Innovative Lithography Solutions for the 450 mm Transition

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Overview

- 450 mm Motivation
- Affordability & Payback
- Success Factors
- Litho Requirements
- Nikon 450 mm Program
- Summary
Demand Keeps Growing

Yesterday: Growth in silicon demand through PC and mobile devices

Tomorrow: The Internet of Things fueling continued demand for silicon

Continued growth for Applications and ICs

Ref: Gartner Q3’13, ITU, ARM

* 10 years growth 2002-2012

Ref: Gartner Q3’13 – CAGR: 5 years 2012-2017
450 mm Motivation

- Combination of scaling and wafer size change needed to drive down costs

Further Cost Decline

Wafer Size change will be needed to maintain Moore’s Law
450 mm: Economics and Technology

Wafer Area +2.25X and Effective Chip Area +2.4X:
Reduces increase in per unit area process costs associated with the technology evolution

Greater Economies of Scale for IC Manufacturing:
Boost property, plant, equipment (PPE) and employee productivity, and reduce associated costs

Stimulate Industry Innovation:
Designers have the chance to think outside of the box

Many Opportunities for Invention and Expanded Industry Collaboration:
Tooling, automation, IC manufacturing processes, green tech, etc.

450 mm is about economics – 30% die cost saving
What Will It Cost?

- $1.4B industry spending to date
- $14B expected development cost – best case

- Must avoid false starts experienced with 300 mm
- $14B spending only achievable through effective industry coordination
- If so, 450 mm has reasonable chance for success
Is It Affordable?

- At $5 per square CM of capacity, fab cost build out favors device makers
- Assuming 3.8% average revenue growth rate for equipment companies, payback occurs 22 years after initial spending
- 300 mm payback took ~ 20 years
- But is this reasonable?
Comparison – Boeing 787 Dreamliner

- A massive, globally-coordinated supply chain effort to design and build – in order to achieve 20% efficiency improvements

- With government support, Japanese companies co-designed and built 35% of the plane
  - Wings: Japan
  - Stabilizers: Korea & Italy
  - Fuselage: USA, Japan, Korea
  - Software: India
  - Doors: France & Sweden

Image courtesy Boeing
Comparison – Boeing 787 Dreamliner

- Program start: 2004
- Development cost: $15B
- Planned first commercial flight: May 2008
- Actual first commercial flight: October 2011
- Plane sales needed to break even: 2150 units
- Net order received (mid 2013): 979 (almost half way there…)
- Boeing manufacturing capacity: 120 (now)
- Estimated year to break even: ~ 2025
- Payback: 22 years from initial funding – sound familiar?

Success or failure?
Successful Transition Management

- Alignment on timing is key
  - Realistic, synchronized roadmaps to ensure sufficient critical mass
  - Pilot line tooling transitioning to HVM systems

- Managing R&D $ and risks
  - Simultaneous development of 300 and 450 mm technology
  - 3D NAND, TSV, new materials, etc.
  - Sharing risk/reward between device makers and equipment suppliers
  - Collaboration on standards, components, etc.

- Importance of G450C:
  - Optimizing timing
  - Cost and risk sharing
  - Collaboration
450 mm Litho Requirements

- Meet both scaling and wafer size transition at the same time
  - Productivity (m²/hr >300 mm) & scaling
  - Cost (< gained productivity)
  - Footprint (optimized)
  - Overlay, imaging, focus, and defectivity meet aggressive scaling roadmap

- Extending 193i, proven core technology, provides solid foundation

- Wafer size transition creates the opportunity to develop innovative technologies to ensure litho meets die cost reduction goals
Opportunities for Innovation

Nikon innovation will meet new process node requirements in either environment

Super High Productivity

Minimized Aberrations
Enhanced Overlay and AF
Source Mask Optimization

Super High Accuracy

Super High Productivity

Cost Innovation

Collaboration
Reliability/Uptime
Productivity & Yield

Advanced Stage
Increased Throughput
Defectivity Reduction
Nikon 450 mm Program

- Customer orders in place

- Advanced litho patterning enabled for G450C in 2014
- 450 mm immersion scanner at Albany in early 2015
- Production tools timed with the market requirements

450 mm innovations will achieve productivity and accuracy requirements
Nikon 450 mm tooling will be ready when the industry makes the transition to 450 mm technology.
Summary

- Motivations for next wafer size transition are present
- Transition requires major investment - particularly by equipment suppliers
- To be successful, we must avoid false starts
- Transition presents opportunity for innovation
- Nikon innovations in immersion extension will meet litho process requirements regardless of wafer size
- Nikon 450mm program will be at the forefront of HVM when the industry is ready

Nikon will be ready when customers are