DOC & PARTICLES
meten en preventie | Bert van der Zwan

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Text-only start sheets can be added using ‘New slide/Nieuwe dia’
THE DEMAND EXAMPLE IN SEMICON YIELD KILLING DEFECTS CAUSED BY PARTICLES

Particle on a wafer → 1 defective die

Particle on a reticle: → 1 defective die in every printed field

Source: The Art of Defect War, KLA Tencor 2001
Economic sane production requires high yield

Particles cause yield loss

Requirement:
- Defect cause $\Rightarrow$ critical defect size (ITRS)
  - International Technology Roadmap for Semiconductors
- Impact $\Rightarrow$ frequency

Wafers $\Rightarrow$ Particle size: $>8$ nm, PWP: 20

Masks $\Rightarrow$ Particle size: $>17$ nm, PRP: 0.0001

Requirements on masks are tightest
Qualification numbers are provided in the period 2015 - 2016 by the manufacturers of the equipment.

**STATUS JUNE 2016**

**Conclusion**

Current status

- Qualification of cleanliness is required
- Need for particle inspection tools for development of EUV equipment

**CURRENT MASK INFRASTRUCTURE**

- Qualification of cleanliness is required
- Need for particle inspection tools for development of EUV equipment

*Un-Qualified Pellicle tooling*
AIMS QUALIFICATION RESULTS
PS 20NM REQUIRED?

142x142mm is evaluated, i.e. excluding the handling zones. Figure 9 shows the results of this particle test. On the mask frontside quality area 9 adders ≥100nm have been measured, on the backside 6 adders ≥100nm with 1 of them ≥1μm. This corresponds to 0.36 adder/cycle ≥100nm for the frontside and 0.04 adder/cycle ≥1μm for the backside. The current status EUV Reticle Infrastructure. Still a huge gap (0.04 @70nm <-> 0.0001 @20nm) between demand for HVM and availability of clean EUV-RH tools.

Conclusion

Current status EUV Reticle Infrastructure. Still a huge gap (0.04 @70nm <-> 0.0001 @20nm) between demand for HVM and availability of clean EUV-RH tools.
Optical Coherence Tomography
OCT-Time image 25X25 mm
Hoogte dom op 2m in 20 msec

SCAN OCT-Freq.
Res. 1,5 μm 2 min

SCAN RN3
45 nm 90 min

SCAN RN4
20 nm 120 min

SCAN Nearfield
1 nm

145 cm² = 74.000 km²
TNO & PARTICLES IN EUV-LITHO - SOME HISTORY

29 March 2016

TNO developed / build / qualified
• EUV Reticle storage box

• Reticle Handling unit with
  • Load Lock
  • Reticle e-clamp

• Suss EUV Reticle handling unit (incl. Library, Innerpod opener)

• Co-developed the Asys Vacuum Robots
### TIMING & CROSS OVER USE OF GAINED KNOWLEDGE

Table 1: Key targets and challenges for implementation of new patterning options.

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<th>Next-generation technology</th>
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<th>Key challenges</th>
<th>Required date for decision making</th>
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<td>Sub-10-nm hp fins in finFETs</td>
<td>‘5-nm’ node logic</td>
<td>Printing and overlay of cut levels</td>
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<td>2017</td>
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<td>‘10-nm’ node logic extension, 16 nm to 20 nm hp LS</td>
<td>7-nm’ node logic, 19-nm DRAM</td>
<td>Cost due to many masks, Enough throughput</td>
<td>2015</td>
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<td>2016</td>
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<td>DRAM logic</td>
<td>Detectivity, Overlay, Throughput, Template infrastructure</td>
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<td>Maskless lithography (ML)</td>
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<td>Detectivity, Pattern placement, Design, Throughput, Demonstrated, Multibeam tool</td>
<td>2016</td>
</tr>
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</table>

M. Neisser and S. Wurm: ITRS lithography roadmap: 2015 challenges

DSA=Direct Self Assembly
VOORBEELDEN HET TOEPASSEN TNO PARTICLE KENNIS & FACILITEITEN
1-E STORAGE BOX VOOR EUV MASKERS PROJECT VOOR ASML
TNO & Particles

EDX spectrum

Full Scale 2305 cts Cur
GE-ANALYSEERD
• coldformed metal part
• Features << 1mm; resolution 1.5µm
  • Acquisition time 0.2s
TNO PARTICLE
KENNIS & FACILITEITEN

HOE KUNNEN WE MET DOC U VAN DIENST ZIJN?
THANK YOU FOR YOUR ATTENTION

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