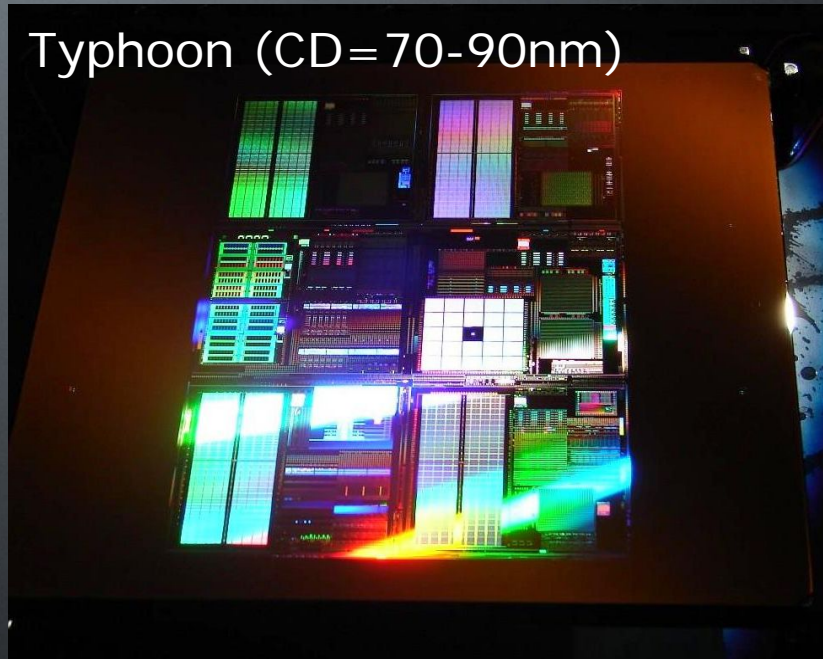
Obert Wood & Bruno La Fontaine

AMD



Defectivity Assessments Test Reticles

- We have focused on blank defects because we believe that any defectivity problem related to reticle patterning should be solvable



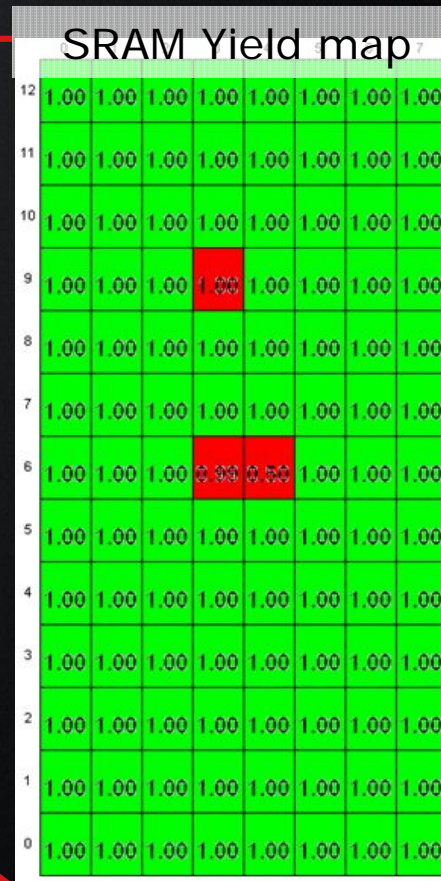
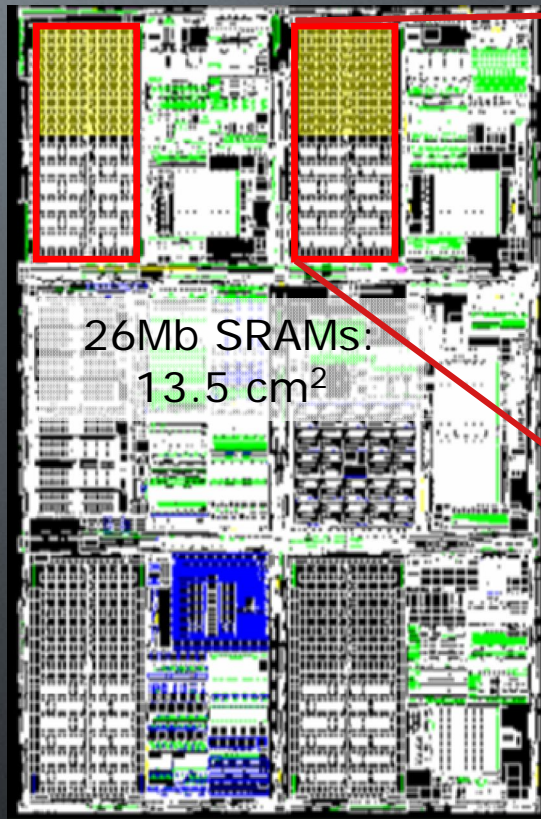
Only ~1-3% of blank defects found to be printable on wafer



