Continuing Progress in 450mm Development

October 8, 2014
SEMICON Europa
Key Messages

• Program progress continues with broad Supplier support

• Technical results are excellent with few capabilities identified as challenges

• Wafer supply
  • Initial M1 grade wafers received
  • Notchless wafer standard ballot approved
Development and Technology Intercept Targets

Early 450mm Development

- Early Development of Silicon and Infrastructure
- ISMI 32/22nm Equipment Performance Metrics
- G450C Demonstrations
  - 14nm
  - 10nm / 7nm

Test Wafers to support development, improvement and demo

Tools for Consortium Baseline, CIP and Demonstrations (unit process)

450mm and 300mm tools progress synchronously through technology generations

Likely profile of tool work scope from tool delivery to program completion

Full set (60+) of process and metrology tools and automation

**CNSE – RF / GLOBALFOUNDRIES / Intel / IBM / Samsung / TSMC**
450mm 193i Patterned Wafer
Courtesy Nikon Corporation
Process Capability Data Progress

<table>
<thead>
<tr>
<th>Functional Area</th>
<th>PA / Supplier Combos</th>
<th>Tools meeting Program goal</th>
<th>New 10nm goal not met</th>
<th>Tools projected to have data by year-end</th>
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<td>Wet Process</td>
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EPM Refresh

• Sub-10nm EPM published as of SEMICON West

• Based on the uncertainties of sub-10nm process applications, modified metrics to include various process options
  • “Metal-plug” to replace “W-plug”; “barrier” instead of “Ti/TiN barrier”; “salicide” instead of “Ni salicide”.
  • Modified epitaxy to include possible options beyond SiGe.
  • Include ALD option for various films.

• Instead of planar, FIN/STI structure will be the target structure

• Design rules and aspect ratio: referred but not fully aligned to ITRS roadmap. Modification based upon:
  • Inputs from member companies, suppliers and collaborating consortia
  • “Realistic and achievable” for tool qualification and CIP goals.

Thanks to EEMI450 Partners for Valuable Input!
G450C / EEMI450 / Metro450 Collaboration

• EEMI450 feedback (including IMEC and Suppliers) improved multiple parameters in sub-10nm Equipment Performance Metrics

• Joint planning on ASM furnace demo at G450C and Recif sorter demo at IMEC: standard methods / data exchange
  • Working with Metro450 to address slip measurement
  • Planning contamination analysis by Fraunhofer and TNO

• Planning fabrication of standard calibration wafer with Metro450
Ongoing Facilities / EHS work with F450C

• Pump / Abatement Green Mode
  • Communication network installed
  • Baseline fingerprinting under way

• Utilities use rates, effluent characterization
  • Sensors, data collection system installed

• GHG emissions
  • Expect to begin 4Q14

• He recycling
  • Defining project scope
ASMC 2014

Addressing process gas use rate concern at 450mm that can benefit 300mm!
The notchless standards (M1 & M20) will be completed by October, 2014. The IP issue should be resolved at SEMICON Europa in October.

The notchless transition started already: some tools, e.g. KLA-T SP3 & WS3 and Nikon 193i, can take notchless wafers now.

The primary fiducial mark has been decided at 180° from the notch of re-worked wafers. G450C plans to order up to 3000 re-work wafers.

G450C plans to order up to 700 pure notchless wafers for future usage.

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**Notchless Wafer Timeline**

- Ballot adjudicated and IP issue resolved at Si Wafer Committee
- Order re-work wafers for tool development
- Tool development (e.g. metrology tools) for notchless transition
- Implementation of fiducial mark detection system
- Order pure notchless wafers
450mm Standardization Support

• SEMI Equipment Energy Savings Mode Task Force (aka “Green Mode”)
  • Developing fab-wide control framework → likely 2015 SEMI standards

• SEMI 450mm Physical Interfaces & Carriers
  • Working with ITG-J to eliminate 450mm carrier issues found at G450C

• SEMI Defectivity Subcommittee
  • Working to improve quality of consumables causing sub-10nm defects
  • Starting with ‘O’-rings and valve seals

• SEMI Wait Time Waste Task Force
  • SECS log file data extraction for G450C offsite equipment

• 450mm Component Lift Working Group
  • Component lift guidelines issued
Summary

• 450mm technical results are excellent
• 193i patterning capability demonstrated
• Notchless wafer standard approved
• Program progress continues
• Global collaboration important as ever