~10% of blank defects found to be printable on wafer



Defectivity Learning from Typhoon



Expected a few hundred defects →

Only found a few →

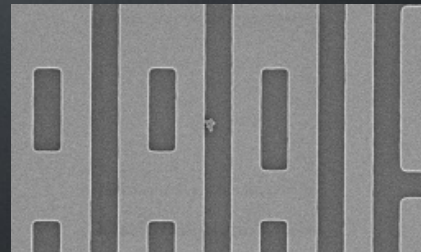
Only a few were electrically critical



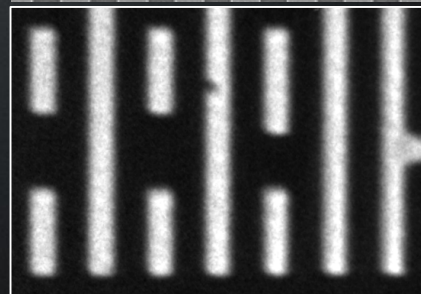
Defectivity Learning from Typhoon

- Possible reasons for discrepancy:
 - Reticle inspection and wafer inspection not sensitive enough
 - Defects on reticle did not print
 - Many defect printed marginally, were not detected, and were not critical electrically
- Example of defects that did not print on the wafer but that were found on the reticle and were clearly visible in the Berkeley AIT

SEM
review of
mask

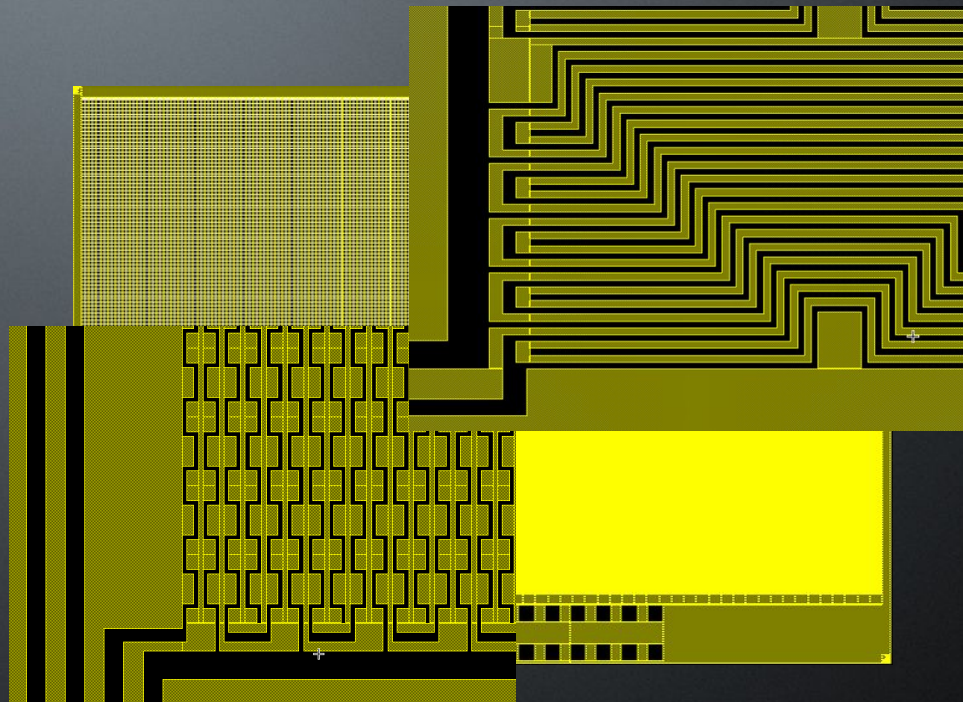


AIT
review of
mask

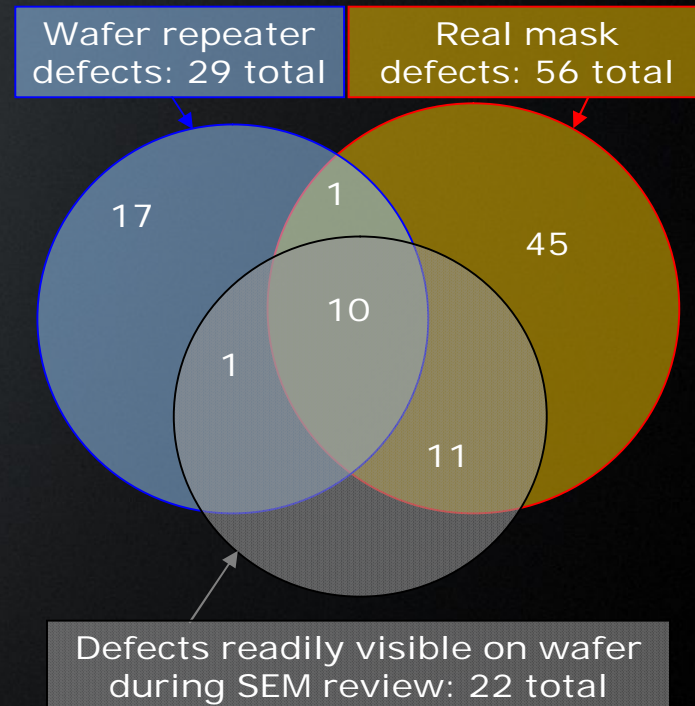


Defectivity Learning from Alpha1

Defect monitor modules
CD = 45 nm



~ 10% of blank defects found
to be printable on the wafer



Density of printable mask defects:
32 def./cm² (4x)

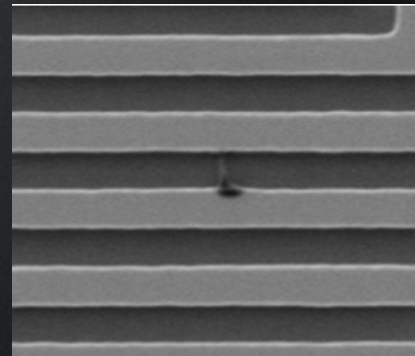
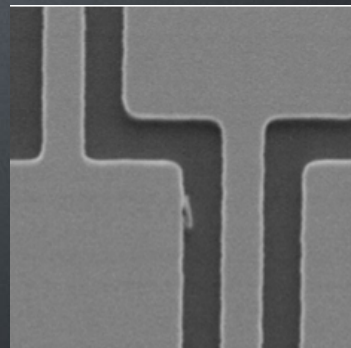
Density of printable blank defects:
~1 def./cm² (4x)



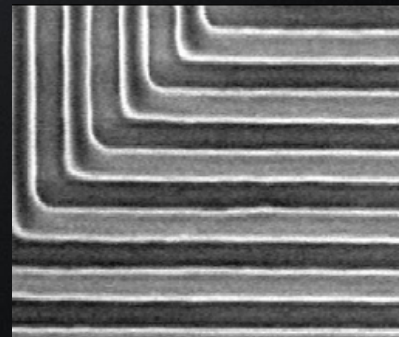
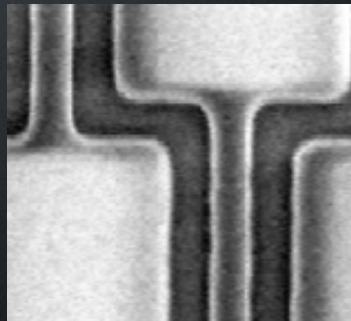
Defectivity Learning from Alpha1

- Examples of defects that did not print clearly on the wafer but were found on the reticle

SEM
review of
mask



SEM
review of
wafer
print



Summary

- Reticle inspection and wafer inspection did not capture all defects
 - Further work is in progress to test optimized recipes and new tools
 - A complementary approach involving inspection of the reticle and inspection of printed wafers is likely to be needed
- Many defects on the reticle either did not print or led only to small variations in printed CD
- Concerns:
 - Will wafer inspection be able to distinguish between a small CD change and ordinary line edge roughness?
 - How do results from printability experiments impact blank specs?

AMD continues to consider EUV mask defectivity to be the most critical issue for EUVL

